Automotive Materials Recycle Bibliography

Argonne National Laboratory

Introduction

This bibliography is a compilation of abstracts of papers that discuss automotive recycling issues.

The bibliography is organized in the following sections:

- Recycle Infrastructure
- Design for Recycle
- Legal and Regulatory Issues
- Life-cycle Analysis
- Research Programs
- Substances of Concern
- Disassembly Technologies and Case Studies
- Re-use of Automotive Parts and Subassemblies
- Remanufacturing
- Mechanical Separation Technology
- Thermo-chemical Conversion Technology
- Energy Recovery Technology
- Other Technology
- Advanced Materials Recycle Technology
- Case Studies of Materials Recycled for Auto Applications
- Lightweighting Materials
- Environmental/Energy Benefits

Section 1
Recycle Infrastructure

TITLE:
Recent Developments in Shredder Downstream Separation Processes and Recycling Options for Automotive Shredder Residue

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Infrastructure, shredder processing

AUTHORS/CONTACTS:
V. Sendijarevic, B. Polorski, D. Klemper, and K.C. Frisch, University of Detroit Mercy

ABSTRACT:
Between 10- and 11-million scrap vehicles are being recycled each year in the United States by the automotive shredder industry. Presently, they are able to recover 95% of the ferrous and non-ferrous metals in an automobile, which translates to roughly 75% of the total car weight. However, up to 3-million toms of waste, commonly known as fluff or automotive shredder residue (ASR), are generated and landfilled by automotive shredders every year. In order to increase the efficiency of recovery of both ferrous and non-ferrous metals from the shredded vehicles, many new developments have been made in separation technology in the last few years. This paper describes recent developments in shredder downstream separation processes and recycling options for automotive shredder residue.

REFERENCE:
Recent Developments in Shredder Downstream Separation Processes and Recycling Options for Automotive Shredder Residue
SAE Paper 970663

TITLE:
Assuring the Continued Recycling of Light Metals in End-of-Life Vehicles: A Global Perspective

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Infrastructure, overview

AUTHORS/CONTACTS:
Adam Gesing

ABSTRACT:
This article reviews issues and technologies in recycling, both current and future, with a focus on end-of-life vehicles (ELVs) and their increasing light material content. Discussion includes the issues involved in designing for recycling, the existing global scrap recycling system, and interactions between different types of recyclables and different sections of the global market. A review follows of current scrap recycling technologies and compares the vehicle recycling regulations in the United States, European Union, and Japan. Finally, opinions are presented on useful, and some not so useful, global and local recycling regulations and initiatives.

REFERENCE:
Journal of Metals, Vol. 56, No. 8, August 2004.

TITLE:
How Prepared are U.S. Dismantlers to Meet the EU Directive for ELV Recycling?

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Infrastructure**,** dismantling

AUTHORS/CONTACTS:
Richard T. Paul, Automotive Recycling Consultant, Lear Automotive EEDS Spain S.L.

ABSTRACT:
This paper will present the results of evaluating the ability of U.S. Automotive Recycling Centers (ARCs) to meet requirements equivalent to the recently legislated European Union (EU) Directive on automotive recycling. Data and other available information regarding these requirements are used for an analysis of the status among dismantlers in the U.S. to meet requirements equivalent to the EU Directive and to estimate the performance of the U.S. recycling infrastructures

Criteria used to categorize the performance of U.S. ARC's include:

- Number of dismantlers
- Facility size
- Facility locations
- Ability to meet certification requirements
- Environmental compliance
- Techniques and methods is use
- Equipment in use
- Disposal practices
- Market factors

This analysis provides insight on current levels of performance at ARC's, vehicle recyclability, component reuse, material recycling, vehicle pretreatment and handling of hazardous materials.

REFERENCE:
How Prepared are U.S. Dismantlers to Meet the EU Directive for ELV Recycling?
SAE Paper No. 2001-01-3744

TITLE:
European Assessment of Plastics Waste from End-of-Life Vehicles: Current Situation and Forecast

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Infrastructure, amount of plastics from ELV's

AUTHORS/CONTACTS:
Michel Costes, Jean-Bruno Monteil, Mavel

ABSTRACT:
Approximately 8 million passenger cars are scrapped each year in Western Europe. The European Union policy towards the environmental protection is to increase the recovery of these End-of Life Vehicles (ELVs) over the next twenty years. The European Commission has now approved a draft directive concerning this topic. This draft directive is currently under final discussion at the European Parliament. The objective is to re-use and recover 85% by the year 2005 and 95% by the year 2015.

The assessment of the nature and quantity of plastics recoverable from ELVs is important in order to prepare their optimal recovery. A complete original, complex and reliable model has been constructed. As an entry to this model, a large amount of data has been collected from the databases of several can manufacturers, from the dismantling of vehicles by our company and from various other sources.

As accurate estimate concerning ELVs and plastics generated in ELVs was calculated.

From the numerous conclusions of analysis, the high increase of plastics generated in ELVs rose from approximately 550,000 tons in 1999 to 1,200,000 tons in 2015. The large increase in the use of polypropylene can also be highlighted.

REFERENCE:
European Assessment of Plastics Waste from End-of-Life Vehicles: Current Situation and Forecast
SAE Paper 2000-01-0734

TITLE:
ARA Activities / Country Report USA

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, disassembly, ARA, US

AUTHORS/CONTACTS:
William P. Steinkuller, Automotive Recyclers Association (ARA)

ABSTRACT:
The Automotive Recyclers Association, or ARA, is an international trade association, whose 1,300+ members span 14 countries worldwide. The Association's priority is to further the recycled motor vehicle parts industry by fostering education and development of the industry. through the growth of "our membership.

Most of the ARA membership is comprised of small or family owned businesses, who make their livelihood by dismantling vehicles, categorizing the mostly Original Equipment Manufacturer (OEM) parts, and reselling them to the consumer and wholesale customer at a substantially lower cost than new OEM parts. Tools such as the Internet and e-commerce have allowed these businesses to sell parts to customers all over the globe.

Many seem to be under the impression that automotive recycling is a relatively new idea. This is not the case. ARA alone has been in existence for over 58 years. Another area where some people may be misled is on a simple definition of what our industry does. Often, when someone speaks of vehicle recyclability, it usually means the percentage of the vehicle materials that can ultimately be recycled. The common definition within the industry, however, is based on the principle that recycled parts mean OEM parts removed from a disabled vehicle, which can be resold to a new customer for installation into a vehicle that is still operational. Our view of Recycling is that Recycling is equal to reuse, rather than a waste issue. This is supported by industry history as well as environmental practicalities.

The industry in the United States is currently experiencing significant readjustments. There are 4 major areas of change: Environmental issues, Business consolidation, Competition and Certification.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Treatment of Shredder Residues as Part of a Fully Integrated Car Recycling System

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, Germany

AUTHORS/CONTACTS:
Manfred Fahrner, R-plus Recycling GmbH, Heilbronner Strasse 13, 75031 Eppingen, Germany

ABSTRACT:
R-plus Recycling GmbH is a recycling company based in Baden-Württemberg, Germany and has been formed in 1998 as the result of the merger of several small companies, some of which were founded already in 1947.

Today we are part of "U-plus Umweltservice AG" {1), a holding company in which "EnBW Energie Baden-Württemberg AG" (2) has grouped its environmental activities.

At 2 locations in southern Germany we recycle among other products end-of life vehicles, electric and electronic waste, consumer goods scrap.

We were among the first companies in. Germany to install a large shredder, to recycle televisions, monitors and cathode ray tubes Today we are the only German recycling company to treat all electric and electronic equipment, from refrigerators containing CFC's to appliances containing asbestos, also production waste from suppliers to the automobil industry.

The emphasis of our development has always been to invest in technology, to move away. from a manual to an automated, mechanical process. Today we see ourselves as one of the important participants in the German market.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Steel Scrap from ELF: A Valuable Secondary Ore Material for the Steel and Zinc Industries

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, SIDMAR, steel recycle, Belgium

AUTHORS/CONTACTS:
Norbert Prüm, SIDMAR N.V., ARBED Group, Belgium

ABSTRACT:
In the second half of the last century consumers, in the Western Countries, added to their welfare expectation a desire for sustainable development. They no longer accept the uncontrolled exploitation of raw material sources and the disposal of end-of-life products. The raw material sources are limited, as is the capacity of the environment to absorb waste. There is a shortage of landfill.

The European Union has responded to the consumers sustainable development expectation by introducing legislation governing the end-of-life vehicle (EL V).

The main objective of this European Directive is to reduce the depletion of resources and reduction in landfill by promoting the reuse, recycling and recovering of the EL V components. Motor vehicles brought onto the market after 2005 must be recoverable or reusable to the extent of 85 % by weight and from 2015 by 95% by weight.

The automotive industry, which must comply with the end-of-life vehicles Directive, firstly increased the lifetime of the motor vehicle, by for example, the use of zinc coated steel and secondly by studying material choice with a view to the complete recycling of the vehicle body.

Although most of the materials taken alone will in the future be recyclable, the recycling of mixed materials can pose problems.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Swiss Solution for the Elimination of RESH

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, VSAI, Switzerland

AUTHORS/CONTACTS:
André Arnaud, Association of Swiss Automobile Importers (VSAI), Switzerland

ABSTRACT:
In the early 90th the Swiss automobile importers - representatives of the automobile manufacturing industry were confronted with two developments requiring special attention.

1. New federal rules were introduced with the aim of terminating the "landfill"-method for the elimination of shredder residue (RESH) from old motor vehicles as of 151 February 1996. No practical information was given on how the goal could be achieved. This for the simple reason that nobody knew how it could be done. The original idea was that all the material contents of a vehicle should be recycled, i.e. all the parts should be re-used in some way.

2. We heard that the European Community was planning and looking for a general solution for the elimination of old vehicles. The responsibility and financing of such a new elimination system was intended to be borne by the manufacturers. Much stronger than in Switzerland the general idea .was that all the parts should be recycled or at least a portion of about 85 to 95 %. A further element for appreciation was the increasing price for landfill, the decreasing prices for scrap and as a consequence the problem of the survival of the shredder.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
The Practical Realisation: Current Situation in Switzerland and Experience with New Technologies

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, IGEA-Foundation, Switzerland

AUTHORS/CONTACTS:
Federico Karrer, Foundation for the environment - friendly disposal of motor vehicles (IGEA), Switzerland

ABSTRACT:
The year 2000 was the first one in history, when we incinerated 100% of SR (Folie 1 SR = Shredder Residue). Switzerland is the first country in the world, which incinerates now 100% of SR. I continue to talk from now on only of SR and no more of ASR automotive shredder residue. Different studies are showing that after all almost 40% of SR is coming from other materials than ELV (end of live vehicles). Our regulations forbid since February 1996 the land filling of hazardous waste. By the way. since January 2000 we also have to incinerate all of our municipal waste. Last but not least I have to mention that - as far as I know - Switzerland is the only country that has a foundation that pays to the shredder companies 80% of the incineration expenses of the SR from EL V. The 20% - a shredder company still has to pay by itself - are corresponding to the original cost for land filling. The IGEA-Foundation contributed last year the amount of over 15 millions of Swiss Francs to the shredder companies.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
The Value of Recovered Material and of Shredder Residue: Material Specifications and the Recycling Market

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, cost analysis, materials recovery

AUTHORS/CONTACTS:
Alexander Stuecheli, Zurich University of Applied Sciences, Winterthur (ZHW)

ABSTRACT:
The importance of considering more carefully the specifications for automobile material is demonstrated by going into some details: The type or grade of up-to-date steel and aluminum material is given. At the same token, the second most-commonly used automotive material, plastics are listed.

The metal recovery of one of the most modem shredder companies (HURON VALLEY STEEL CORP.) with its sophisticated sink-float and eddy-current separation system is explained and the difficulties to separate the various metal grades. Chemical composition limits of various material grades of e.g. aluminum makes obvious that metal recycling includes some downcycling.

By giving sources of information for scrap specifications as well as base prices for metal scrap, primary metals and a price watch of waste plastics and commodity plastics, the market or money factor is brought into discussion. It is believed that this aspect is hardly ever discussed in depth, and that the consequences for the small- and medium-sized enterprises are not faced. It is believed that recovery of plastics from ELV will never pay, and from the point of view of the life-cycle of a car, material recovery is less efficient than energy recovery: Incineration of all plastic material, Le. the shredder residue is the reasonable recycling solution.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 12-14, 2003.

TITLE:
A Monitoring Report on Automobile Recycling in North America

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, US

AUTHORS/CONTACTS:
Richard T. Paul, Automotive Recycling Consultant

ABSTRACT:
This presentation will discuss the results of evaluating the North American automotive recycling infrastructure and calculating vehicles processed, materials recycled, parts reused and shredder residue landfilled. Data and other available information regarding these procedures and material volumes will be used for a report on monitoring vehicle recycling. Monitoring of vehicle recycling, reuse and recovery is important to governments, vehicle manufacturers, suppliers, material recyclers, dismantlers and shredders. Monitoring serves to verify materials diverted from landfill, recycling rates of a high volume consumer product and can be used to ensure compliance with regulatory requirements. Although N. America has no single comprehensive, automotive specific law similar to Europe or Japan, there are myriad federal, state and local regulations which require vehicle pretreatment, fluid collection, separation of selected materials of concern and landfill restrictions.

This analysis will provide insights on current levels of performance at N. American automotive recycling centers, vehicle recyclability, component reuse, material recycling, vehicle pretreatment and handling of hazardous materials.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 12-14, 2003.

TITLE:
Do Closed-Loop Recycling Quotas Help Vehicle Recycling? The Example of Steel

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, steel

AUTHORS/CONTACTS:
Philippe Russo, Jean Pierre Birat, Norbert Prüm, Michel Tuchman, Bernard Gros
Arcelor, Maizieres-les-Metz, Paris-La Defense & Luxembourg

ABSTRACT:
In the early 1950s, the growth of the car industry in North America raised the question of dealing with End-of-Life Vehicles (ELV). The first solutions that emerged consisted in landfilling including in dams, but, because of their high iron content and because of the increasing demand of steel, recycling rapidly became the logical solution. This is the reason why, between the 1950s and 70s, the shredding process developed in all industrial countries, providing a more economical and environmental friendly solution than the previous practice.

Thus, long before the European El V directive was written, but premonitorily in accordance with it, a sustainable market arose for the ferrous fraction of shredded cars outside the steel industry, generating profit and creating market value. No ferrous materials arising from ELVs were landfilled anymore.

Nowadays, most of the shredded scrap is recycled in long product and alloyed steels, because the Electric Arc Furnace is the cheapest route to produce such steels. They also accept a small amount of tramp elements such as copper, which remain sometimes in market scrap. 30 % of the steel used in a car, namely the mechanical parts, already originate from the recycling of end-of-life goods. The other 70 %, namely the car body, are made of steel produced from 80 % iron ore and 20 % scrap, for several economic reasons, an important one of them being the fact there would not be enough market scrap available to feed this route.

Recycling car bodies in a closed-loop would nevertheless be possible: this has been demonstrated at the CTRA (Technical Center for Steel Recycling) using optical sorting devices; dezincing technologies may also be required. But these technologies bring additional costs and this scrap is needed for producing long products and alloyed steels.

There has been a market for end-of-life ferrous products for historical times, because steel is indefinitely recyclable. Iron ore is also still used, because steel demand has been increasing in the World. In such a context, the Steel Industry has optimized its use of iron units to produce a high technology product with at a steadily decreasing price.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Application of Recycled Plastic Materials in Vehicles

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, Opel, Germany

AUTHORS/CONTACTS:
Jörg Seide, General Motors Europe, Germany

ABSTRACT:
Adam Opel AG has dedicated itself to follow a strict guideline on how to treat and meet environmental challenges and targets. We based these guidelines on our social responsibility for nature, health, and the protection of resources. These guidelines are one of our pillars for a sustainability strategy.

By adopting such a strategy, OPEL set the following targets:

- embrace product development and production from an encompassing point of view
- avoid environmental pollution across the whole product life cycle

Our environmental guidelines are an essential part of our corporate policy. They impact our products and production, define environmental protection as a managerial task, and challenge everyone to improve the already achieved results continuously.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Results of a Cost Analysis of ELV Industrial Treatment in France

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, France

AUTHORS/CONTACTS:
Eric LeCointre, French Agency for Environment and Energy Management (ADEME), France

ABSTRACT:
In France it is estimated that around 80% of the average weight of EL Vs (end-of-life vehicles) is currently recovered, by organisations whose activities are self-financing:

- Dismantlers : between 2 000 and 3 000 operators, of whom between 900 and 1 200 have obtained operating permits.
- Dealers and distributor networks.
- Shredders: around 40 plants belonging to twenty or so companies, with the largest (CFF Recycling) handling two thirds of national shredding capacity.
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In France, publication of the act concerning construction of vehicles and disposal of EL Vs, making particular provision for handing EL Vs to approved dismantlers, or collection facilities set up by manufacturers, as well as the free take-back of EL Vs by operators, could destabilise the economic balance of the industry.

Against this background, ADEME (French Agency for Environment and Energy Management) wished to establish an objective analysis of the economic situation within the industry in France, based first on cost analysis, and its predicted development in the short and medium term.

This study was commissioned and financed by ADEME. Following a tender, the project was awarded to ERNST & YOUNG. The initial phases of the study were devoted to a functional analysis of the costs and revenues of each sub-system of the EL V industry, essentially dismantling and shredding. Work focussed on the development of a tool, which was subsequently used for compiling the data collected on site from a sample of 25 dismantlers and 5 shredders. The selection criteria for this sample were defined with the Steering Committee for the study.

Subsequent phases of the study initially dealt with analysis of the compiled data, the determination - in collaboration with the Steering Committee - of key factors in the development of how the industry deals with ELVs.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Depolllution and Dismantling Costs in Application of the European Directive – Situation in Belgium

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, Belgiium

AUTHORS/CONTACTS:
Frédéricq Peigneux, COBEREC – Belgian Confederation of Recovery & Recycling, Belgium

ABSTRACT:
The Belgian Federation of Ferrous and Non-Ferrous Metals Recovery Companies, member of COBEREC, had to cope a few months ago with the problematic of determination of the cost for depolluting and dismantling of EL V. This happened in the context of discussions with car manufacturers. These discussions were launched in the very first steps of the negotiation round for a new "voluntary environmental agreement" that would be the basis for the EL V collecting and treatment system in Belgium, monitored by FEBELAUTO.

In order to give fair economic information, COBEREC made an interesting exercise by collecting economic, technical and administrative data at depollution centres managed by recovery and recycling professionals.

This presentation gives, throughout the content of this cost analysis, a clear message to the different sectors involved in the "ELV story" . The recovery and recycling industry is able to produce, through its federation and beyond the personal interests or approaches in managing a company, an economic and well- founded analysis, that fully follow and answer the legislative requirements on EL V depollution and dismantling operations. This should reinforce the necessity to discuss, with all the partners, the future of EL V treatment systems.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Harmonizing Car Dismantling, Recycling and Remanufacturing, Enabled by Best Available Technologies and Networks

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, remanufacturing

AUTHORS/CONTACTS:
Dr. M. Hieber, Fraunhofer - Institute for Manufacturing Engineering and Automation (IPA)

ABSTRACT:
The disposal of end-of-life vehicles (EL V) will soon undergo a fundamental change. The impacts on the environment are hard to assess, especially with regard to light-density automotive shredder residues (ASR), which are at present almost exclusively disposed of on landfills. Changing materials in cars and the increase of registration figures will make assessments even harder. Reducing and avoiding influences that are harmful to the environment, in particular ASR, is the primary goal of the future disposal of EL Vs, and has already been included in the EC's Directive on end-of-life vehicles.

The given requirements can be met by combining the dismantling process with a post-shredding treatment. The reduction of materials to be disposed of will create new markets which need to be developed first. In view of that, today's production, distribution and disposal processes have to be redesigned adjusted and linked in an ecoefficent way.

Another leverage point for minimising the environmental impacts is to establish new treatment and recovery technologies. Some of the new treatment and recovery techniques have not yet become state-of-theart, but are available in pilot systems or as pilot studies.

Reverse logistics is necessary to efficiently close the product life cycles in car recycling. The disposal infrastructure in car recycling has quickly developed over the past years. It consists not only of approx. 1,100 car dismantlers and 5,000 collection points, but also includes the used car and used parts markets, specialised disassembling (dismantlers), 47 shredding sites, metallurgical plants, etc. . The waste collection logistics (Le. the flow of substances from collection and acceptance facilities to EL V dismantling and recycling facilities) is completely done by truck.

The obligation to dismantle glass and plastic parts envisioned in the EC's EL V directive will probably direct big enough material flows onto the market to enable the recycling of materials that so far have been mainly disposed of on landfills.

The above-illustrated model of a “decentralised dismantling/decentralised treatment (only shredding) and centralised treatment process" provides a possible solution based on the availability of facilities and the use of synergies, and considers the logistical expenditure.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Why Recycle? Demand Driven Recycling of Engineered Thermoplastics

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle infrastructure, B&M Plastics, U.S.

AUTHORS/CONTACTS:
Richard W. Kaskel Jr., B&M Plastics, Inc.

ABSTRACT:
Large-scale change, as we all know, can be very difficult. Successful change, whether reactive or proactive, normally requires both the willingness to change (fuel) along with the ability to change (engine). .

Successful recycling efforts require vision, commitment, energy and strength. As with all change, for engineered thermoplastics change to recycling will have to be based on solid environmental and economic foundations.

On a global basis, not national or state, we are facing many environmental issues, including a depleting ozone layer, acid rain, global warming, and perhaps most visible... ... pollution and solid waste generation.

This paper focuses on recycling plastics, specifically, a new demand driven approach to recycling of engineered thermoplastics. I will share with you what I believe is required to profitably recycle ETP's, and how we at B&M are doing just that. I will attempt to dispel a few of the misperceptions of recycling engineered thermoplastics as well as discuss what is driving recycling plastics today, and what the drivers of tomorrow will be.

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
ELVS: How They Fit in the Global Material Recycling System and with Technologies Developed for Production or Recycling of Other Products and Materials

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle Infrastructure

AUTHORS/CONTACTS:
Adam J. Gesing
Gesing Consultants Inc.

ABSTRACT:
The -50 million vehicles produced worldwide in 1995 are due to be scrapped as end-of-life vehicles (ELVs). These will supply nearly 60 million tonnes of reusable components and recyclable materials. They also will supply -17 million tonnes of nonmetallic shredder residue (SR), which currently is not recycled and ends up mostly in alternate daily landfill cover (ADLC). In both EU and North America (NA), landfill regulations require a daily cover for municipal solid waste, which in NA alone is over 300 million tonnes. ADLC could easily consume this small amount of nonmetallic SR.

EU directives, however, require recycling or "recovery" of nonmetallic materials from the ELV. This means diversion of materials from ADLC to either secondary raw materials or conversion to a lower volume of ash in waste-to-energy (WTE) incinerators. The directives place the responsibility for achieving these goals on vehicle manufacturers, who are not experts in material extraction, minerals processing, or bulk material handling. Over the last decade, vehicle manufacturers, often funded by governments, have focused on developing technologies for recycling of materials from ELVs into vehicle components, often ignoring previous work and existing technology in scrap recycling and in other industries.

Manufacturers have responsibility and interest only in the recycling of their own products. However, products and their components are only "recycled" as components for "reuse and re-manufacture." Eventually one needs to recycle or recover value from end-of-life (EOL) materials. Materials are used across a range of products from many manufacturers in several industries. A product can contain several attached or bonded materials; a material can be a composite containing fillers and reinforcements, or an alloy of several metallic elements or polymer resins with additives, plastizers, fire retardants, etc. The ELV is a prime example of a complex assembly of thousands of individual components representing hundreds of various, often permanently bonded, materials.

Mechanical disassembly of components for reuse is more than justified by the market value of the remanufactured component. The material values are significantly lower than those of components or subassemblies; additional manual disassembly down to the individual materials costs more than their market value. After ELVs are de-polluted and stripped of marketable components, the resultant hulks are flattened for cost-efficient storage and transport; no further manual disassembly is feasible. Flattened hulks are shipped to the gateway of the true material recycling system - the steel shredding plant.

Steel shredding plants were built by the scrap processing industry before car recycling became fashionable in response to the demand for steel scrap for the electric arc furnace - the mini-mill steel production process that revolutionized steel production in the latter part of the 20th century.

Development and subsequent recovery of other metal scrap came before environmental concerns targeted recycling, and before the concepts of "polluter pays" and "manufacturer is responsible" were codified in EU regulations, to be copied by the rest of the world. The current material recycling system, how it serves the ELV, how it should be expanded to recover value of still nonrecycled materials, and how regulations both help and hinder this process, will all be explored.

REFERENCE:
Proceedings of the 6th International Automobile Recycling Congress, Amsterdam, Netherlands, March 15-17, 2006.

TITLE:
Integrating ELV Management into Late Model Salvage Operations

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle Infrastructure

AUTHORS/CONTACTS:
Joseph Holsten, CEO, LKQ Corporation, Chicago, Illinois USA

ABSTRACT:

In the United States, like all other nations, the industry of Automobile Recycling was born when the first motor vehicles were produced. Motor Vehicle Recyclers are one of the very first true Recyclers in the industrial age. Although recycling is predominantly associated with environmental responsibility in the form of recycling aluminum cans and waste paper products, Motor Vehicle Recyclers have been providing one of the most basic forms of recycling for over a hundred years: Reuse. Reuse has to be the ultimate form of recycling - it saves material, energy, and money, and conforms to the most desirable hierarchy of environmental management - reduce, reuse, and recycle.

Today, the Automotive Recycling Industry is growing both in the number of vehicles being processed and in gross revenues, but not in the number of businesses that are operating as legitimate Vehicle Recyclers. In fact they are decreasing. For now, I want to take a quick look at the latest figures we have been able to obtain from the U.S. Census Bureau for 2002. Later in my presentation I shall cover the make up of the industry in greater detail.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands,
March 9-11, 2005.

TITLE:
EMS: The Belgian End-of-Life Vehicles Monitoring System

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle Infrastructure

AUTHORS/CONTACTS:
Catherine Lenaerts, FEBELAUTO, Belgium

ABSTRACT:
Based upon 3 years of experience with the first version, the Belgian monitoring organism Febelauto has developed a new EL Vs monitoring system (EMS).

This internet enabled application offers a complete solution covering functionalities as e.g. the de-registration of the EL Vs and the printing of the certificate of destruction but also the management of all treated materials. Moreover, the application allows the continuous monitoring of the mass balance and the on-line calculation of the recycling targets of each authorized treatment facility and as a result also the consolidated figures by country.

The advantages of the internet based application are evident: a centralised management (maintenance, updates, bug handling...) avoiding local system configuration.

Every European member state is considered to provide information.
Current application can support countries or monitoring organisms by providing accurate data and reports so that they can meet the approaching deadlines.

Since Febelauto wants to share best practices, it therefore will demonstrate its new application. The methodology of EMS is conform with the Belgian regional legislation and as well with the 'Commission decision laying down detailed rules on the monitoring of the reuse/recovery and reuse/recycling targets set out in Directive 2000/53/EC of the European Parliament and of the Council on end-of life vehicles' .

EMS deals with real and representative data provided by all authorised treatment facilities, due to the shared responsibility of all operators involved with the treatment of EL Vs, a principle that has been established by the Belgian legislation.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands,
March 9-11, 2005.

TITLE:
Establishment of Complete Treatment System of Recyclable Materials Generating from Home Appliance Recycling Plants at Mitsubishi Materials Corporation

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle Infrastructure

AUTHORS/CONTACTS:
T. Sakai , S. Yamaguchi

ABSTRACT:
Home appliance recycling law was put into force in April 2001 in Japan. Specified kinds of home appliances, such as air conditioners, television sets, refrigerators and washing machines, should be recycled according to the law. Mitsubishi Materials Corporation (MMC) in cooperation with home appliance manufacturers is operating five home appliance recycling plants in Japan. MMC established complete treatment system of recyclable materials generating from home appliance recycling plants, which is formed by unique collaboration among home appliance recycling plants, copper smelter and refinery, and cement plants. Recyclable materials containing copper and precious metals are only handled and treated within the MMC group. By using this lock-in system, safe treatment and traceability of materials are guaranteed as 100% materials recycle.

CONCLUSION:

REFERENCE:
Proceedings of the TMS EPD Congress, 2008.

TITLE:
Effect of Global Trade on Recycling and Recycling Technology

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle Infrastructure

AUTHORS/CONTACTS:
W. Dalmijn

ABSTRACT:
This paper explores the complex interrelationship between the resource cycle, recycling and metal production as a function of economics, environmental legislation, and product design. It is argued that central to optimizing this resource cycle lies the control in particular of physical separation plants by the application of advanced sensor technology and sorting equipment as well suitable control and sampling algorithms supported by optimizing mass balance models. Keywords: Recycling, resource cycle, feed forward control

CONCLUSION:

REFERENCE:
TMS EPD Congress, 2007.

TITLE:
The Success of Vehicle Recycling in North America

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle Infrastructure

AUTHORS/CONTACTS:
R. Paul

ABSTRACT:
This paper will discuss the results of evaluating the North American automotive recycling infrastructure and calculating vehicles processed, materials recycled, parts reused and shredder residue landfilled. Data and other available information regarding these procedures and material volumes will be used for a report on the success of vehicle recycling. Vehicle recycling, component reuse and metal recovery is important to governments, vehicle manufacturers, suppliers, material recyclers, dismantlers and shredders. The highly efficient car recycling infrastructure serves to divert materials from landfill and recycle metals from a high volume consumer product and serves as an alternative source of low cost components for repair of vehicles that might otherwise be taken out of service. Although N. America has no single comprehensive, automotive specific law similar to Europe or Japan, there are myriad federal, state and local regulations which require vehicle pretreatment, fluid collection, separation of selected materials of concern and landfill restrictions.

CONCLUSION:

REFERENCE:
TMS EPD Congress, 2007

Section 2
Design for Recycle

TITLE:
Optimization of Instrument Panels to Assist Recycling Quota – Dismantling/Mechanical Recycling vs. ASR Treatment/Chemical Recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Design for disassembly/recycle

AUTHORS/CONTACTS:
Frank E. Mark, DOW Europe
Christian Niewerth and Gerhard Slik, DOW Automotive

ABSTRACT:
The European ELV directive will demand from the automotive industry an 85% reuse and recycling quota met by 2015. New Vehicle registration requirements will force the industry to show already beginning 2005 for new vehicles how this can be done in principle. Methods for calculation the overall vehicle reuse and recycling quota will be defined and agreed within the automotive industry today.

This very high reuse and recycling quota of 85% for the complete vehicle forces the OEM and the supply industry to reach a target level for recycling of plastics, which is higher than legislation, has set targets in other market sectors. All large plastic parts are assessed how and to what extent they can contribute to the target

The Instrument Panel (IP) as manufactured today is probably the most challenging part in an ELV to recycle. But new design solutions, material concepts and recycling strategies are working toward this 85% target. Design of a future IP takes into account all essential criteria in the manufacturing like parts consolidation etc. and the “de-manufacturing” process (dismantling, logistics, recycling, etc.).

The all PP IP design concept has been deliberately chosen due to the large cost reduction potential in the manufacturing step. The requirement to meet the 85% reuse and recycling target should be met at the lowest compliance cost, which does include the de-manufacturing.

In this paper the “de-manufacturing” chain will be presented under different scenarios like integrated with other materials or not integrated plastic dismantling concepts. The economic analysis was carried out for a combined recycling and recovery IP approach using today’s facilities of different industries like ELV dismantling and polymer recycling to optimize overall existing intra structure. Product applications for the recycled materials are also addressed.

REFERENCE:
Optimization of Instrument Panels to Assist Recycling Quota – Dismantling/Mechanical Recycling vs. ASR treatment/Chemical Recycling
SAE Paper No. 2001-01-3741

TITLE:
Design for Recycling as Integrated Engineering Tool

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Design for recycle, analysis tool, Netherlands

AUTHORS/CONTACTS:
Ir. M. T. H. Peters, PD&E Automotive B.V., Helmond, The Netherlands

ABSTRACT:
Selective dismantling of materials from end,-of-life vehicles (EL V's) clearly helps to reduce the environmental impact. In order to reach a more efficient dismantling operation, vehicles and components must be designed for recycling right from the start, or existing products must be redesigned.

In order to achieve this, PD&E Automotive uses Design for Recycling as an integrated engineering tool in the development process. Through a combined , application of Function Analysis, Design for Assembly, Design for Environment and Failure Mode and Effect Analysis in the development process, well-balanced engineering solutions are obtained, in many cases at increased functionality and reliability as well as at reduced costs.

PD&E Automotive BV., formerly Netherlands Cars' Product Design and Engineering centre, develops automobiles for, among others, Volvo Car Corporation and Mitsubishi Motor Corporation. Today PD&E Automotive offers its services to the market as an independent contractor.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Analysis and Assessment of Automobiles with Regard to the Requirements of Design for Recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Design for recycle, FORGIS, analysis

AUTHORS/CONTACTS:
Joachim Boes, FORGIS, Germany

ABSTRACT:
The Forschungsgemeinschaft für Integrierte Systemlösungen (FORGIS) has developed from the Recycling Technology (RCT) working group set up. in 1991 by Prof. Dr.-Ing. Wolfram Seibert. FORGIS is organized into four areas and handles industrial projects dealing mainly with the following.
Environmental engineering, vehicle technology and quality engineering.

The car manufacturer has to find technical solutions within statutory regulations (KrWg, AAVO, EU Directive ELV, etc.), which cover not only existing technical requirements but also ecological aspects. This is all the more so because in future the verification of suitability for recycling of the vehicle, and thus also of the vehicle systems, will become part of the homologation.

Car manufacturers are increasingly including in their specifications requirements regarding the ecological aspects of the product As part of product responsibility, these requirements not only contain a demand for the recyclability of the product but also for a logical, comprehensive recycling concept and for statements regarding take-back guarantees and financial consequences with respect to the recycling of products.
This not only increases the area of tension between engineering, ecology, economy, politics and society in which the manufacturer/supplier develops his products, but also ecology is increasingly relevant for competition and carries with it increasing risks with regard to product responsibility.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Process and Tools to Support Design for Environment at Mercedes Car Group

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Design for recycle, Mercedes

AUTHORS/CONTACTS:
Klaus Ruhland, Dr. Matthias Finkbeiner, Stephan Griesser, Rudiger Hoffman; DaimlerChrysler, Mercedes Car Group / Development, Design for Environment, Germany
Marc Binder, Hartmut Schoch, Dr. Thorsten Volz ; PE Europe GmbH

ABSTRACT:
Mercedes-Benz at DaimlerChrysler has been developing and applying Design for Environment (DfE) since almost 10 years. Extensive experience and know-how has been gained by several complete car LCAs, more than 100 LCAs for parts and Recycling studies for all new cars. According to our experience Life Cycle- and Recycling assessment is most effectively and efficiently used to support the development of new products.

The concept and implementation of Design for Environment at Mercedes-Benz will be introduced.
Both, concept and implementation are the result of several years of development. Nowadays, DfE is established as common practice and fully integrated in the Mercedes-Benz Development Process. The parameters assessed during the development process include hazardous materials, use of recycled materials, use of renewable materials and others.

The main aspects of the DfE process are LCA studies on the complete vehicle and part level as well as Dismantling- and Recycling examinations for complete cars and new material concepts. To handle all the relevant information software support is indispensable. One focus of the paper will be a new approach to integrate the LCA and Dismantling/Recycling views into one common software solution.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Chances and Limits of Design for Recycling. View on Current Development.

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Design for Recycle

AUTHORS/CONTACTS:
W. Hang, G. Koenn, G. Wörle
BMW AG, München

ABSTRACT:
As early as1989 the first project group on end-of-life vehicle recycling was established within the BMW Group. At this time there was little specific information on recycling properties of vehicles and the end-of-life vehicle recycling process was little. Consequently one of the prime task of this project group was initial research. For this purpose BMW established a Pilot Dismantling Plant in Landshut. In depth dismantling analysis and process studies were carried out. Soon two main areas of responsibility were identified:

1. The introduction of "Design for Recycling" in the design of products to ensure that vehicles are prepared appropriately for recycling at the end of their lifetime;

2. The need to physically take back the product from the customer and recycle it.

The BMW Group has taken initiative on both subjects in parallel and continued research work in the Pilot Dismantling Plant. For the physical take back the first recycling partner was contracted in 1992. Today mainly small ahd medium sized enterprises cooperate with the BMW Group and form the backbone of recycling networks in most of the EU member states.

For the physical take back of end-of-life vehicles two subjects were highlighted:

- The recycling industries' demand for information on product properties and

- The necessity to establish appropriate quality criteria for the selection of recycling facilities.

Both subjects can be found within the European directive on end-af-life vehicles today.

REFERENCE:
Proceedings of the 6th International Automobile Recycling Congress, Amsterdam, Netherlands, March 15-17, 2006.

Section 3
Legal and Regulatory Issues

TITLE:
Elimination of Shredder Residue: The Swiss Approach

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, Switzerland

AUTHORS/CONTACTS:
Daniel Christen, Director of IEEA
Foundation for the environment-friendly disposal of motor vehicles

ABSTRACT:
The Foundation for the environment-friendly disposal of motor vehicles was set up by the Swiss automobile importers in 1992 with a view to organizing the disposal of automobile shredder residue (ASR) in compliance with the relevant standards. In our view, ASR from the shredder process represents the biggest volume of environmentally-relevant material accruing from the disposal of end of life vehicles (ELV). Dumping is not a clean method of disposal! We therefore take no little pride in pointing out that Switzerland is the first country in the world to dispose of all shredder residue by thermal processing. Between 1996 and the present day, over 250,000 tonnes have been eliminated in municipal waste incineration facilities. However, we still do not satisfy the particularly stringent Swiss specifications for slag quality. A special installation for slag vitrification is needed. This is the only way of ensuring that the heavy metals present in the shredder residue are reliably protected against elution.
As we reported to last year's 'congress, two technologies enabled successful experiments to be conducted with 400 tonnes of ASR in each case. Both technologies are being presented to this congress. The prestigious Paul Scherrer Institut (ETH ZOrich) assessed and evaluated the two projects last year with reference to four main criteria: technology, ecology, economy and management. As a result, the Foundation decided in favour of the RESHMENT process by Metraux Services and CT Umwelttechnik.
Martin Schaub of CT Umwelttechnik will be presenting the process to you tomorrow.
For reasons of confidentiality, I cannot discuss the evaluation process and the detailed results more fully. Our decision relates to a recycling plant in Switzerland subject to Swiss standards and things may be different in other countries. The process which we did not choose is also in principle suitable for thermal recycling of ASR.
The next steps towards the implementation of the ASR recycling plant will be as follows:

1. Financing must be definitively agreed. The Foundation will contribute about one-third of the capital investment costs.
2. The site must be evaluated. So far around 14 site owners have expressed their interest. A broad selection must be made in a first phase. A final decision is due to be taken in mid-2002. The most important moment in the design phase is the issue of the building permit. But many hurdles remain to be taken before we reach that stage.
3. Operational commissioning is scheduled for mid-2005.

Metraux Services will be responsible for operating the plant. This company has been active in the special waste business for many years and has been involved in ASR projects since 1993. With its 920 employees it provides a comprehensive service for the "Supply", "Support" and "Recycling" functions.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Automotive Recycling In the Context of Legal, Technical and Sustainable Development

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, VW perspective on EU Directive

AUTHORS/CONTACTS:
Dr. Daniel Goldmann, Volkswagen AG

ABSTRACT:
For a about a hundred years the creativity of engineers involved in the development of the automobile was centered around maximising its utility benefit. The focus, therefore, was on the customer. Since the beginning of the 90's, however, the issue of end of life vehicle treatment has developed critical mass. Needless to say, this concern has impact on vehicle construction.
The development was initially triggered by the acknowledgement of policy-makers that a solution was needed to one of the most severe environmental problems facing modern industrial nations:

- minimising waste output
- and, as part of that goal, re-introducing used materials into a life cycle as a means of conserving limited resources.

Structures for vehicle recovery evolved at a very early stage – long before the word “recycling” actually came into being. Even before the first regulations on scrap-vehicle disposal were introduced, around 75% of overall vehicle mass, mainly the metal fractions, found the way back into the economic cycle.
The remaining 25% disposal, coupled with, in some cases, ecologically dubious recovery practices, aroused the concern of national legislators.
In September 2000, European legislators passed their own directives on end-of-life (ELV) recovery, one which more strongly addresses product accountability on the part of manufacturers and which introduced more stringent regulations on a range of technical issues previously contained in national ordinances.
A range of new approaches have therefore emerged, and continue to emerge, for all vehicle phases from construction to recovery. Virtually indissoluble conflicts of target, however, are also being highlighted in the process.
In the following sections we aim, first, to shed light on the technical and legal framework conditions governing vehicle recycling and on technical solutions strategies. Having established this basis, we can deduce the practical consequences and open issues that need to be dealt with in the context of sustainable development.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Directive on End of Life Vehicles and Its Impact on the Automotive Italian Market: Problems and Opportunities

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, Fiat perspective on EU Directive

AUTHORS/CONTACTS:
Alessandro LEVIZZARI (FIAT RESEARCH CENTER) - Italy
Francesco BONINO (FIAT RESEARCH CENTER) - Italy
Silvio CORRIAS (FIAT RESEARCH CENTER) - Italy

ABSTRACT:
It is not simple to make an elaborate and a generalised approach on the European situation on End of Life Vehicles, because of the different policy decisions of each European members on these items.
Anyway it is possible to say a large number of initiatives involving consumers associations, governments, producers and recycling companies has been realised in order to reach the environmental targets defined by the European Directive 2000/53 published in September 2000.
The existing systems created within the various European States and addressed to reduce the volume of waste derived from the used vehicles vary with reference to the contents, time and nature of each State decision.
Some scenarios indicate that auto design will drastically change due to regulation and economic and societal requirements within next 15 years.
This study aims to show some theoretical and possible scenarios referred to the Italian situation of the End-of -Life Vehicles management, showing the problems and the opportunities of each possible solution overall with regard to the next technological changes.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
A Vehicle Producer's Remarks Regarding National Implementations of EU ELV Directive

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, AUDI perspective on EU Directive

AUTHORS/CONTACTS:
Dr.-Ing. Siegfried Schäper, AUDI AG, Ingolstadt

ABSTRACT:
Directive 2000/53/EC of the European Parliament and of the Council on End-of-Life Vehicles [1] has been in force since 21.10.2000. Its aim is to lay down uniform minimum standards for environmentally sound treatment of end-of-life vehicles (EL Vs) throughout Europe. The reuse of components and material recycling are understood to be the core characteristics in terms of environmental soundness. For this reason, the Directive lays down recycling quotas for promoting the recycling of non-metals, and limits the energy recovery. The costs of uneconomical EL V recovery are to be borne by the vehicle producer, see Figs. 1 and 2, in order to ensure that the last owner is not faced with the cost consequences of a possibly uneconomic EL V recovery.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Technical standards for ELV recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, BMW perspective on EU Directive

AUTHORS/CONTACTS:
Marcus Essenpreis
BMW Group, Germany

ABSTRACT:
Significant guidelines from the EU Directive End-of-Life Vehicles:

- Developement of take back and recycling infrastructure
- Take back of end-of-life vehicles
- Recovery quotas
- Material restrictions (Annex II)
- Technical requirements for recycling plants (Annex I)
- Marking of components

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Implication of the EU EL V Directive on the European Steel Recycling Market

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, Scrap processor perspective on EU Directive

AUTHORS/CONTACTS:
Roland Menken TSR, Industrial Services
Bjőrn Voigt Managing Director TSR Recycling GmbH & Co. KG, Duisburg
President of German Eco-Cycle Organisation ESN Board member of BDSV (German Recycling Federation) and BIR (World Recycling Federation) Member of ESG - European Shredder Group, Brussels

ABSTRACT:
Steel scrap is a basic raw material plenty of values for the steel industry and for the foundry industry. Since the iron age man knows that obsolete iron, steel and foundry products can be the basis for new objects - by re-forging or by remelting.

Steel scrap becomes a more and more important carrier of iron (FE) in the production of steel. In the year 2000 worldwide steel production exceeded the first time 800 Mio. metric tons (mt). With a consumption of around 400 Mio. mt tons the raw material scrap became one of the pillars of steel production.

Scrap is mainly used in electric arc furnaces, where high value long products, by technical progress nowadays flat products too, are produced.

The part of electric arc produced steel in Europe is 40%, worldwide of 34%. The international Iron and Steel Institute expects a rise to 40% worldwide by 2010.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
European and National ELV Regulations of Car Recovery, Their Impact on Polyurethane Applications in the Automotive Industry and a Proposal by the German Plastics Industry to Solve the Plastics Recovery Issue

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, Tecpol, Bayer perspective on EU Directive

AUTHORS/CONTACTS:
Werner Rasshofer, Bayer AG, Don Schomer, Bayer Corp.

ABSTRACT:
Information on current European and national legislation concerning end-of-life-vehicles and their effects on raw material producers, TIER 1 suppliers, European OEMs and car importers, and the different recycling technologies and their importance for the future for fulfilling recycling quotas and other demands of the EU laws are presented. Twelve years of polyurethane recycling projects in the European car industry and their consequences for the future are discussed. It is shown that it will not be possible to recycle all plastic waste by means of mechanical recycling alone. Therefore a large scale technology to solve the waste problem is proposed. This solution will favorably include other waste streams and thus includes an integrated total waste management. This represents an offer of the German plastic industry to take over more responsibility and enhance co-operation with OEMs. To facilitate this the German plastics industry will set up a legal entity “Tecpol” which will continue to work on this approach. Other industries are invited to join.

REFERENCE:
European and National ELV Regulations of Car Recovery, Their Impact on Polyurethane Applications in the Automotive Industry and a Proposal by the German Plastics Industry to Solve the Plastics Recovery Issue
SAE Paper No. 2003-01-0644

TITLE:
ELV Directive implementation in Europe

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, Peugeot position on EU Directive

AUTHORS/CONTACTS:
Dr P. Feillard, ELV Co-ordinator, Strategy & Product Planning - PSA Peugeot Citroen

ABSTRACT:
This paper deals with the evolutions that will take place in the future in ELV recycling/recovery due to the enforcement of the end-of-life vehicles Directive. The novelty of the approach lies in the fact that, contrary to the common opinion related to the recycling/recovery of industrial waste, ELV recovery can create revenues higher than the operating costs and therefore induces some profits. The strategy developed here after relies on economical reality and therefore tries to enhance and reinforce the economic competition as well as complying with the more stringent environmental requirements.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Legal Issues of Concern Arising from the European Union End-of-Life Vehicles (ELV) Directive

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, EU Directive overview

AUTHORS/CONTACTS:
Ursula Schliessner, Oppenheimer Wolff & Donnelly IIp, Brussels

ABSTRACT:
The EU ELV Directive (2000/53) is the result of lengthy negotiations and a heavy lobbying battle. The first European Commission working document dated back to 1991 (a priority waste stream project). A working draft for a Directive was issued in 1995. The Commission in 1997 adopted a proposal for a Directive. The ELV Directive was finally adopted on
September 18, 2000.

Member States have to implement the ELV Directive into national law by April 21 2001. The delivery of vehicles to authorized treatment facilities has to be possible as of July 1, 2001 for vehicles put on the market as of this date, and as of January 1, 2007 for vehicles put on market before July 1, 2002.'

To date, according to the official European Commission database Celex updated at the end of each month, none of the EU Member States have yet communicated to the European Commission their national legislation implementing the ELV Directive. Accordingly, it is to be expected, as for so many other pieces of EU legislation, that Member States will be late with implementation.

The ELV Directive is the second in a series of EU Directives that aim at both completion of the Internal Market as well as environmental and consumer health protection. This complicates the rule-making because it means that the product-related parts of the regulations should be as detailed and as complete as possible in order to count as full harmonization - in fact they should have been adopted in form of a directly applicable Regulation rather than in form of a Directive ¬whereas as far as the environmental (waste) related part is concerned, considerable leeway is left to the Member States, to take into account their local specifications as well as the local infrastructures already existent. Accordingly, and this was already the case for the Directive on Packaging and Packaging Waste (94/62/EC) which is structured along the same lines as the ELV Directive, the system so created within the ELV Directive somehow is not really coherent.

Also, due to the heavy lobbying that accompanied the ELV Directive that ended in a conciliation process between Council and European Parliament, several provisions were knit with a rather hot needle, without too much attention to definitions and provisions in already existing legislation.

This presentation is aimed at highlighting some of those contentious issues and attempts to present practical solutions to get across the hurdles.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
The Optimization of End-of-Life Vehicle Recycling in the European Union

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, Recyclablility models and calculations

AUTHORS/CONTACTS:
A. van Schaik and M.A. Reuter

ABSTRACT:
This paper discusses how design software tools and recycling models can be linked to predict the recyclability of a car during the design phase and to provide a sound technological basis when designing for recycling. Due to the car's complex design and time-varying parameters such as lifetime, weight, and composition, recycling must be optimized on a sound technological basis in which the dynamic and statistically distributed parameters affecting the recycling rate are described and understood. This paper presents dynamic and recycling models developed to optimize the recycling of the car and to calculate recycling rates. The performance of a large-scale industrial recycling experiment based on the theory presented here is also discussed. It is indicated that without any statistics involved in the estimation of recycling-rate calculation, as well as the inclusion of the issues and theory discussed in this paper, the International Organization for Standardization norm for recycling rate calculation is really useless.

REFERENCE:
Journal of Metals, Vol. 56, No. 8, August 2004.

TITLE: End-of-Life Vehicles Recovery and Recycling Polyurethane Seat Cushion Recycling Options Analysis

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, Options analysis for seat foam

AUTHORS/CONTACTS:
Frank E. Mark, DOW Europe
Axel E. Kamprath, Recticel n.v.

ABSTRACT:
Polyurethane is now one of the key materials in automotive production. It is used in a wide variety of applications in a car and end-of-life considerations should be addressed at the higher volume parts.
The polyurethane raw material and converting industry through its industry associations ISOPA Euro-Moulders respectively has evaluated best practices for recycling of seat cushions within the European End-of-Life Vehicle (ELV) Directive. The different aspects of ELV compliance, technical, investments, market, quality requirements of product and chain deficit were addressed and evaluated from a stakeholder industry point of view.

The reason for addressing mainly the recycling route is due to the stringent 85% reuse and recycling quota for the End-of-Life vehicle (ELV) to be met in 2015.

REFERENCE:
End-of-Life Vehicles Recovery and Recycling Polyurethane Seat Cushion Recycling Options Analysis
SAE Paper 2004-01-0249

TITLE:
Actual Recyclability of Selected Honda Vehicles

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, Honda recyclability calculations

AUTHORS/CONTACTS:
Richard T. Paul, Automotive Recycling Consultant
Dennis Chung, Honda R&D Americas, Inc.
David W. Raney, American Honda Motor Co., Inc.

ABSTRACT:
The purpose of the recyclability pilot project was to evaluate and confirm the reality of reuse, material recycling and landfill potentials of parts and components over a range of Honda vehicles by model and year. A total of 18 vehicles, model years ranging from 1982 to 2001, were selected for study and processed at two automotive recycling centers and a scrap metal processing facility with an automotive shredder. The automotive dismantlers identified which parts and components were removed for reuse or remained with the hulk for further processing at an automotive shredder facility. Dismantling times and part weights were recorded and dismantling procedures were videotaped. The remaining hulks were delivered to the scrap metal processing facility for further processing. After shredding, the ferrous, nonferrous and landfill materials were separately collected for determining weights of these different process output. The data allow for multiple analyses, including the identification of parts and components frequently selected for reuse, dismantling times, ease of dismantling, high and low value parts and unique dismantling characteristics. Estimates of the fixed rate of recyclability and calculation of the actual total recyclability of selected Honda models over a 20-year period were also made.

REFERENCE:
Actual Recyclability of Selected Honda Vehicles
SAE Paper 2004-01-0246

TITLE:
Flame Retardants in Automotive Plastics

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, Automotive use of flame retardants

AUTHORS/AUTHORS/CONTACTS:
David L. Edenburn, Albemarie Corp.

ABSTRACT:
Currently, at least 10% by weight of a modern car is plastic, this would be over 100Kg of plastic in an average mid sized car and is increasing every year. Clearly, the use of plastics in automotive applications is important. These plastics are used for various technical and economic reasons. In the countless engineering decisions made to design and build a car, plastics were chosen because they were the best material for the task.

Also important are the changing laws and requirements. Tougher emission standards mean lower weight, tougher impact requirements mean stronger and more ductile materials. Environmental restrictions limit the material choices of the designer. In addition are the Federal standards for flammability in the U.S. and similar standards in other countries.

This paper will discuss the various flammability regulations required for cars and the types of formulations typically used to meet these requirements for the various plastics used. Also discussed will be the impact of various types of flame retardants have on the plastic and where compromises have to be made.

REFERENCE:
Flame Retardants in Automotive Plastics
SAE Paper No. 2001-01-0845

TITLE:
Country Report Austria

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, ELV directive, Austria

AUTHORS/CONTACTS:
Stephan Schwarzer, Austrian Economic Chamber, Austria

ABSTRACT:
In Austria the issue of recycling of end-of-life-automobiles was already tackled almost 10 years ago. In 1991 Austria's car business proposed an agreement with the government. One year later, a voluntary agreement - a radical measure at this time -was signed by the Minister of Environmental Policy, the Minister of Economic Affairs and by the President of the Austrian Economic Chamber (AEC), representing the business sectors involved such as the car industry, car retailers, car service companies and car recyclers.

Being a voluntary agreement and not a governmental regulation, this document does not bind anybody legally. But behind this document was the will of the parties to realise the requirements of the agreement. Here I take the opportunity to underline that Austrian business prefers self regulation to prescriptive government legislation. As far as I know the Austrian voluntary agreement on automobile recycling was the first of its kind Europe-wide.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Side-effects of the Recycling Quotas of the EU End-of-Life Vehicle Directive on Lightweight Construction Concepts and on the Use of Biomass Based Materials in Car Production

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, ELV directive implications

AUTHORS/CONTACTS:
Siegfried Schäper, AUDI, Germany

ABSTRACT:
In order to promote the recycling of plastics in particular, the EU End of Vehicle Life Directive requires at least 85% of the weight of the vehicle to be recycled or re-used in the recovery process chain. The share to be used for energy production or dumped is thus limited to 15% of the weight of the vehicle. In the context of type approval for new vehicles, it must be proved that it is possible to achieve the prescribed recovery qu~ta.
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The purpose of the directive is to harmonize the recycling of old cars in Europe as a whole. It would be desirable for this to be successful. However, many parts of the directive now agreed upon entail considerable problems. The. discussion conducted up to now dealt virtually exclusively with the free return of vehicles for the last owner. However, the ecological aspects, which are also problematic, tended to be disregarded. In the following we shall discuss the effects of the quota 'prescribed in Article 7, one of the central ecological points of the directive.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Implementation of the EL V Directive: The Views of a Resin Manufacturer

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, ELV directive implications

AUTHORS/CONTACTS:
Dr Viktor Williams, DuPont de Nemours Int SA, Geneva, Switzerland

ABSTRACT:
In the early '90's the EU Commission, worried by the increasing amount of waste for disposal, launched the Priority Waste Stream initiative. The first market segment has been Packaging. In light of this, the Automotive industry promoted the development of voluntary agreements in several European Countries, hoping to avoid legislation. But under the push of the Waste Unit of DG Environment, the ELV Directive has been approved and published on October 2000; it will become national law by April 2002.

The Directive will have a profound influence not only on how EL V will be treated in the future, but also on how new cars will be designed, assembled, sold and maintained.

This paper illustrates the likely scenario that will be developed by Authorities and Industry at Country level with a shared responsibility approach.

What needs to be in place is:

- A network of regularly authorised dismantlers
- An increased number of qualified recyclers
- Investment in ASR (Automotive Shredder Residue) separation technologies
- A funding system that covers the economic deficit of the recovery chain
- The creation of a Country Recovery Organization including Materials Groups that coordinates the compliance with the recovery targets

The paper concludes illustrating the contribution of DuPont in Industry initiatives and in the development of sustainable recycling technologies.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Problems with Automobile Shredder Residue (ASR) and Solutions for ASR

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, ELV directive, Germany

AUTHORS/CONTACTS:
Dr. Beate Kummer, Haase & Naundarf Umweltcansulting, Bad Hannef, Germany

ABSTRACT:
The 42.4 million vehicles licensed today in Germany contain over 12 million t of non-recyclable materials according to current/actual estimations. Although the end of life vehicle recycling is discussed on many political levels, experience shows a completely different picture: Fact is that only the scrap stream of old vehicles is used containing 75% of the total weight. The majority of plastics, textiles, glass and nonmetal portions however goes into the shredder process and is as so-called auto shredder residue ASR (light fluff and heavy-fraction) to a large extent dumped untreated on a land filling station.

The dumping of ASR (light fluff) is ecologically seen doubtful, because too many pollutants are contained. The land filling of ASR at least in Germany and in the EU-countries, in which the EU council directive of landfilling must be converted, is in a foreseeable period no longer possible. A strong increase of ASR in the upcoming years due to the rising return ratio of ELV is expected by the EU Commission. With the EU council directive of EL V vehicles came into force also new demands for the recycling of passenger cars came out. Starting from 1.1.2006 at least 85 % of an old vehicle needs to be recovered, at least 80 % of it recycled in accordance with the European Union directive. The solution for the difficulties of the recovering processes could be a reasonable handling of the plastic fractions found in vehicles.

However the enterprises have a variety of problems with recovering these plastics, which have a huge impact on the lightweight construction way and thus to the fuel saving. An average car contains different plastic construction, those at least are from homogeneous, easily usable materials up to 2.000 different kind of plastics. Most plastics are coated, fiber-reinforced or consist of inseparably connected plastic compounds. Difficulties arise after the shredder procedure, when high amounts of residues remain. Residues may contain all materials of a vehicle electronics inserted by the seat belt up to the road dust.

However raw materials and energy in the ASR are to be recyled after the new legislation framework. It postulates the reuse of materials and energy. So far there was hardly one ecologically and economically meaningful way to the utilization of the light fluff of the ASR. Due to the requirements of reprocessing new technological solutions come forward, which will be emphasized during the lecture.

On 1 July 2002 the law of end of life vehicle (ELV) took effect in Germany. Herewith Germany placed prefaces for the future of old vehicle utilization and recovering for further reuse and processing of old vehicles. Thus the EU council directive on EL V already existing was converted in German legal framework, which calls for more implications regarding the processing of the EL V. Although for many years was obvious that the disposal of the EL V represented a substantial problem, so far there was no way of finding ecological and economical solutions for recovering. The presentation will try to evaluate a concept dealing with these problems. Especially for the manufacturers the convertion of the guidelines is a big challenge, so far the automobile companies and importers have to finance the waste management because of the producer responsibility. They must guarantee together with the other stakeholders high recovering ratios.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 12-14, 2003.

TITLE:
Car Recycling and Producer Responsibility in Sweden

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, ELV directive, Sweden

AUTHORS/CONTACTS:
Nils Hernborg, BIL Sweden, Automobile Producer Responsibility Sweden, Sweden

ABSTRACT:
In my presentation, I intend to describe how we in Sweden have so far handled matters related to car recycling within the framework of the EL V Directive.

Some parts of the system that have been established will live on, whereas developments in the car industry and other related industries indicate that it would be advisable and, in certain cases, necessary b introduce changes so that car recycling will be economically justifiable and sustainable in the long term.

I intend to describe the players who are involved in the Swedish system and their various roles.

Since the financing of the future collection and recovery of all ELVs is currently being studied, I do not intend to discuss the financing issue from 2007 onwards.

In the current discussions between the car industry and various economic players, it is considered possible that the contents of EL Vs could currently largely finance the recycling of cars.

The future material content of the EL V and other factors related to the regulations, etc. can obviously affect this aspect. I do not intend to look into the future with regard to these matters, but I will only describe how the car industry in Sweden, in co-operation with other players, has established a system in which we conform to the present Swedish legislation that, in all significant respects, represents an implementation of the EL V Directive. However, it should be noted that the regulations will be coming into force and the targets will be attained in Sweden a few years before corresponding requirements come into force in other European countries.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Collective Collection and Recycling of ELV in Austria

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, ELV directive, Austria

AUTHORS/CONTACTS:
Erwin Janda, ÖCAR Automobilrecycling GmbH

ABSTRACT:
For the recycling of end-of-life vehicles (EL V), an innovative and well-functioning system was introduced in Austria as early as 1992. The basis for this system was formed by - the Voluntary Pledge of ELV recycling and - the Recycling Guarantee of the working group of Austrian shredder operators (Arbeitsgemeinschaft Osterreichische Shredder) .

The voluntary pledge was agreed upon by the Austrian Federal Ministry of Agriculture and Forestry, Environment and Water Management (in the text below, it will be referred to as Ministry of the Environment), the Austrian Federal Ministry for Economy and Labour and the Austrian Federal Economic Chamber in 1992. It aimed at providing new and innovative ELV recycling standards by introducing the following items:

- Guidelines with general principles for the collection and treatment of ELV;
- Step-by-step take-back of EL V by the vehicle dealers (take-back free of charge upon purchase of a new car);
- Informing the general public on the disposal and recycling of ELV.

The entire Austrian business community in the sectors automobile industry, vehicle dealers and secondary raw materials dealers agreed to comply with these obligations. Thus, app. 4,800 companies undertook to implement the contents of this pledge.

A report on the pledge was drafted for the performance period 2002. It was commissioned by the Austrian Federal Economic Chamber (Department of Environment, Energy and Infrastructure Policies, author: UV&P, DI Franz Neubacher). The report formed the basis for the ELV statistics for 2002.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
How to Fulfill the ELV Directive Cost Effective in Thinly Populated Areas

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and Regulatory, ELV directive, Sweden

AUTHORS/CONTACTS:
Peter Domini, Stena Gotthard, Sweden

ABSTRACT:

- It has to be easy for the last owner to get rid of the EL V, if not they probably stay in the woods.
- If you compare with other directives like the triple E there are more take back points per capita in thinly populated areas than in the big cities.
- If the authorities demands the same service for EL V's the cost to set up take back points will be extensive.
- The regulation requires tight ground with oil separation facility, Annex 1, Stena's Tray solution is cost effective and still environmentally satisfactory

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.\

TITLE:
Environmental Regulations for Cockpits

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and regulatory, EV, auto interior

AUTHORS/CONTACTS:
Mike Keranen
Jim Hanford

Visteon, Corporation

ABSTRACT:
With a global economy, comes increased complexity from additional regulatory requirements beyond the country of design and/or manufacture. While traditionally these requirements have been safety-related, there is an increasing volume of environmental requirements being added to the mix. Examples include hazardous materials and End-of-Life Vehicle (ELV) requirements emanating from the European Community and various US states.

The EL V directive requires that Original Equipment Manufacturers (OEMs) assume responsibility for taking back a vehicle at the end of its useful life, specifies the percentage of a vehicle that must be reusable/recyclable, and provides a time line for incorporation. Identification of materials in all components is being requested, as is the use of the International Material Data System (IMDS) in a manufacturer's tracking process. While OEMs and suppliers are expected to bear the brunt of the costs of these actions, many markets lack an infrastructure to facilitate these recycling actions.

This paper presents an overview of environmental regulations and directives as they affect automotive cockpits. The engineer must ensure that their design effectively meets all applicable requirements. The complexity and sheer volume of the approaching regulation is driving organizations to look for innovative ways to ensure that design engineers have the latest regulations and interpretations, and the tools and abilities to understand them. It is our hope that this overview will help organizations recognize the oncoming challenge and implement the appropriate organizational actions to enable them to stay abreast of existing, new, and developing regulations and directives.

REFERENCE:
GPEC 2003, Proceedings of the 9th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 26-27, 2003, Detroit, MI.

TITLE:
End-of-Life Vehicle Recycling in the European Union

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and Regulatory, ELV Directives

AUTHORS/CONTACTS:
N. Kanari, J.-L. Pineau, and S. Shallari

ABSTRACT:
Vehicles, essential to society, are continually increasing in use. However, throughout their life cycle vehicles impact the environment in several ways: energy and resource consumption, waste generation during manufacturing and use, and disposal at the end of their useful lives. About 75 percent of endof-life vehicles, mainly metals, are recyclable in the European Union. The rest (-25%) of the vehicle is considered waste and generally goes to landfills. Environmental legislation of the European Union requires the reduction of this waste to a maximum of 5 percent by 2015.

REFERENCE:
JOM, August 2003, pp. 15-19.

TITLE:
Background of the Automobile Recycling Law Enactment in Japan

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and Regulatory Issues

AUTHORS/CONTACTS:
Kenichi TOGAWA
Kumamoto University

ABSTRACT:
On July 5, 2002 the Law Concerning Recycling of End-of-Life Vehicles, popularly known as the **"Automobile Recycling Law"**, was enacted in Japan. This paper examines the features of this Law, reasons why the Law was brought into existence, and its predicted impacts on the automobile industry. Pursuant to the Law, the current automobile recycling system will be replaced by a new one in January 1,2005.

REFERENCE:
Proceedings of the 6th International Automobile Recycling Congress, Amsterdam, Netherlands, March 15-17, 2006.

TITLE:
Future Developments in Car Recycling in the Netherlands

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Legal and Regulatory Issues

AUTHORS/CONTACTS:
D. Babelaar

ABSTRACT:
In the European Union Legislation regarding treatment of End of Life Vehicles is described in much detail in the European Directive [Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of-life vehicles]. Implementation of this directive in each member state is mandatory. In the Netherlands this implementation is done by Auto Recycling Netherlands.

CONCLUSION:

REFERENCE:
TMS EPD Congress, 2007.

Section 4
Life-cycle Analysis

TITLE:
The Optimization of Recycling: Integrating the Resource, Technological, and Life Cycles

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Life-cycle analysis, overview of infrastructure

AUTHORS/CONTACTS:
M.A. Reuter, U. Boin, P. Rem, Y. Yan2, N. Fraunholcz, and A. van Schaik

ABSTRACT:
Market-driven industrial recycling can only be optimized if recycling companies adopt a comprehensive overview and are able to combine and integrate economics with the system engineering of interconnected recycling systems. To succeed in this endeavor, the companies require detailed knowledge of the interaction between the process/quality control, physics, and chemistry of separation technology, and legislation on the materials they are recycling as well as product design. This article summarizes the authors' practical and fundamental approach to optimizing the resource cycle. The research is focused on areas in the resource cycle where the largest impact will be achieved, as suggested by system perspective and models.

REFERENCE:
Journal of Metals, Vol. 56, No. 8, August 2004.

TITLE:
Treatment of Aluminium Recycling in Life Cycle Assessments Methodology and Examples

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Life-cycle analysis, aluminum

AUTHORS/CONTACTS:
Kurt Buxmann
Alcan Technology & Management Ltd., Chippis, Switzerland

ABSTRACT:
Life cycle assessments based on the ISO 14040 ff standards should include recycling operations of car components in the product system to be analysed.
Therefore, the recycling technique and the value of the recycled material is of great importance for the result of the study.
Based on the aluminum car body of an Audi A8, different recycling scenarios of aluminum car body sheet have been examined, including
- shredding, sink-float sorting and remelting;
- dismantling and remelting;
- combination of both techniques.
At present, dismantling and remelting and the more realistic combinations of both techniques show advantages in comparison with the shredding and sinkfloating technique. In the future, this advantage may tend to decline as sorting techniques improve.
Moreover, it can be concluded that, based on the applied methodology, the use of a high percentage of recycled metal in the car body has no major environmental advantage.
Benchmarking with different steel scenarios shows that the use of aluminum for car bodies is justified.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Life cycle analyses and environmental effects on Lead containing parts in cars

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Life-cycle analysis, lead

AUTHORS/CONTACTS:
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ABSTRACT:
With the EU-end-of life regulation for vehicles ((EL V), 2000/53 EC /1/) established a prescription with a total ban of lead, mercury, cadmium and hexavalent chromium for use as material and component for cars. Unavoidable further use of some materials is listed in an annex of exemptions and/or for prescriptions to strip them out before treatment. This annex is reviewed on a regular basis according to technical and scientific progress.

As an argument for this regulation the basic papers do not contain effect caused by use of lead. What is missing also is an investigation of the effects caused from possible substitutes and a scientific based judgement. The only one given argument is that lead should not be contained in the shredder fluff fraction.

To find the dimension of the problems linked with lead this investigation undertakes an estimation of the environmental effects caused by the use and disposal of lead containing vehicle components. It has been assumed that the lifetime of a vehicle is 12 years and that for recycling 'state of the art' process technologies for EL V's and EL V parts are used as already described in European or German regulations.

The complexity of a scientific based substitute decision is given for the use of tin instead of lead in balance weights as an example.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
EC ELV Directive: Ecological-economical Usefulness – Reuse and Recovery Rates versus Life-Cycle Analysis of a Car

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Life-cycle analysis, Zurich University

AUTHORS/CONTACTS:
Alexander Stuecheli, Zurich University of Applied Sciences

ABSTRACT:
A total energy analysis for a passenger car during its life cycle, i.e. from material production, car manufacture, operation over 150'000 km to final scrap shows that 89 % is due to gasoline consumption, gasoline production and its transportation, and maintenance which is also proportional to driving. Metal recovery in a shredder is important and reduces the total energy for material and car manufacture from 75 MJ per kilogram car weight by 20 MJ/kg. On the contrary, the net energy value of shredder residue of a car is less than 1 % of the life-cycle primary energy consumption of 487'800 MJ or 11'450 kg oil-equivalent. Therefore the argument and requirement envisage by the EC EL V Directive that energy conservation by means of reuse of components and by means of additional material recycling, in particular plastics recovery, is for nothing.

From the ecological-economical point of view the ASR treatment has to be so that all harmful and not worth to recover material such as heavy metals must be immobilized.

The energy content of ASR is high enough to not only incinerate but also vitrify slag.

There is technology on the market today which has been developed so far that even the vitrified products are recyclable as secondary construction materials (e.g. for road construction), additional metals and steam for electricity production is recovered. Therefore the reuse and recycling targets stipulated in the EC ELV Directive are achievable.

And, last but not least, the cost are competitive to a solution which is focussed on dismantling and forgets to solve the final waste .treatment of the heavy metal loaded ASR.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Recovery of Plastics from ELVs – New Insights from a Sustainable Development Point of View

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Life-cycle analysis, APME perspective on plastics recycling

AUTHORS/CONTACTS:
Axel Kistenmacher, APME, Belgium

ABSTRACT:

Plastics play a major role in modern vehicles and may be found in exterior-, interior- and under-the-hood applications. Plastics are used in car parts such as bumpers, body panels, mirror housings, front grills, lamp covers, fuel tanks, battery housings, intake manifolds, electronics housings, trim panels, dashboards, etc. The different types of plastics offer nearly unlimited opportunities to the designer while at the same time combining properties such as softness, stiffness, toughness, transparency, colorability and durability. Innovative applications of plastics can be found in some of the most recent concept cars. With new developments underway such as car window systems and paintless body panels further exciting application areas are being explored.

Whereas an average new car in 1984 contained 8,5% by weight of plastics, a similar car today contains about 11 % of plastics or approximately 130 kg per car. This corresponds to 2,5 million tonnes of plastics per year going into this application in Europe. Plastic parts contribute considerably to fuel savings. For the European Union, it is estimated that the reduced vehicle weight made possible by plastics annually saves 12 million tones of oil. At the same time the oil needed to produce the 2.5 million tones of plastics sums up to approximately 5.5 million tones annually. So in effect, plastics in vehicles save more oil than they require. On top of this, the material or energy can be recovered when plastic parts reach the end-of-life phase, which contributes further to the sustainable use of plastics in car applications.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
The Effect of Design on Recycling Rates for Cars – Theory and Practice

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Life-cycle analysis, recycle rate, Delft University, Netherlands

AUTHORS/CONTACTS:
A. van Schaik and M.A. Reuter, Delft University of Technology, Mijnbouwstraat 120, Delft, The Netherlands.

ABSTRACT:
This paper discusses the theory developed by the authors that relates product design to recycling rates based on the combination of dynamic modelling and the modelling of recycling systems. Although this theory may on first look be considered rather theoretical, it takes realistic care of the distributed properties of the product, design, life cycle, the metallurgy and physical processing, etc. This provides an insight into what factors affect the recycling rate related to design associated with a standard deviation determined by all steps within the life cycle of a car. With this knowledge a methodology is presented how recycling rates should be determined in practice based on this sound fundamental basis. Subsequently a procedural basis is provided from which the recycling rate can be calculated from an industrial experiment, for example for a recently performed recycling experiment of 1153 end-of-life vehicles, which was initiated and managed by Auto Recycling Nederland BV and executed at CometSambre in Belgium. Therefore this paper demonstrates how recycling rates can (should) be calculated from data collected from recycling experiments, referring to the various methodologies to be used in such experiments, based on the developed theory by the authors.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Modular Life Cycle Model - Basis for Analyzing the Environmental Performance of Different Vehicle End of Life Options

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Life-cycle analysis, ELV options

AUTHORS/CONTACTS:
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Nakia L. Simon DaimlerChrysler (VRP/USCAR)
Claudia M. Duranceau Ford (VRP/USCAR)
Gerald R. Winslow KBS Consulting Engineering (VRP/USCAR)

ABSTRACT:
The Vehicle Recycling Partnership (VRP) of USCAR (United States Council for Automotive Research) is evaluating and analyzing separation and recycling technologies for shredder residue (SR). In order to have a better understanding of the environmental impacts offered by these technologies, the VRP decided to develop a life cycle model of the entire end of life process as it relates to shredder residue. To achieve this goal, the VRP is currently creating a flexible Life Cycle Inventory (ICI) model that maps the different options for the treatment and recycling of SR based on the process flows of the considered technologies. The End of Life (EoI) model is being built as separate modules, which allows for increased user flexibility. Since, the model is not fixed; it enables the VRP to expand the existing model by including the latest technologies for the separation of materials that make up SR, as well as the recycling and potential applications of the separated fractions.

The VRP's reasons for the creation of a modular EoI model, the procedure used to create the model, and the use of the EoI model is discussed in this paper. One of the first technologies to be evaluated as part of this study was the mechanical separation process developed by Salyp. The Salyp separation process is presented focusing on the ecological analysis and the technical application of the outputs of the technology. This paper also discusses Changing World Technology (CWT)'s Thermal Conversion Process (TCP), which is another technology that is currently being investigated by the VRP for inclusion in the EoI model.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands, March 9-11, 2005.

TITLE:
Eco Efficiency Recovery of Plastics from Automotive Applications

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Life-cycle analysis, APME

AUTHORS/CONTACTS:
Dr. Herbert Fisch, APME – Association of Plastic Manufacturers in Europe

ABSTRACT:
The new European End-of-life-vehicles (EL V) directives 2000/53/EC defines specific recovery, reuse and recycling targets for cars.

In an eco-efficiency study, Okoinstitut in Darmstadt/Germany analysed and evaluated the recycling - and recovery options*1) for seven different plastic parts (ranging from 200 g up to 3,1 kg) from EL Vs. The study intends to provide a transparent evaluation tool for the various technology options in terms of environmental impact and corresponding costs. The results are displayed in ecoefficiency portfolios.

The background data and the resulting portfolios were reviewed by a panel of independent peers. The study was commissioned by the Association of Plastics Manufactures (APME) in Europe.

REFERENCE:
GPEC 2003, Proceedings of the 9th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 26-27, 2003, Detroit, MI.

TITLE:
Recovery options for plastic parts from end-of-life vehicles - an eco-efficiency assessment

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Life-cycle analysis, APME

AUTHORS/CONTACTS:

ABSTRACT:
The study undertaken by Öko-Institut e.V. Darmstadt provides quantitative findings for the comparison of recovery and recycling options for plastic parts in end-of-life vehicles (ELV) as a basis for a rational contribution to the debate on the overall targets set by legislation. The study is based on the 'Eco-Efficiency-Analysis'-method as a useful tool to quantify and compare different recovery I recycling options with regard to their environmental and economic impacts.

REFERENCE:
Association of Plastics Manufacturers in Europe, Summary Report, #8041/GB/08/03.

TITLE:
Modular Life Cycle Model of Vehicle End of Life Phase - Basis for Analysis of Environmental Performance

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Life-cycle Analysis

AUTHORS/CONTACTS:
Marc Binder, PE Europe GmbH
Candace S. Wheeler, General Motors/VRP
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Claudia M. Duranceau, Ford/VRP
Gerald R. Winslow, DaimlerChrysler/VRP

ABSTRACT:
In previous projects, the Vehicle Recycling Partnership (VRP) and Salyp N.V., has demonstrated the ability to separate plastics, foams, ferrous, and non-ferrous products from shredder residue using the Salyp recovery process. As discussed in a previous SAE paper by the VRP and Salyp (SAE 2004-01-0469), Salyp's recovery process consists of a number of different stages, including sized-based material separation, a foam cleaning system, additional material type separation based on material type, etc. During those previous projects it was determined that these stages may impact the environment via air emissions, waste emissions, or in terms of energy consumption.

Subsequently, the VRP decided that a life cycle approach to investigate the energy and specific environmental impacts of this technology was necessary. PE Consulting Group was contracted to create a parameterized LCI (Life Cycle Inventory) model which would enable the VRP to conduct life cycle evaluations of different recycling/recovery scenarios. This paper will discuss first results of the analysis.

REFERENCE:
SAE Paper 05 ENV-32

TITLE:
United States National Life Cycle Inventory Database Project -- A Status Report

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Life-cycle Analysis

AUTHORS/CONTACTS:
John L. Sullivan, Ford Motor Company/VRP
Candace S. Wheeler, General Motors/VRP
Nakia L. Simon, DaimlerChrysler/VRP

ABSTRACT:
The National Life Cycle Inventory (LCI) Database Project, initiated about three years ago, is intended to be a resource for peer reviewed, publicly available, web served LCI information. The Vehicle Recycling Partnership (VRP) of USCAR co-initiated this project with the Athena Sustainable Materials Institute and has been working steadily to date on providing LCI modules for the database. Athena International now manages the project. The purposes of this presentation are two-fold: 1) to provide an overview of contributed VRP modules, and 2) to give a status report on the National LCI/DB Project as a whole. Who is participating and what they are providing is also discussed. The scope of the project and areas in need of data module development are covered as well.

REFERENCE:
SAE Paper 05 ENV-30.

TITLE:
Modular Life Cycle Model - Basis for Analyzing the Environmental Performance of Different Vehicle End of Life Options

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Life-Cycle Analysis

AUTHORS/CONTACTS:
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Claudia M. Duranceau, Ford (VRP/USCAR)
Gerald R. Winslow, KBS Consulting Engineering (VRP/USCAR)

ABSTRACT:
The Vehicle Recycling Partnership (VRP) of USCAR (United States Council for Automotive Research) is evaluating and analyzing separation and recycling technologies for shredder residue (SR). In order to have a better understanding of the environmental impacts offered by these technologies, the VRP decided to develop a life cycle model of the entire end of life process as it relates to shredder residue. To achieve this goal, the VRP is currently creating a flexible Life Cycle Inventory (lCI) model that maps the different options for the treatment and recycling of SR based on the process flows of the considered technologies. The End of Life (EoI) model is being built as separate modules, which allows for increased user flexibility. Since, the model is not fixed; it enables the VRP to expand the existing model by including the latest technologies for the separation of materials that make up SR, as well as the recycling and potential applications of the separated fractions.

The VRP's reasons for the creation of a modular EoI model, the procedure used to create the model, and the use of the EoI model is discussed in this paper. One of the first technologies to be evaluated as part of this study was the mechanical separation process developed by Salyp. The Salyp separation process is presented focusing on the ecological analysis and the technical application of the outputs of the technology. This paper also discusses Changing World Technology (CWT)'s Thermal Conversion Process (TCP), which is another technology that is currently being investigated by the VRP for inclusion in the EoI model.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands,
March 9-11, 2005.

Section 5
Research Programs

TITLE:
Sustainable End-of-Life Vehicle Recycling: R&D Collaboration between Industry and the U.S. DOE

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Research programs, US

AUTHORS/CONTACTS:
Edward J. Daniels, Joseph A. Carpenter, Jr., Claudia Duranceau, Michael Fischer, Candace Wheeler, and Gerald Winslow

ABSTRACT:
Approximately 15 million cars and trucks reach the end of their useful life in the United States each year. More than 75% of the materials from end-of-life vehicles are profitably recovered and recycled by the private sector; automotive materials recycling is a success story. To achieve greater fuel efficiency and safety, today's cars incorporate an increasing share of innovative light-weight materials. While these materials greatly enhance efficiency during vehicle use, they can present special challenges for recycling. These challenges will persist as automotive designs and the mix of materials used in vehicles continue evolving to further improve safety and performance. To meet the challenges of automotive materials recycling, the US. Department of Energy has recently expanded its collaborative research with industry in this area. This article discusses this collaborative government/ industry approach to sustainable end-of-life vehicle recycling.

REFERENCE:
Journal of Metals, Vol. 56, No. 8, August 2004.

TITLE:
Shredder Residue Treatment and Use Today and in the Future

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Research programs, EU Thematic network

AUTHORS/CONTACTS:
Frank E. mark, Dow Europe SA
Pierre Picot, IXAS Conseil

ABSTRACT:
The European Union (EU) Thematic network sponsored by DG Research of the European Community analyzed the subject of eco-efficient treatment with respect to plastics End-of-Life Vehicles (ELV). This paper deal with the shredder residue treatment and use for today and in the future.

REFERENCE:
Shredder Residue Treatment and Use Today and in the Future
SAE Paper 2001-01-0307

TITLE:
Life Project Shredder Waste Recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Research programs, Sweden

AUTHORS/CONTACTS:
Monica Svenner, Managing Director
Stena Fragmentering AB, Halmstad, Sweden

ABSTRACT:
Stena Metall Group is the largest recycling company in the Nordic Region. The company collects, transports, up-grades and trades steel, metals, paper and has a turn over of about 500 million € .
Stena Fragmentering AB processed year 2001 almost 650 000 tons of Swedens total volume of about 700 000 tons of complex scrap with 4 shredder plants spread out in Sweden. (Picture 3)
The scrap from cars has during the last decade fallen from 1/3 to about 1/4 of the total. The reason is that the total volume of scrap going to shredders is increasing faster than the volume of car scrap.
The shredder produces about 70% iron, a heavy fraction containing most of the non-ferrous metals (also called SHF) 10% and a light fraction containing most of waste such as plastics, rubbers, glass etc (also called SLF or fluff) 20%.
The heavy fraction goes to a sink-float plant belonging to Stena Fragmentering. There we recover about half of the heavy fraction as pure aluminium, copper and other non-ferrous metals. The remaining part of SHF is also a waste which together with the SLF make up the total 25% waste that has been taken as normative for the car shredder process and is the basic figure for state-of the art car recycling.
Important to note is that car scrap contains more waste, estimated by tests to 26% than community scrap 20% and industrial scrap 16%. The shredder light fraction amounts to 140 000 tons. It goes to 4 landfills. Two of them are our own monotype landfills containing some 1.5 million tons of only shredder waste.
ECRIS, stands for Ecological Car Recycling in Scandinavia and was a 4 year research project 1994-1998 initiated by Volvo Car with the participation of Stena. SLF analysis and incineration was studied with the help of the Dept. of Environmental Chemistry of Umea University. A large scale coincineration test with SLF and household waste was made by Renova in Gothenburg that has a large waste incineration plant.
The incineration test pointed out that a lower ash content < 30% and less heavy metals in the ash after incineration were critical parameters to get acceptance for the use of shredder fluff in waste incinerators.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
The Concept of End-of-Life Car Recycling System in Russia

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Research programs, Russia

AUTHORS/CONTACTS:
Roman L. Petrov, Research Center AVTOVAZ, Inc.

ABSTRACT:
Dismantling and utilization of end-of-life vehicles (ELV) greatly influences the total ecological parameters of the vehicle in terms of it complex impact of human beings and nature.

So far in Russia there are not specialized centers with ELV utilization capabilities. Further there are no laws regulating ELV issues. Al the same time, in some developed Russian regions, having a high population density, the ELV utilization problem becomes more and more critical.

AVTOVAZ is the biggest producer of passenger cars (trade mark: LADA) in Russia. AVTOVAZ has developed a concept for ELV recycling system for the Samara region (the plant's locations). The system starts with ensuring that legislation is in place to define responsibilities for addressing the major participants of the ELV cycle: Car manufacturer, the last car owner, ELV stacking center, dismantling and recycling center, residue disposal shredder center and Regional Environment Committee on vehicle-environment inspection

AVTOVAZ together with the Samara region's Environment Committee and the other companies form an infrastructure that is expected to provide arrangement, technical and financial support during implementation of the ELV recycling system in Samara region.

AVTOVAZ R&D specialists also are working on comparative analysis of all LADA cars dismantling, materials in-use (holders and fasteners), developing appropriate catalogues on recycling and instructions on dismantling of all cars in production. Another field of activity is improving the ecological safety of new LADA cars. These specialists define the direction of environment safety improving and recyclability of new LADA cars.

REFERENCE:
The Concept of End-of-Life Car Recycling System in Russia
SAE Paper 2001-01-0696

TITLE:
Mechanical Pre-Concentration of Automotive Shredder Residue

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Research programs, Mechanical separation of shredder residue, Delft University

AUTHORS/CONTACTS:
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ABSTRACT:
This paper describes a low-cost mechanical pre-treatment of automotive shredder residue (ASR). The philosophy of this approach is to separate ASR into pre-concentrates at the lowest possible costs in such a way that the produced fractions can either be upgraded in specialised separation facilities for material recovery or subjected to energy recovery. The latter includes incineration of the highly contaminated fractions and co-combustion of clean organic fractions. The concept is designed for high flexibility with regard to the unit operations applied, local differences of ASR composition and processing site (e.g. at the shredder yard or at specialised processing facilities). As we currently witness a rapid development in both plastics separation and metal recovery, flexibility of the chosen concept for ASR treatment may be a key issue to combine optimal costs with a high recycling rate of EL V's.

The proposed concept starts with a mechanical processing including screening and magnetic separation. Preliminary studies show that fibres in ASR are magnetic due to adhering rust particles allowing separation into a magnetic fluff fraction and a non-magnetic rigid fraction using a powerful magnetic separator. The rigid fraction (mainly plastics, rubber some non-ferrous metals, etc.) is well-suited for further mechanical processing by, e.g., density separation in existing separation plants. We offer some new processing opportunities for the rigid fraction, such as a two-steps mechanical dechlorination of the rigid organic fraction. The fluff fraction can probably be best subjected to thermal processing. The proposed concept is expected to be substantially cheaper than full thermal processing. In addition, as it mainly relies on existing separation facilities, it can be applied on a relatively short term.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
What really stops us from using recycled plastics in automobiles

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Research programs, Mechanical recycling, University of Brighton, UK

AUTHORS/CONTACTS:
Richard Hooper
Marie K. Harder
Anthony K. Potter
University of Brighton, UK

ABSTRACT:
The use of recycled plastic in automotive components is not new, but there are substantial barriers that need to be overcome to include such material as a 100% recyclate in large quantities. This paper addresses some of the underlying issues related to such use and possible future options that can allow for high levels of recycled plastics back into high specification automotive components. The research that has been conducted at the University of Brighton for the past two years has assessed several of the options for recycling plastics from end-of-life vehicles (ELVs), including a manual dismantling approach compared to recovery from shredded EL Vs. This contribution will highlight the findings of the research and present summary scenarios open to the UK recycling industry to achieve the European EL V Directive recycling targets by 2006.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
European Information Network for the Treatment of Plastic in End-of-Life Vehicles, Status and Evolution

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Research programs, European Information Network

AUTHORS/CONTACTS:
Dr. Herbert Fisch, APME, Brussels

ABSTRACT:

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Shredder Residue Treatment and Use Today and in the Future

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Research programs, Thematic Network, Eco-efficient treatment of plastics in ELV

AUTHORS/CONTACTS:
Frank E. Mark, Dow Europe SA
Pierre Pico, IXAS Conseil

ABSTRACT:
European legislation enforces high recycling and recovery targets. The high recycling target embedded in the European Union End of Life Vehicles (ELV) Directive would require extremely high mechanical and chemical feedstock recycling investments. The eco-efficiency of such measures are questioned as no broad based analysis is available for backing up scientifically the rigid formula of SO/50 recycling / recovery methods applied for the ELV Directive. Many stakeholders have raised considerable concerns on the recycling targets as they are in conflict with other environmental objectives like fuel savings and CO2 reduction targets set after the Kyoto protocol.

The European Commission DG Research has sponsored a European Thematic Network project on the "Eco-Efficient Treatment of. Plastics in End of Life Vehicles". Over 40 industrial participants from eight EU Member States were involved in the network.

Three working groups, were created dealing with Dismantling, Material recycling, Shredder Residues Treatment and Use. Each of these working groups had a broad range of concerned parties comprising the car manufacturers, the plastic raw material manufacturers, shredder companies, dismantlers, recyclers, energy users, and research institutes representing the scientific community.

Each groups addressed the points of today's disposal system and the point of the future eco-efficient treatment (of plastics in end of life vehicles) from a technology and research point of view, while associating as well costs consideration and environmental aspects. -

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Automotive materials recycling: a status report of U.S. DOE and industry collaboration

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Research programs, U.S.

AUTHORS/CONTACTS:
Edward J. Daniels, Argonne National Laboratory

ABSTRACT:
The objectives of this status report are: I) to briefly outline the current status of automotive materials recycling, 2) to provide an overview of the U.S. Department of Energy (DOE)/industry collaborative technology development to improve automotive materials recycling, to date, and 3) to outline the goals and objectives of DOE and industry's new five year automotive materials recycle research effort.

Today, about 75% of automotive materials are profitably recycled via parts reuse (through the dismantling industry), parts and components remanufacturing (through the remanufacturing industry) and, ultimately by materials recovery (through the scrap processing industry). Working with industry, the DOE has supported the development of technologies to increase the current level of automotive materials that are recycled. For example, a process for recovering and recycling flexible urethanes foams, developed at Argonne National Laboratory, is presently undergoing commercial demonstration. The DOE has also supported development of technology to improve the efficiencies of both steel and aluminum recycling. As the complexity of automotive materials and systems increases, new technologies will be required to sustain and maximize the ultimate recycling of these materials and systems at end-of-life. To meet the challenges of automotive materials recycling, the DOE has recently expanded its collaborative research in this area. This paper discusses current and planned recycle R&D.

REFERENCE:
Proceedings of the International Symposium on Ecomaterials and Ecoprocesses, The 42nd Annual Conference of Metallurgists, COM2003, Vancouver, British Columbia, Canada, August 24-27, 2003.

TITLE:
Market Driven Technology Development tor Sustainable End-ot-Life Vehicle Recycling: a Perspective from the United States

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Research Programs

AUTHORS/CONTACTS:
Edward J. Daniels
Bassam J. Jody
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Argonne National Laboratory

ABSTRACT:
To achieve greater fuel efficiency and safety, today's cars incorporate an increasing share of innovative lightweighting materials. While these materials greatly enhance efficiency during vehicle use, they can present special challenges for recycling. These challenges will persist as automotive designs and the mix of materials used in vehicles continues evolving to further improve safety and performance. To meet the challenges of automotive materials recycling, the U.S. Department of Energy is supporting research at Argonne National Laboratory in cooperation with the Vehicle Recycling Partnership of USCAR and the American Plastics Council. The scope of this cooperative government/industry approach to sustainable end-of-life vehicle (EL V) recycling is discussed. The paper will focus on research to develop technology to foster materials and resource recovery from shredder residue.

REFERENCE:
Proceedings of the 6th International Automobile Recycling Congress, Amsterdam, Netherlands, March 15-17, 2006.

TITLE:

Plastics Recycling and Ultimate Shredder Residues? How to Get Nearer to the ELV's 2015 Targets

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Research Programs

AUTHORS/CONTACTS:
Frédéricq Peigneux - COMET TRAITEMENTS (Group COMETSAMBRE)
Pierre François Bareel - University of Liège - Geomac Dpmt

ABSTRACT:
EU legislation on End-of Life Vehicles Recycling imposes ambitious (reuse, recycling and recovery) targets for 2006 and 2015. Shredder plants which recover most of the metals (Fe) produce about 20 to 25% of Shredder Residues. COMET TRAITEMENTS, member company of "Group COMETSAMBRE" -which integrates the whole chain of activities on ELV Recycling (dismantling, shredding, SR treatment) -is studying the process of SR for years, and had showed in 2004 that its industrial PST (Post Shredder Techniques) achieve the 2006 targets.

The next step and objective is now 2015!

REFERENCE:
Proceedings of the 6th International Automobile Recycling Congress, Amsterdam, Netherlands, March 15-17, 2006.

TITLE:
From Painted "Scrap" to Painted Production Parts

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle of painted industrial plastic scrap

AUTHORS/CONTACTS:
Veronica Mitchell and Matt Carroll, General Motors Corp.

ABSTRACT:
Saturn currently injection molds and paints PPE+PA66 exterior body panels in its Spring Hill, TN facility. These manufacturing operations result in a continuous stream of waste material that needs to be responsibly and economically managed. This paper will summarize the process that General Motors and Saturn used to evaluate and validate the use of post-industrial painted PPE+PA66 reprocess material in Saturn and General Motors' wheel trim applications (wheel covers). Not only did this project increase the amount of recycled content in General Motors' vehicles, but it also provided Saturn Corporation with a favored outlet for an internal waste stream.

REFERENCE:
From Painted "Scrap" to Painted Production Parts
SAE Paper 2000-01-0024

Section 6
Substances of Concern

TITLE:
Substances of Concerns: A Collaborative Database

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Substances of concern, Database

AUTHORS/AUTHORS/CONTACTS:
Marc Maguad, Chamber of Commerce and Industry
Francios Jallon, French Plastics Converters Federations

ABSTRACT:
As the automotives industry faces increasing pressure regarding substances and end-of-life issues, a group of OEMs, chemical suppliers and two professional organizations have joined their supports to generate a common database. This instrument, which contains regulatory requirements and automakers' standards will serve as a common reference to the entire automotive supply chain.

REFERENCE:
Substances of Concern: A Collaborative Database
SAE Paper No. 2001-01-3734

TITLE:
Screening Study to Evaluate Shredder Residue Materials

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Substances of concern, Cleaning and removal of SOCs from recycled materials

AUTHORS/CONTACTS:
Dr. Vahid Sendijarevic, Troy Polymers, Inc.
Nakia L. Simon, VRP/USCAR(DaimlerChrysler)
Dr. Claudia M. Duranceau, VRP/USCAR(Ford Motor Company)
Gerald R. Winslow, RP/USCAR (KBS Consulting Engineering)
Dr. Ronald L. Willliams, and Dr. Candace S. Wheeler, VRP/USCAR (General Motors)
Stephen F. Niemiec and Don R. Schomer, Polyurethane and Recycle and Recovery Council

ABSTRACT:
The Vehicle Recycling Partnership (VRP) initiated feasibility studies to evaluate the use of automated separation processes to recover plastics and polyurethane (PU) foams from shredder residue. One of the prevailing issues impeding the commercial process of these processes is contamination of the shredder materials. The contaminants include dirt, oil, glass, metal fines, polychlorinated biphenyls (PCBs) and heavy metals. The presence of PCBs and heavy metals was determined in a number of mixed plastics and PU form samples being separated using an automated separation process. An aqueous cleaning approach was investigated using various commercial surfactants to determine their effectiveness for removing oils, PCB s, and heavy metals. Mass balances of processed and cleaned materials were calculated to determine the cleaning efficiencies of the various surfactants.

REFERENCE:
Screening Study to Evaluate Shredder Residue Materials
SAE Paper 2004-01-0468

TITLE:
Methods for Protecting Automobile Shredders from Radioactive Contamination

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Substances of concern, radioactive contamination

AUTHORS/CONTACTS:
Steve Steranka, RAD/Comm Systems, Canada

ABSTRACT:
The presentation is meant to give an overview of the problem associated with shredding radioactive material and protecting the shredder from radioactive material. .

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Negotiated Performance Standard for the Removal of Mercury Switches from End-of-Life Vehicles - USA

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Substances of concern, mercury switches, U.S.

AUTHORS/CONTACTS:
Lynn Rubinstein, Executive Director, Northeast Recycling Council, Inc.

ABSTRACT:
Many programs have been launched in the U.S. to remove mercury switches from end-of-life automobiles. Because U.S. automobile manufacturers have stated that they cannot provide definitive information concerning the use of mercury convenience light switches and/or ABS brake system by make, model, and year, it has been very difficult to design and implement widespread programs that effectively capture all mercury switches. Consequently, learning which vehicles contain or may contain such switches, how many were installed in each vehicle, and the location of the switches in each make and model requires trial and error on the part of processors of end-of-life vehicles. In order to move beyond this obstacle, this project set out to develop a multi-party negotiated agreement to establish a performance standard for determining if dl mercury switches have been removed at the end of a vehicle's life.

Key stakeholder groups that participated in the negotiation included American and Japanese automobile manufacturers, automobile manufacturer trade associations, auto recyclers and auto recycler trade associations, scrap metal trade associations, environmental organizations, and utilities. The process included data collection and analysis, and the development of negotiated protocols for reporting. The project was organized and facilitated by the Northeast Recycling Council, Inc. (NERC), and was funded by the United States Environmental Protection Agency. This paper will present the negotiation process, key steps and products produced and a status report.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Exploring the End-Of-Life, Safety, and Regulatory Concerns for Flame Retarded Electrical and Electronic Equipment

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Substances of concern, flame retardants

AUTHORS/CONTACTS:
Raymond B. Dawson and Susan D. Landry

Albemarle Corporation

ABSTRACT:
Advances in the technology of electrical and electronic equipment (EEE) have resulted in transformations in our lives in both domestic and business settings. These improvements touch our lives in many ways. People across the globe have greater access to information and education due to the proliferation of computers, mobile phones, CDs, and televisions. Each year's new EEE demonstrate advances that push the envelope on size, speed, features that save time and energy, and cost-savings. All indications are that this market will continue to grow, particularly with improvements in technology. This growth has brought to light concerns over the environmental effects of materials used in this market. End-of-life issues, such as reuse-reduce-recovery-recycle; fire safety; and compliance with regulatory matters are all of major concern.'

This paper is a continuation of previous papers. It will explore these safety, compliance with regulatory (including the proposed WEEE and RoHS directives), and end-of-life issues for EEE. It will examine the effect that particular flame retardants can make toward meeting various demands placed on electrical and electronic equipment.

REFERENCE:
GPEC 2003, Proceedings of the 9th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 26-27, 2003, Detroit, MI.

TITLE:
Decomposition Process for Polychlorobiphenyl Containing 1 to 5 Chlorine by Using Basic Molten Salts as Reaction Field

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Substances of Concern

AUTHORS/CONTACTS:
O. Takeda, T. Handa, M. Kimura, Y. Yokka, Y. Sato

ABSTRACT:
A decomposition process for PCBs by using basic molten salts as a reaction field was investigated in order to establish a safe, simple and highly efficient decomposition process for polychlorobiphenyls (PCBs). PCB containing chlorine (e.g. 2, 2', 4, 4'-tetrachlorobiphenyl) dissolved in n-nonane solution was supplied into basic molten salts (NaOH-Na2CO3 or KOH-K2CO3) maintained at 500-700 ○C together with the carrier gas (N2-21% O2) through an injection tube. The injected PCBs in a bubble are decomposed by the reaction with the molten salts and oxygen during rise in the molten salts. The decomposition efficiency of PCBs increased with increasing temperature and was achieved to be higher than 99.995% in a certain condition. From a series of systematic study, the effectiveness of the decomposition process for PCBs by using molten salts was demonstrated.

CONCLUSION:

REFERENCE:
Proceedings of the TMS EPD Congress, 2008.

Section 7
Disassembly Technologies and Case Studies

TITLE:
Rapid Identification of Automotive Plastics in Dismantling Operations: Evaluation of Specular-Reflectance Infrared Spectroscopy Systems

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Dismantling, IR spectroscopy

AUTHORS/CONTACTS:
Stephen W. Garrenstroom. General Motors Research and Development Center
Patricia B. Coleman, Ford Scientific Research Lab.
Claludia M. Duranaceau, Ford Motor Co.

ABSTRACT:
Specular-reflectance infrared spectroscopy systems can identify the polymer material of an automotive part in about 5 seconds and are currently commercially available. Issues related to the rapid identification of plastics were recently examined at the Vehicle Recycling Development Center, which is operated by the United States Council for Automotive Research (USDAR). The accuracy of identification is a crucial concern in order to minimize co-mingling or contamination of sorted plastics in dismantling-sorting-recycling operations. Accuracy reports in the literature have ranged from 70% to >90%. Our investigation of the signal-to-noise levels of spectrometers, identification algorithms, and spectral reference libraries indicated that the quality-and-completeness of the reference library is the strongest determinant of accuracy when evaluating current commercial systems. With adequate spectral libraries, identification accuracy of 99% can be achieved. Further, most identification errors tend to be “near misses”, with polymers of similar composition chosen instead of the correct polymer. Foams and elastomers are problem specimens for specular-reflectance, because the give poor spectral reflectance and hence inadequate signals. Other concerns with specular reflectance of systems are rough surfaces verses smooth surfaces and the selection of coating-removal tools.

REFERENCE:
Rapid Identification of Automotive Plastics in Dismantling Operations: Evaluation of Specular-Reflectance Infrared Spectroscopy Systems
SAE Paper 970420

TITLE:
USCAR U.S. Field Trial for Automotive Polymers Recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Dissassembly for Materials Recovery

AUTHORS/AUTHORS/CONTACTS:
William W. Gallmeyer, VRP/USCAR (Gallmeyer Design & Development)
Claudia M. Duranceau, VRP/USCAR (Ford Motor Company)
Ronald L. Williams, VRP/USCAR (General Motors Corporation)
Gerald R. Winslow, VRP/USCAR (DaimlerChrysler/KBS Engineering)

ABSTRACT:
The United States Field Trial was chartered by the United States Council for Automotive Research/Vehicle Recycling Partnership (USCAR/VRP) with the objective of evaluating the feasibility and viability of collecting and recycling automotive polymers from domestic End-of-Life Vehicles (ELVs). European concerns regarding vehicle abandonment risks, decreasing landfill capacity, and disposal practices have resulted in the legislated treatment of ELVs in Western Europe. The emergence of attendant material collection schemes promoting material recycling may not apply to the free-market economic conditions prevalent in North America vehicle recycling infrastructure. Although ELVs are among the most widely recycled consumer products, 15-25% of their total mass is currently discarded with no material recovery, although their residue, when permitted, is a preferred landfill day cover in some areas. The portion of the vehicle remainder that is polymeric has to most potential for further recycling. In order to determine the potential success of polymeric recovery for further vehicle recycling within the North America recycling market, the United States Field Trial (USFT) was initiated in 1998 with interim documentation in 2000 (SAE 2000-01-0735). With the trial now completed, this paper reports on the entire project. The project identified North American ELV recycling practices, explored scenarios for plastic material handling, local transportation, sorting, processing, and compounding. Specifically, recovered ABS and PP plastic material were formulated to OEM specifications and molded using production tooling to establish the viability and economics of the pursuit of these materials as a commercial enterprise. Conclusions indicate that, while the materials and parts are acceptable, the economic incentives and altered logistics needed to support this endeavor will not currently be borne by existing North America market economics.

REFERENCE:
USCAR U.S. Field Trial for Automotive Polymers Recycling
SAE Paper No. 2001-01-0645

TITLE:
Recycling Study of Post-Consumer Radiator End Caps

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Disassembly, mechanical separation of disassembled parts

AUTHORS/CONTACTS:
Blaine Paxton, MBA Polymers, Inc.
John Caron, General Motors

ABSTRACT:
In June 1997, the Vehicle Recycling Partnership (VRP) and the American Plastics Council (APC) asked MBA Polymers to conduct a study to determine the technical and economic feasibility of recovering metals and plastics from end-of-life radiator end caps (RECs). The VRP worked with the Institute of Scrap Recycling Industries (ISRI) to obtain samples of RECs from two metal recycling companies, SimsMetal America and Aaron Metals.
MBA performed its standard Recyclability Assessment on the materials, which included a detailed density and material characterization study and an actual processing study using its pilot processing line. It was found that the polyamide from RECs could be recovered in reasonably high yield and purity using tight density separations.
The recycling of the REC samples used for this study generated about 40% nonferrous metal, 19% mixed ferrous and nonferrous metal and about 20% polyamide flakes. The composite recovered material values were estimated to be about $0.15 to $0.25 per pound of incoming material, including subtraction for disposal cost of unrecovered material. The range is due to material value ranges for the nonferrous, ferrous/nonferrous mix, and polyamide fractions.
MBA believes that the yields could be improved to about 52%, 6%, and 29% for the nonferrous, ferrous, and plastic fractions, respectively, with minor processing changes in a production operation. These changes would significantly improve the estimated composite recovered material values to between $0.19 and $0.32 per pound of incoming material.
The testing of the polyamide material demonstrated that it could be blended with virgin material to create a 25% post-consumer recycled content material exhibiting very good properties (near virgin). A significant drying challenge was encountered, however, by all three of the laboratories testing the material. The material had to be dried much longer than virgin material to prevent outgassing during extrusion, presumable due to absorbed coolant that is more difficult to evaporate than water. It is not clear if the residual coolant leads to property degradation during melt processing, therefore, extensive drying may not be an absolute requirement. Vented extrusion might be possible.

REFERENCE: Recycling Study of Post-Consumer Radiator End Caps
SAE Paper 1999-01-0666

TITLE:
Modeling and Solving of Product Disassembly Activity Logic Network

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Disassembly, process modeling

AUTHORS/CONTACTS:
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Junjun Hu, Multimedia Research Division, Guangdong Telecommunications Academy of Science and Technology

ABSTRACT:
Product disassembly is a basic period of life cycle design. This paper first introduces the modeling method and basic concepts of the disassembly activity logic network, then establishes the optimal model of the minimum disassembly cost. According to the characteristics of the model, the solution for the single disassembly object is acquired by constructing the orthogonal list storage structure and the reverse search algorism which follows the depth-first policy. At last, a complete example is illustrated.

REFERENCE:
Modeling and Solving of Product Disassembly Activity Logic Network
SAE Paper No. 2002-01-1259

TITLE:
Treatment Centre of End-of-Life Vehicles

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Disassembly, depollution

AUTHORS/CONTACTS:
Vicente Diaz and M. Guadalupe Fernandez, Carlos III Univ.

ABSTRACT:
Problems generated by waste coming from end-of-life vehicles (ELVs), the increase of the total number of cars and indiscriminate abandonment of vehicles has given rise to publishing of European Union Directive 2000/53/EC on ELV, in which measures intended for prevention and recovery of waste coming from ELVs are established.

A methodology relating to depollution and disassembly of ELVs is presented in this article, aspects that shall allow to describing the main guidelines that define future authorized centers for processing of ELV. The processes for depollution disassembly, re-use, recycling and recovery for elements and components have been analyzed so that experience has been attained both for present treatment of ELVs according to the European Directive and what refers to the future of recycling capacity of car vehicles coming into service at the present time.

REFERENCE:
Treatment Centre of End-of-Life Vehicles
SAE Paper No. 2001-01-3745

TITLE:
Design for Automotive Glass Removal Using Active Disassembly

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Disassembly, glass removal

AUTHORS/CONTACTS:
Nicholas Jones, David Harrison, Joseph Chiodo and Eric Billet,
Brunel University, Department of Design

ABSTRACT:
Active disassembly is a well researched technique for creating assemblies or casings that can break themselves apart for recycling using a heat trigger. 'Chiodo' has applied this principle to consumer electronic goods since the mid nineties. In response to pending EU legislation, the scope of active disassembly has broadened to include automotive disassembly. The first automotive demonstrators produced have been to make self-disassembling window glass retaining channels that enable easy glass removal for recycling. This waste glass can then be used in coastal defences as an alternative to landfill. Both shape memory alloy and shape memory polymer solutions have been successful. Optimization for the polymer solution is required.

REFERENCE:
Design for Automotive Glass Removal Using Active Disassembly
SAE Paper No. 2002-01-2246

TITLE:
Dutch ELV Recycling in Progress

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Disassembly, ARN, Netherlands

AUTHORS/CONTACTS:
Jan Zimmerman, Automobile Recycling Netherlands (ARN), Netherlands

ABSTRACT:
The Dutch recycling system suites the Directive, because the system

- Is based on producer responsibility
- Includes 'free of charge take back' for the last owner
- Introduced a 'certificate of disposal'
- Has set recycling and recovery targets that exceed the EU target of 2006
- Restricts the collection of ELVs to authorized and professional treatment facilities

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Finding a Balance Between Dismantling and Shredding

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Disassembly, dismantle vs shredding, Europe

AUTHORS/CONTACTS:
Maira Magnan, Kevin Sweeney, and Florian Golm, Ford Forschungszentrum Aachen GmbH
Martin Sander and Wolfram Seibert, Fargis GmbH - Institut für Fahrzeug- und Umwelttechnik

ABSTRACT:
The European directive on end-of-life vehicle (EL V) recycling will demand substantially more effort in the recycling of old vehicles than is currently the case. The increased reuse/recovery quotas foreseen (85% by 2006,95% by 2015) will require the development of recycling technologies and solutions addressing both achieving the legal requirements and doing so economically. This challenge can only be met when product, process and market are all considered with equal importance. In support of this requirement, this project examines the recycling processes and technologies as well as possible alternative processes and tools. Since the output product (recyclable material) is dependent on the input product (EL Vs), a closer investigation into EL Vs is needed with regard to material composition, quantity of cars being turned in for recycling, etc. A study of the material composition of a vehicle over time was necessary. Prices used for the calculations in this report are average prices collected from different sources; the assumed volumes necessary in order to achieve the given prices are based on a potential future market and not on an existing one. Since the amount of data necessary for such an analysis was quite large, the study was limited to Germany.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 12-14, 2003.

TITLE:
Future Developments in Car Recycling in the Netherlands

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Disassembly, ARN

AUTHORS/CONTACTS:
Dave Bebelaar , Auto Recycling Nederland (ARN), Netherlands
Prof. Wijnand Dalmijn, Delft University of Technology, Netherlands

ABSTRACT:
Auto Recycling Nederland (ARN) was established in 1993 by the automobile and automobile related branch organizations in the Netherlands in anticipation of the producers' responsibility stipulated in the European EL V directive. Ever since, ARN is the officially recognised authority for the recycling of cars in the Netherlands. Under the direction of ARN the requirements to realize an 85% recycling rate were met years before the implementation date of the directive. This was achieved predominantly by dismantling and recycling a list of hazardous and other materials on top of the metal content of cars.

ARN is now facing the next challenge of the directive to meet a 95% recycling target which in the Netherlands will be due in 2007. This cannot be achieved by simple continuation of the strategy of 'pre shredder' dismantling of materials. The strategy is therefore adjusted and the efforts will be concentrated on the treatment of shredder waste to meet the additional recycling quota.

Studies of different post shredder separation processes and tests run by ARN show that higher than 85% results are achievable with technology presently existing. How much higher is depending however not only upon technology but primarily on the marketability of the output fractions. Whether it is feasible to implement such technology in the Netherlands will depend on the economic parameters. Increasing the landfill cost will have a positive effect on the recycling efforts but can also have a negative influence on the economy of the car cycle. But above all market forces like the seemingly endless demand for secondary materials in China dictates what the nearby future will look like.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Recyclability of Selected Vehicles in North America

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Disassembly Technologies and Case Studies

AUTHORS/CONTACTS:
Richard T. Paul, Automotive Recycling Consultant

ABSTRACT:
The purpose of the recyclability pilot project was to evaluate and confirm the reality of reuse, material recycling and landfill potential of parts and components over a range of vehicles by model and year. A total of 18 vehicles, model years ranging from 1982 to 2001, were selected for study and processed at two automotive recycling centers and a scrap metal processing facility with an automotive shredder. The automotive dismantlers identified which parts and components were removed for reuse or remained with the hulk for further processing at an automotive shredder facility. Dismantling times and part weights were recorded and dismantling procedures were videotaped. The remaining hulks were delivered to the scrap metal processing facility for further processing. After shredding, the ferrous, nonferrous and landfill materials were separately collected for determining weights of these different process outputs. The data allow for multiple analyses, including the identification of parts and components frequently selected for reuse, dismantling times, ease of dismantling, high and low value parts and unique dismantling characteristics. Estimates of the fixed rate of recyclability and calculation of the actual total recyclability of selected models over a 20-year period were also made.

REFERENCE:
Proceedings of the 6th International Automobile Recycling Congress, Amsterdam, Netherlands, March 15-17, 2006.

TITLE:
The Recycling of ELVs from the Point of View of a Car Dismantler's Network

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Disassembly Technologies and Case Studies

AUTHORS/CONTACTS:
Wolfgang Kaerger, Managing Director
Callparts System GmbH, Germany

ABSTRACT:
Callparts System GmbH is a service company, located near Berlin in Germany. In 1995, the Callparts shareholders Mosolf (a car logistic company which also grants services to the automotive industry) and u-plus (specialist for the disposal of commercial and industrial waste) decided to establish in Germany a company which organises services for the automotive industry to achieve EL V treatment according to the European legislation. As a first step, a car dismantling company named MAS Fahrzeugrecycling GmbH was established and one year later, Callparts System GmbH, the former Preussag Recycling GmbH, was integrated into the group.

REFERENCE:
Proceedings of the 6th International Automobile Recycling Congress, Amsterdam, Netherlands, March 15-17, 2006.

TITLE:
The European 2000/53/EC Directive: Problems Regarding Recovered Materials

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Disassembly Technologies and Case Studies

AUTHORS/CONTACTS:
Luigi Bianchi, A.D.A. - National Association of Vehicle Dismantlers

ABSTRACT:

The European 2000/53/EC directive was incorporated in Italian legislation by means of legislative decree 209/03, which introduced a large number of often complex variations in the operations regarding the breaking up of old motor vehicles, of both administrative and operational natures, with a significant effect on the balance sheets of the single companies and, as a result, the sector as a whole.

We wish to focus our attention in particular on the problems deriving from the terms of article 7, paragraph 2, of the European directive, that is, the achievement of the objectives with regard to the recycling, recovery and reuse of the materials deployed in the manufacture of the vehicles.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands, March 9-11, 2005.

Section 8
Re-use of Automotive Parts and Subassemblies

TITLE:
Automotive Recycling as Reuse: Investigation to Establish the Contribution of Reuse on Recyclability

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Reuse, contribution to US recycle infrastructure

AUTHORS/CONTACTS:
Claudia Duranceau, Vehicle Recycling Partnership
Terry Lindell, Automotive Recyclers Association

ABSTRACT:
The goal of this paper is to define and quantify the contribution of used parts to vehicle recycling. In 1997, this research was stimulated when the Federal Trade Commission opened hearings on the definition of recycling. At this time, general facts about the automotive recycling industry and reuse of automotive parts were hard to find. This study's goal was to produce actual data on the contribution of reuse to vehicle recycling and to answer questions about the industry. Can accurate reuse measurements be calculated with data collected from recyclers? What should be the expected average performance of a company in the recycling industry? What effect can reuse have on landfill avoidance? The results of this study established that the sale and reuse of used parts played a significant role in vehicle recycling. The Automotive Recyclers Association, representing the existing industry, testified at the FTC hearings using preliminary results from this study. On May 1st 1998, the Federal Trade Commission in its report on the hearings recognized and included automotive part reuse as a form of vehicle recycling for time.

REFERENCE:
Automotive Recycling as Reuse: Investigation to Establish the Contribution of Reuse on Recyclability
SAE Paper 1999-01-0987

TITLE:
Agent-based Solutions to Support Car Recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Reuse of Automotive Parts and Subassemblies

AUTHORS/CONTACTS:
G. L. Kovacs and G. Haidegger
CIM Res. Lab., Comput. & Autom. Inst., Budapest

ABSTRACT:
Recycling and reuse urgently need development and introduction of advanced ICT networking technology, keeping in mind that recycling is crucial in achieving a global sustainable development through saving growing amounts of primary materials, and in diminishing global pollution. The requirements upon networking technology in ELV (end of life vehicles) recycling are exceptionally complex. The networking of small and medium enterprises (SMEs) involved in car recycling in Europe is of very high importance. Our project intends to develop a set of advanced (multi) agent-based ICT solutions, to support establishment and operation of dynamic networks of car recycling SMEs, and an appropriate methodology is provided, too. The specific complexity represents a multi-threaded character of networks, i.e. the participation of each SME in several value chains cause strong interconnection of networks

CONCLUSION:

REFERENCE:
Mechatroniucs, 2006 IEEE International Conference, July 2006

Section 9
Remanufacturing

Section 10
Mechanical Separation Technology

TITLE:
Size Reduction and Material Separation Technologies for the Recovery of Automotive Interior Trim ABS and PP Plastics from Dismantled End-of-Life Vehicles: Preliminary Research into Continuous Processing

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation of disassembled car parts

AUTHORS/CONTACTS:
Michael M. Fisher, American Plastics Council
Michael B. Biddle and Chris Ryan, MBA Polymers, Inc.; Metech International

ABSTRACT:
The life-cycle benefits of plastics in automotive applications are significant and continue to expand. Achieving cost-effective recycling of interior plastic components obtained from end-of-life vehicles (ELVs) remains a formidable technical and economic challenge worldwide. The America Plastics Council (APC) has pioneered large-scale process development work toward advancing environmentally and economically sound recovery technologies for plastics from ELVs. Groundbreaking studies have focused on the recovery of ABS and PP interior trim plastics. A combination of dry and wet processing of over 50,000 pounds of interior trim parts obtained through selective dismantling has been completed and streams of ABS and PP isolated. This work included the evaluation of fast mid-infrared plastics ID technology to facilitate the separation and purification process. Both sorted and unsorted trim was processed. The overall program objective was to obtain from both of these recovered automotive plastics in acceptable form for possible reuse in automobile or other applications. Detailed information on process equipment and plant design along with process strategies. This work quantified the limitations of density separation to achieve clean streams and unfilled PP, filled PP, and unfilled ABS interior trim plastics from end-of-life vehicles.

REFERENCE:
Size Reduction and Material Separation Technologies for the Recovery of Automotive Interior Trim ABS and PP Plastics from Dismantled End-of-Life Vehicles: Preliminary Research into Continuous Processing
SAE Paper No. 2001-01-0697

TITLE:
Advanced Separation of Plastics from Shredder Residue

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, Salyp process technology

AUTHORS/CONTACTS:
Gerald R. Winslow, VRP/USCAR (KBS Consulting Engineering)
Nakia L. Simon, VRP/USCAR (DaimlerChrysler)
Dr. Claudia M. Duranceau (VRP/USCAR (Ford Motor Company)
Dr. Ronald L. Williams and Dr. Candance S. Wheeler, VRP/USCAR (General Motors)
Dr. Michael M Fischer, American Plastics Council
Dr. Alex Kistenmacher, Association of Plastics Manufacturers in Europe
Ivan VanHerpe, Salyp NV

ABSTRACT:
The United States Council of Automotive Research (USCAR) under the Vehicle Recycling Partnership (VRP) along with our collaborators Argonne National Laboratory (ANL), American Plastics Council (APC) and the Association of Plastics Manufacturers in Europe (APME) has been conducting research on automated recovery of plastics from shredder residue. A Belgium company Salyp NV located in Ypres, Belgium has been contracted by the VRP to demonstrate a recovery process that can separate several plastic types including polyurethane foam out of the shredder residue stream. One hundred metric tons of shredder residue waste was supplied from three different metal recycling companies (shredders) including a US metal recycler as well as two different European metal recyclers/shredders. This shredder residue was evaluated and processed by Salyp. This paper explains the separation processes along with processing efficiencies, material characterization, mass balances and the amount of plastics recovered. Results of a plastics testing phase are also reported, along with a molding evaluation by an automotive supplier Collins & Aikman, which molded several automotive parts.

REFERENCE:
Advanced Separation of Plastics from Shredder Residue
SAE Paper 2004-01-0469

TITLE:
Upgrading Scrap Quality By Improving Shredder Operation

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation

AUTHORS/CONTACTS:
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Jean Pierre Birat
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ABSTRACT:
As a renewable raw material originating from steel recycling, scrap is an important resource for the steel industry in the perspective of sustainable development. This resource needs to be managed carefully, in order to avoid pollution by tramp elements due to sloppy practices during the recycling and scrap preparation stages. Among the process reactors that the scrap industry uses, the shredder is the most versatile tool. with a large potential for quality control. The study presented in this paper aimed at estimating and demonstrating how far the shredder can help improve the quality and purity in tramp elements of scrap, through an experimental approach.

A first part of the work has been concentrating on the first order parameters that control shredded scrap quality, Le. control of input material. including pre-treatment prior to shredding, and careful sorting at shredder exit. making use of existing technologies. The results obtained have shown that a simple dismantling before shredding, a sieving extraction of the fine shredded particles or a better hand-picking and magnet sorting practices are the three methods that come out of this study as both technically feasible and economically reasonable.

A longer-term approach, based on a more basic analysis of the process engineering behavior of the scrap shredder. has also been conducted on a shredding pilot plant. which belongs to an association of scrap processors and steelmakers called the CTRA. It is a small industrial shredder, with a driving power of 400 kW, which is large enough to process a car. It has special features such as the control of the input rate, rotor speed, grid mesh, suction power and magnet parameters as well as sophisticated sorting technologies at shredder exit.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Studies on Optimizing the Cryogenic Process for Recycling Plated Plastic to Achieve Improved Quality of Remolded Parts

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, cryogenic grinding

AUTHORS/CONTACTS:
Richard Dom and Gary Shawhan, American Society of Electroplated Plastics
Jackie Kuzio, Angela Spell, and Matt Warren, Air Products and Chemicals, Inc.

ABSTRACT:
Electroplated plastic from hubcaps was cryogenically ground and magnetically separated into a metallic and a recyclable plastic stream. A high purity plastic was achieved using a magnetic, multi-pass separation process. The ground plastic was palletized and molded. The recycled samples revealed properties very similar to a pure unprocessed resin and an unplated, control plastic which had been cryogenically ground and remolded. Only elongation properties of the plated and unplated, material degraded as compared to the pure resin. The favorable recycled resin performance warrants additional testing of electroplated plastics and investigation the benefits of incorporating varying percentages of this recycled material with virgin resin.

REFERENCE:
Studies on Optimizing the Cryogenic Process for Recycling Plated Plastic to Achieve Improved Quality of Remolded Parts
SAE Paper 970664

TITLE:
Economical Aspects of Automobile Recycling CITRON's solution for ASR

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, CITRON S.A.

AUTHORS/CONTACTS:
Christopher Günther, CITRON S.A.

ABSTRACT:
CITRON is operating a plant for the recycling of metal containing organic and inorganic wastes including automobile shredding residues (ASR), hydroxide sludges, grinding sludges and household batteries. Since August 1999, the industrial plant is operational with a treatment capacity of 130'000 tons. In 2000, more than 10.000 tons of ASR were recycled.

General economic and ecological parameters for ASR-Recycling are analysed and a calculation of a new ASR-plant is presented.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Industrial Recycling of Plastics from Automotive Shredder Residues

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, GALLOO

AUTHORS/CONTACTS:
Olivier Francois and Hugues de Feraudy, Galloo, France

ABSTRACT:
GALLOO PLASTICS was created in 1997 by GALLOO and ENVIRONNEMENT 2000.

Nowadays, the part of thermoplastic materials in consumer goods keeps growing and at the same time, the metallic content of these products gets smaller.

Consequently, while these materials are being recycled, not only incomes from metal keep decreasing, but treating costs of these organic material increase too. .

Therefore, a solution had to be found in order to perpetuate the recyqling channel of these products. This is the reason why GP was created in order to recycle end-of-life consumer goods (cars, home appliances..) .

Rather than to make a long statement on the use or not of recycling plastic material from shredder residues, I would rather like to present you the concrete case of GP, that is, the case of an industrial and business reality.

While people were talking more and more about manual dismantling of plastic pieces for recycling, GP preferred to choose the solution that implemented the recognition and the automatic sorting of these pieces, but already grinded.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Mass-Balance in Post-Shredding Technology: Results of a Trial Based on the Shredding of 201 ELVs – A Joint Work of Galloo, PSA, and Renault

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, GALLOO, Belgium

AUTHORS/CONTACTS:
Olivier Francois, Group GALLOO Recycling, Belgium

ABSTRACT:
In order to check the latest post-shredding technologies available, at an industrial scale, and to quantify their impact on the shredded vehicles recovery, a shredding test based on 201 ELVs has been conducted by the Galloo group during winter 2002:

- The first main innovation of this trial is the fact that ill.!. the EL Vs shredded were complete: coming directly from the last user, as they are collected now in Belgium, from the dealer's shop straight to the depollution center, and finally to the shredder, without dismantling aside the depollution's requirements.

- The second main innovation comes from the use, at nominal efficiency, of the plastic sorting capacity of the Galloo-Plastics processes, operational from 2000 at 12.000 tons/year level, and rise at 18.000 tIyear in 2003. The 201 ELV's trial included the polvolefin sorting (PP, polypropylene, and PE, polyethylene), and also the polvstvrenics sorting now available for GP production of compounded granulates.

- In addition to these 2 important innovations quoted above, PSA (Peugeot Citroen) and Renault performed a mass-balance of the 201 shredded vehicles based on the material composition of the E"LVs selected for the trial.
  To our knowledge, it is the first time we can evaluate the shredder efficiency for ELV's metals mass-balance, and also for the ELV's plastics mass-balance.

The driving force of this trial is to give a reliable experimental data needed for the calculation of the EL V's valorization rate, when this one will be available from the ongoing discussion at the European level.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 12-14, 2003.

TITLE:
The Automation of Automobile Recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, Delft University

AUTHORS/CONTACTS:
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Delft University of Technology
Faculty of Civil Engineering and Geosciences,
Department of Geotechnology, Resource Engineering
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ABSTRACT:
After shredding, ferrous and non-ferrous metals from automobiles can be recycled at high efficiency and relatively low costs. Another fact is that the costs of prior dismantling of non-metallic fractions for specific treatment are high. Unfortunately industrial processing of the postshredder non-metals mix requires considerable effort. Its products have up till now low economic value and there remains residue to be disposed against costs. When high recycling rates are required it provides an incomplete alternative to prior dismantling. On the other hand the objective of the car industry is to recover the maximum amount of materials from end-of-life (EOL) cars. This can only be I achieved against acceptable costs when the best possible match between supply of EOL cars and demand on the various raw materials markets is found. The treatment can be subdivided into dismantling, metal recovery and (non-metallic) residue treatment. Of each operation costs can be reduced by maximising returns on the extracted fractions and minimising process costs by process control and newly designed equipment.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands, March 9-11, 2005.

TITLE:
Automatic and Industrial Sorting For ASR Thermoplastics at Galloo Plastics SA in Halluin Plant

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, GALLOO

AUTHORS/CONTACTS:
Hugues de Feraudy, Galloo Plastics SA, France

ABSTRACT:
For hundred years the world has produced more and more automotive vehicles. At the origin, they were made up mainly of metallic and wood parts. Little by little, they have been more and more sophisticated by the introduction of new functions to better their performance, safety, economy, ergonomy and so on.

During the year 1990, the introduction of more and more thermoplastics have improved safety and economy.

Today, as for the majority of common goods, the thermoplastic materials have substitute parts of the metals and it is not finished.

As for the metals, the thermoplastics can be melded again; so these can be recycled.

Due to the evolution and life cycle, the automotive car lasts longer and longer. Today we consider that a car is recycled around fifteen years after its construction. That means it is only now that we really find thermoplastics in the end of life vehicle (EL V).

In the ELV, we can find:

- metals (ferrous and non ferrous),
- minerals (insulation, glass, concrete stabilizators)
- organics (wood, plastics and so on)

Today with the technologies developed by Galloo and Galloo Plastics SA, it is possible to extract selectively all the main components of these goods.

We will focus today on the treatment of the shredded residues after the recovery of the metals.

We will see an original approach to extract plastics by family and the different constituents of these families providing new original row materials to substitute virgin ones.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands, March 9-11, 2005.

TITLE:
END-OF-LIFE VEHICLE RECYCLING: THE VOLKSWAGEN-SICON PROCESS® FOR THE RECYCLING OF SHREDDER RESIDUES

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, VW-Sicon process

AUTHORS/CONTACTS:
Heiner Guschall, Managing Director, SiCon GmbH
Dr. Wolfgang Lindner, Managing Director, Dr. Lindner GmbH
Sebastian Schulke, Project Manager, SiCon GmbH
Florian Haug, Project Manager, SiCon GmbH

ABSTRACT:
… since the fall of 1999, Volkswagen in cooperation with SiCon is working on the development of a process to achieve a user-oriented production of recyclable materials by mechanically processing shredder waste. The process consists of a processing and a recycling phase. Processing, mainly aimed at material recycling solutions, considers the requirements of existing industrial-scale recycling operations. During implementation planning, potential buyers of recyclable materials, already familiarized with the concept over a period of years through intensive canvassing, and shredder plant operators are brought together. This ensures markets for the products and guarantees recycling.

By stage crushing, classification and separation based on physical parameters such as specific gravity, grain shape, magnetizability, electrical conductivity and optical properties, more than 95 % of shredder waste can be converted into recyclable fractions. Specific process steps produce the following fractions:

- "Shredder Granules" (hard plastics, rubber),
- "Shredder Fibres" (foam, textiles),
- "Shredder Sand" (glass, rust, iron particles, heavy metals)

for which applications have already been studied and field-proven.

The Volkswagen-SiCon process® has been specifically developed for shredding of EL Vs, but may as well be applied for shredder residues from other sources. In close cooperation with the recycling partners, the process is to be implemented EU-wide in order to create a sustainable solution which will accomplish the environmental objectives at acceptable cost. A reference unit is currently in the planning phase in order to offer the market a technology based on market-oriented solutions.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands, March 9-11, 2005.

TITLE:
Separation and Recovery of Thermoplastics from Mixed-Scrap Plastics

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, Argonne National Laboratory

AUTHORS/CONTACTS:
J.A. Pomykala, Jr.
B.J. Jody
E.J. Daniels
J.L. Greminger

Argonne National Laboratory

ABSTRACT:
This paper describes a flotation process developed by Argonne National Laboratory (ANL) for separating and recovering individual plastics at high purity and yield, from mixed post-consumer and post-manufacturing scrap sources. The physical separation, flotation, and froth-flotation techniques developed by Argonne National Laboratory (ANL) were successfully used to recover plastics from several waste streams including nylon resin manufacturing waste, plastic films from curbside recycling and obsolete music CD's. A pilot plant with a design capacity of 50 pound/ill was successfully operated to produce high-purity Polyethylene (PE), Polypropylene (PP), Polycarbonate (PC), polystyrene (PS), and nylon at purity levels exceeding 98% and yields in excess of 80%. Economic analysis of the process showed a potential payback of about 2 years. This paper describes the process and discusses the technical and economic results obtained for the various waste streams.

REFERENCE:
GPEC 2003, Proceedings of the 9th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 26-27, 2003, Detroit, MI.

TITLE:
Instrument Panel Recycling; A Commercial Breakthrough Eliminates the Waste

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, instrument panels, American Commodities

AUTHORS/CONTACTS:
Mark Lieberman
American Commodities, Inc.

ABSTRACT:
Since the inception and commercialization of padded instrument and door panels for automobile applications, manufacturers have struggled with the problem of scrap and waste related to the production of these parts and components. American Commodities presents a solution to this scrap and waste issue. A joint effort between American Commodities and ACI/WIPAG (American Commodities' Europeanjoint venture) has commercialized an automated technique for being able to recover instrument and door panel waste from these multi-layer laminate applications. This ground breaking technology separates the skin, foam, and substrate materials in 3 clean autonomous streams and enables the producer to reuse this scrap in making new first quality parts. This technology first liberates the 3 materials and then segregates them into separate streams of high purity. The result enables manufacturers to eliminate the landfill associated with the production of these parts and significantly reduce the cost of raw materials by reusing the scrap that was previously discarded. ACI will present an overview of the collection, separation, quality control, and reintroduction of this material into direct OE Automotive applications.

REFERENCE:
GPEC 2003, Proceedings of the 9th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 26-27, 2003, Detroit, MI.

TITLE:
The Pre-Production Pilot Plant Processing of Automotive Shredder Residues

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, RPI

AUTHORS/CONTACTS:
Ronald W. Kobler, M.S., Recovery Plastics International
Gerald Winslow, DaimlerChrysler
Christopher J. Bedell, P .E., The David J. Joseph Company
Pat Christopher, Hugo Neu Corporation

ABSTRACT:
Automated processing techniques, recovered plastics, and processing economics are described from pilot plant processing of automotive shredder residue. Program participants included major metal shredders Hugo Neu and The David J. Joseph companies, and vehicle manufacturer DaimlerChrysler. The recovered plastic materials were utilized by DaimlerChrysler to produce recycle content components in more than 20 automotive plastic systems for the CARE CAR II program. The processing was conducted at Recovery Plastics International's pilot production facilities in Salt Lake City, Utah. The Pre-Production program paves the way to cost effectively utilize an automated recovery process to recycle materials from landfill-destined automotive shredder residues.

REFERENCE:
GPEC 2002, Proceedings of the 8th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 13-14, 2002, Detroit, MI.

TITLE:
Materials Recovery From Shredder Residues

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, Argonne National Laboratory

AUTHORS/CONTACTS:
E. J. Daniels
B. J. Jody
J. Pomykala, Jr.

Argonne National Laboratory

ABSTRACT:
Each year, about five (5) million ton of shredder residues are landfilled in the United States. Similar quantities are landfilled in Europe and the Pacific Rim. Landfilling of these residues results in a cost to the existing recycling industry and also represents a loss of material resources that are otherwise recyclable. In this paper, we outline the resources recoverable from typical shredder residues and describe technology that we have developed to recover these resources.

REFERENCE:
Proceedings of the Fourth International Symposium on Recycling of Metals and Engineered Materials, October 22-25, 2000.

TITLE:
A Novel Approach to the Mechanical Processing of ASR

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical processing, Delft University

AUTHORS/CONTACTS:
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E. A. Schokker
P. C. Rem
W. L. Dalmijn

Delft University of Technology
The Netherlands

ABSTRACT:
ABSTRACT Many processes developed for the mechanical processing of Automotive Shredder Residue (ASR) suffer from high processing costs. We offer a distinct concept for low-cost mechanical processing still allowing high value-added recycling of the recovered materials. The basic idea behind this approach is to produce saleable pre-concentrates at the lowest possible costs that can be further processed in existing separation facilities. Our process includes screening, size reduction and magnetic separation. Preliminary studies showed that fibers in ASR are magnetic due to adhering rust particles allowing separation into a fiber traction and a non-magnetic rigid traction by high-intensity magnetic separation. The fiber traction is most suited for thermal processing. The rigid traction mainly consists of plastics and rubbers with up to 10 wt.-% of non-ferrous metals, some inert material and copper wires. This traction is very well suited for mechanical processing by, e.g., sink-float separation in existing metal separation plants. The non-metal traction can be processed further to recover the plastics and rubbers. The process proposed in this study is expected to be substantially cheaper than full thermal processing. In addition, as it mainly relies on existing separation facilities, it can be applied in the short term.

REFERENCE:
Proceedings of the Fourth International Symposium on Recycling of Metals and Engineered Materials, October 22-25, 2000.

TITLE:
Cost Effective Recovery Of Thermoplastics From Mixed-Scrap

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, froth flotation, Argonne National Laboratory

AUTHORS/CONTACTS:
B. Jody
J. Pomykala
E. Daniels

Argonne National Laboratory

ABSTRACT:
More than 12 million automobiles and trucks and about 2 million tons of appliances (refrigerators, washers, dishwashers, dryers, computers, air conditioners, etc.) are disassembled and/or shredded in the U.S. annually to recover their metals content A by-product of the metal-recovery operations is the nonmetallic fraction, known as automobile shredder residue (ASR). This waste is about 30 % by weight plastics. Current technologies for recovering plastics from such waste streams are not cost-effective. Therefore, these plastics are disposed of in landfills at the cost of about $20-$50 per ton of ASR. Furthermore, the amount of plastics used in these durable products is increasing. In 1996, about 4.3 billion pounds of plastics were used in appliance and automobiles. In 2006 it is expected to be about 5.5 billion pounds, Figure 1.

More than two dozen types of plastics are used in appliances and automobiles and most of these plastics are not compatible with each other. Therefore, most of them must be separated individually at high purity rates in order to be marketed as value-added materials. Successful development and application of a technology for the separation of these plastics could conserve as much as 100 trillion Btu/yr and reduce the amount of waste going to the landfill by about a million tons annually. The major problems facing the recycling of these plastics include:

1) Collection. For some items, such as automobiles and large home appliances (refrigerators, dishwashers and dryers) the infrastructure for the collection of the absolute articles already exist. For others, such as computers and smaller electronic devices the collection process is not fully developed yet
2) Cost-effective technology for the separation of the plastics from the waste stream and from each other is not commercially available. This issue is the subject of this paper.
3) Markets for recycled plastics are not developed yet.

REFERENCE:
Materials Technology and Advanced Performance Materials, Vol. 18, No. 1, pp. 18-24 (March 2003).

TITLE:
Electrostatic Separation and Recovery of Mixed Plastics

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, electrostatic, Plas-Sep

AUTHORS/CONTACTS:

Chuanfu (Chuck) Xiao
Laurence Allen III
Michael B. Biddle
MBA Polymers, Inc.

Michael M Fisher
American Plastics Council

ABSTRACT:
A triboelectric separator manufactured by Plas-Sep, Ltd., Canada was evaluated at MBA Polymers, Inc. as part of a project sponsored by the American Plastics Council (APC) to explore the potential of triboelectric methods for separating commingled plastics :from end-of-life durables. The separator works on a very simple principle: that dissimilar materials will transfer electrical charge to one another when rubbed together, the resulting surface charge differences can then be used to separate these dissimilar materials from one another in an electric field.

Various commingled plastics were tested under controlled operating conditions. The feed materials tested include commingled plastics derived from electronic shredder residue (ESR), automobile shredder residue (ASR), refrigerator liners, and water bottle plastics. The separation of ESR ABS and HIPS, and water bottle PC and PVC were very promising. However, this device did not efficiently separate many plastic mixtures, such as rubber and plastics; nylon and acetal; and PE and PP from ASR.

All tests were carried out based on the standard operating conditions determined for ESR ABS and HIPS. There is the potential to improve the separation performance for many of the feed materials by individually optimizing their operating conditions.

Cursory economics shows that the operation cost is very dependent upon assumed throughput, separation efficiency and requisite purity). Unit operation cost could range from $0.03/lb. to $0.05/lb. at capacities of 2000 lb./hr. and 1000 lb./hr.

REFERENCE:
ARC ’99 Quality is the Answer, 6th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 9-11, 1999, Detroit, MI.

TITLE:
Separation and Recovery of Thermoplastics by Froth Floatation

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation, froth flotation, Argonne National Laboratory

AUTHORS/CONTACTS:
D. E. Karvelas
B.J. Jody
Joe Pomykala Jr.
E .J. Daniels

Argonne National Laboratory Argonne, Illinois

ABSTRACT:
This paper describes efforts by Argonne National Laboratory to develop a troth flotation process for separating and recovering plastics trom mixed plastics waste streams generated from shredding obsolete appliances and automobiles. A process for recovering and separating equivalent-density ABS and HIPS from obsolete appliances was developed and pilot-tested with a through-put of 1,250 lbs/hr. The basic process is outlined: unit operations and equipment are discussed, and material balances are presented. The resulting ABS product was analyzed and its physical and mechanical properties were established. Its properties resembled those of virgin, midgrade ABS that is commercially sold today and is widely used by the automotive industry. Injection-molding tests were also conducted by automotive-components suppliers, using the 100% recovered ABS. Headlamp "back-cans" and automotive ventilation-system duct components were injection molded and the results showed that the recovered ABS met the specifications for these applications. These results confirmed that the recovered ABS can be used as a substitute for virgin plastic materials for molding highly complex automotive component designs, and in parts for other durable goods. Economic analysis of a commercial-scale system was also performed using manufacturers' equipment quotes and operating data from the pilot plant, and it predicts a simple payback of less than 2 years for plants producing about 850 tons per year of ABS.

REFERENCE:
ARC ’99 Quality is the Answer, 6th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 9-11, 1999, Detroit, MI.

TITLE:
Automatic and Industrial Sorting for ASR Thermoplastics at Galloo Plastics SA in Halluin Plant

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical Separation Technology

AUTHORS/CONTACTS:
Hugues de Feraudy, Galloo Plastics SA, France

ABSTRACT:
For hundred years the world has produced more and more automotive vehicles. At the origin, they were made up mainly of metallic and wood parts. Little by little, they have been more and more sophisticated by the introduction of new functions to better their performance, safety, economy, ergonomic and so on.

During the year 1990, the introduction of more and more thermoplastics have improved safety and economy.

Today, as for the majority of common goods, the thermoplastic materials have substitute parts of the metals and it is not finished.

As for the metals, the thermoplastics can be melded again; so these can be recycled.

Due to the evolution and life cycle, the automotive car lasts longer and longer.
Today we consider that a car is recycled around fifteen years after its construction.
That means it is only now that we really find thermoplastics in the end of life vehicle (EL V).

In the ELV, we can find:- metals (ferrous and non ferrous), - minerals (insulation, glass, concrete stabilizators) - organics (wood, plastics and so on)

Today with the technologies developed by Galloo and Galloo Plastics SA, it is possible to extract selectively all the main components of these goods.

We will focus today on the treatment of the shredded residues after the recovery of the metals.

We will see an original approach to extract plastics by family and the different constituents of these families providing new original row materials to substitute virgin ones.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands,
March 9-11, 2005.

TITLE:
End-of-Life Vehicle Recycling: The Volkswagen-SiCon Process® for the Recycling of Shredder Residues

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical Separation Technology

AUTHORS/CONTACTS:
Heiner Guschall, Managing Director, SiCon GmbH
Dr. Wolfgang Lindner, Managing Director, Dr. Lindner GmbH
Sebastian Schulke, Project Manager, SiCon GmbH
Florian Haug, Project Manager, SiCon GmbH

ABSTRACT:
European Union lawmakers have extended product responsibilities of car manufacturers beyond the end of the useful life of their products and have established high recycling rates for ELVs, which will take effect in 2006 or 2015 respectively. Regulatory requirements on the European level as well as on the national level of member states together with implementation of technical processes for the recycling of EL V's pose considerable challenges for both the recycling and the automotive industry.

Initially, manual dismantling of vehicle parts was the solution most industry insiders favoured. For reasons of cost-effectiveness however, this option is not feasible in wage-intensive countries. In addition, this method produces secondary materials for which exist only limited markets. Therefore, the main focus of all activities aimed at meeting the established recycling rates in a costeffective manner is the development and implementation of processes with minimum manpower assignment to recover recyclable fractions of the waste currently disposed of in landfills. We need to find intelligent recovery solutions fitting the technical know-how of an industrialized Europe.

As a result, since the fall of 1999, Volkswagen in cooperation with SiCon is working on the development of a process to achieve a user-oriented production of recyclable materials by mechanically processing shredder waste. The process consists of a processing and a recycling phase. Processing, mainly aimed at material recycling solutions, considers the requirements of existing industrial-scale recycling operations. During implementation planning, potential buyers of recyclable materials, already familiarized with the concept over a period of years through intensive canvassing, and shredder plant operators are brought together. This ensures markets for the products and guarantees recycling.

By stage crushing, classification and separation based on physical parameters such as specific gravity, grain shape, magnetizability, electrical conductivity and optical properties, more than 95 % of shredder waste can be converted into recyclable fractions. Specific process steps produce the following fractions:

- "Shredder Granules" (hard plastics, rubber),
- "Shredder Fibres" (foam, textiles),
- "Shredder Sand" (glass, rust, iron particles, heavy metals)

for which applications have already been studied and field-proven.

The Volkswagen-SiCon process® has been specifically developed for shredding of ELVs, but may as well be applied for shredder residues from other sources. In close cooperation with the recycling partners, the process is to be implemented EU-wide in order to create a sustainable solution which will accomplish the environmental objectives at acceptable cost. A reference unit is currently in the planning phase in order to offer the market a technology based on market-oriented solutions.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands,
March 9-11, 2005.

TITLE:
Mass Balance and Composition Analysis of Shredder Residue

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical Separation Technology

AUTHORS/CONTACTS:
J. A. Pomykala, Jr., B. J. Jody, J. S. Spangenberger and E. J. Daniels
Argonne National Laboratory, Argonne, IL, USA

ABSTRACT: The process of shredding end-of-life vehicles to recover metals results in a byproduct commonly referred to as shredder residue. The four and a half million metric tons of shredder residue produced annually in the United States is presently land filled. To meet the challenges of automotive materials recycling, the U.S. Department of Energy is supporting research at Argonne National Laboratory in cooperation with the Vehicle Recycling Partnership (VRP) of the United States Council for Automotive Research (USCAR) and the American Plastics Council. This paper presents the results of a study that was conducted by Argonne to determine variations in the composition of shredder residue from different shredders. Over 90 metric tons of shredder residues were processed through the Argonne pilot plant. The contents of the various separated streams were quantitatively analyzed to determine their composition and to identify materials that should be targeted for recovery. The analysis established a reliable mass balance for the different materials in shredder residue.

CONCLUSION:

REFERENCE:
2007 SAE Transactions Journal of Materials & Manufacturing, August, 2008
SAE Paper No. 2007-01-0527

TITLE:
Recovery and Recycling of Polymers from Shredder Residue

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical Separation Technology

AUTHORS/CONTACTS:
B. J. Jody, J. A. Pomykala, Jr., J. S. Spangenberger, and E. J. Daniels
Argonne National Laboratory, Argonne, IL, USA

ABSTRACT:
Metals recovery from end-of-life automobiles, home appliances and other metals containing scrap involves shredding these items and then recovering the metals from the shredded material. The remaining non-metallic fraction, commonly called shredder residue is presently landfilled. Over four and a half million metric tonnes of shredder residue is generated in the United States annually and essentially all of it is landfilled. About 15 million tonnes are generated worldwide. Shredder residue contains, among other materials, polymers that could be recovered and recycled. Argonne National Laboratory is developing technology for producing revenue streams, such as plastics, from shredder residue. This paper describes a process developed by Argonne National Laboratory for the separation and recovery of plastics from shredder residue. The process consists of two parts. First, the plastics are mechanically separated from the shredder residue as a mixed polymer concentrate and then the individual plastics are separated from the polymer concentrate via a froth flotation process. The process has been demonstrated in a mechanical separation pilot plant that has a design capacity of 1.8 tonnes/hour followed by a froth flotation pilot plant that has a capacity of 500 kg/hour. Preliminary process economic analyses indicate that the process is potentially economical.

CONCLUSION:

REFERENCE:
The Journal of Solid Waste Technology and Management, Vol. 23, No. 4, Nov 2006, PP 228-236

TITLE:
Unit and method for processing of shredder residues and uses of a sand fraction produced thus

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical Separation Technology

AUTHORS/CONTACTS:
Daniel Goldman (Goslar, DE)
Bram den Dunnen; (Wolfsburg, DE)
Michael Knust; (Isenbuettel, DE)

ABSTRACT:
A method and system are for sorting shredder residues of metal-containing wastes, in particular of body shells Shredder residues are separated into a shredder light fraction and a non-ferromagnetic fraction (shredder heavy fraction). During the sorting of the shredder light fraction and the shredder heavy fraction in preliminary processes and a main process, a crude-sand fraction is produced by separating out at least a ferromagnetic fraction, a fraction containing nonferrous metals, a fiber fraction, and a granulate fraction. In a refining process, the crude-sand fraction is separated into a residual fraction rich in organics, a dust fraction containing heavy metals, a sand fraction depleted in organics and metals, and a metallic fraction, using the sequential process steps of density separation and metal separation.

CONCLUSION:

REFERENCE:
U.S. Patent No. 7,389,880; Goldman et.al., June 24, 2008

TITLE:
Process to recycle shredder residue

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical Separation Technology

AUTHORS/CONTACTS:
Bassam J. Jody, Edward J. Daniels, Patrick V. Bonsignore
Argonne National Laboratory, Argonne, IL, USA

ABSTRACT:
A system and process for recycling shredder residue, in which separating any polyurethane foam materials are first separated. Then separate a fines fraction of less than about 1/4 inch leaving a plastics-rich fraction. Thereafter, the plastics rich fraction is sequentially contacted with a series of solvents beginning with one or more of hexane or an alcohol to remove automotive fluids; acetone to remove ABS; one or more of EDC, THF or a ketone having a boiling point of not greater than about 125.degree. C. to remove PVC; and one or more of xylene or toluene to remove polypropylene and polyethylene. The solvents are recovered and recycled.

CONCLUSION:

REFERENCE:
U.S. Patent No. 6,329,436; Jody et.al., December 11, 2001

TITLE:
System and process for separating and recovering/recycling solid wastes and waste streams

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical Separation Technology

AUTHORS/CONTACTS:
Paul A. Olivier

ABSTRACT:
A system and process for continuously separating and recovering materials from a heterogeneous mixture of particulate solids, from a solid waste or waste stream source, which uses a plurality of liquid media of different specific gravity to effect the separations, the solids having a plurality of different specific gravities and the recovered fractions each having a different specific gravity, wherein a first separation vessel receives the heterogeneous mixture, contacts the material with a first liquid medium having a first specific gravity of about 1.0, thereby causing a first part of the mixture to rise in the liquid medium as float particles, the remaining part to settle as sink particles, removing the separated float particles and sink particles without intermixture, then providing a second separation vessel, which receives the sink part from the first separation vessel contacts the material with a second liquid medium having a second specific gravity different from that of the first liquid medium, thereby causing a first particle of the material to rise in the liquid medium as float particles, the remaining part to settle as sink particles, and removing the separated float particles as a substantially organic particulate mixture, and the separated sink particles as a substantially inorganic particulate mixture, without intermixture between the product streams.

CONCLUSION:

REFERENCE:
U.S. Patent No. 6,024,226; Olivier, February 15, 2000

TITLE:
Efficient continuous dryer for flexible polyurethane foam and cleaning apparatus

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical Separation Technology

AUTHORS/CONTACTS:
Bassam Jody, Edward Daniels, Joseph A. Libera
Argonne National Laboratory, Argonne, IL, USA

ABSTRACT:
A method of cleaning polyurethane foams where the material is transported through a wash station while alternately soaking the polyurethane foam in an organic solvent and squeezing solvent from the polyurethane foam a number of times. Then the polyurethane foam is sent through a rinse or solvent transfer station for reducing the concentration of solvent in the foam. The rinsed polyurethane foam is sent to a drying station wherein the foam is repeatedly squeezed while being exposed to hot air to remove wet air from the foam.

CONCLUSION:

REFERENCE:
U.S. Patent No. 5,882,432; Jody et.al., March 16, 1999

TITLE:
Automobile shredder residue-synthetic plastic material composite, and method for preparing the same

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical Separation Technology

AUTHORS/CONTACTS:
Jack Lazareck, Winnipeg, MB, CA
Martin Walsh, Brampton, Ont., CA

ABSTRACT:
A method is provided for processing a mixture raw automobile shredder residue, and virgin and/or contaminated synthetic plastic material, e.g., raw post consumer plastic waste. By means of this method, automobile shredder residue produced by a conventional automobile shredder is formed into a first stream by being ground in a first granulating zone to a reasonable small granular size using conventional equipment. A second stream comprising virgin and/or contaminated synthetic plastics material is ground in a second granulating zones. The two streams are combined to provide a processable mixture. The processable mixture is introduced into a high intensity, mixer. The processable mixtures transformed into a semi-molten discharge stream by the kinetic energy imparted to the processable mixture by the mixer are simultaneously vented from the mixer. The semi-molten mixture emerging from the mixer is then introduced into an extruder or press where it is formed into a mass of desired shape, and cooled. This method allows for the production of useful, shaped masses from two different classes of materials which have been otherwise treated as waste.

CONCLUSION:

REFERENCE:
U.S. Patent No 5,503,788; Lazareck, et.al., April 2, 1996

TITLE:
Automobile shredder residue (ASR) separation and recycling system

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical Separation Technology

AUTHORS/CONTACTS:
Bennie A. Baker, Kenneth L. Woodruff, Joseph F. Naporano
Nimco Shredding Co., Newark, NJ, USA

ABSTRACT:
An ASR separation and recycling system which permits the separation of ASR into many constituent components for recycling or reuse. Among the products recovered are steel, stainless steel, copper, aluminum, other non-ferrous metals, fine magnetic fraction (iron oxide product), clean grit, polyurethane foam, various plastics, fibers and rubber. The ASR separation and recycling system comprises four major components. The first is initial size and separation of ASR into three separate fractions. The second component comprises a grit processing subsystem. The third component is a rubber and plastics recovery subsystem and the fourth component is a polyurethane foam separation and cleaning subsystem.

CONCLUSION:

REFERENCE:
U.S. Patent No 5,443,157; Baker, et.al., August 22, 1995

TITLE:
A Mechanical Separation Process to Recover Metals and Polymers from Shredder Residue

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical Separation Technology

AUTHORS/CONTACTS:
J. A. Pomykala Jr., B. J. Jody, E. J. Daniels, J. Yang, J. S. Spangenberger

ABSTRACT:
Shredder residue is a byproduct from the recovering of metals from end of life vehicles, home appliances and other metal containing materials. The four and a half million metric tons of shredder residue produced annually in the United States is presently land filled. Shredder residue contains about 5-10% by weight metal pieces that are larger than 6 mm in size. It also contains about 5-10% by weight metal and metal oxide fines smaller than 6mm. To meet the challenges of automotive materials recycling, the U.S. Department of Energy is supporting research at Argonne in cooperation with the Vehicle Recycling Partnership of the United States Council for Automotive Research (USCAR) and the American Plastics Council. Argonne National Laboratory has developed a mechanical separation process for separating and recovering the metals as well as other materials such as polymers from the shredder residue. Argonne also tested a process to produce reduced iron from the fines. This paper describes the Argonne processes.

CONCLUSION:

REFERENCE:
TMS EPD Congress, 2007.

Section 11
Thermo-chemical Conversion Technology

TITLE:
Gasification of shredder residue at SVZ Schwarze Pumpe .

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermochemcial conversion, gasification to methanol

AUTHORS/CONTACTS:
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Sekundärrohstoff-Verwertungszentrum Schwarze Pumpe GmbH
Germany

ABSTRACT:
Since October 2000 the recycling and disposal of end-of-life vehicles has been regulated by the directive on used cars. With that the recycling of end-of-life vehicles and their components was given a new legal basis. The problem in the recycling of end-of-life vehicles is that the shredder residue or light-density fraction contains not only the metals from the vehicles' core components, which are easily separated and recycled, but a multitude of other materials.
The waste material reprocessing centre Schwarze Pumpe has recycled such shredder residue physically for more than seven years now. The material, which is supplied pre-treated or untreated, is processed together with other waste into highpurity methanol at SVZ. In this process the shredder residue can be totally consumed. With that gasification of the light shredder residue demonstrated at Schwarze Pumpe is the only process, where this material is physically completely recycled.
The gasification of shredder residue as practised in the waste material recycling centre Schwarze Pumpe is at present probably the only procedure for the complete physical recycling of shredder residue.
The traditional fixed-bed gasification, which had originally been developed for the gasification of hard and soft coal, was advanced after 1991 to meet the requirements of the combined gasification of high-calorific waste and coal. Seven reactors, each with a throughput of 11 - 12 tonnes of gasification material per hour, are operated at the moment.
Since 1992, when the conversion of the former pressurized-gas plant into a modern recycling park began, the quantity of waste processed has continually risen. In July 2001 the millionth tonne of waste was gasified. During the past years the quantitative and qualitative increase in the recycling of high-calorific waste has always been accompanied by the upgrading of the existing equipment and the construction of new plants.
As soon as the preparatory work for the start-up of the world's first slagging gasification plant for waste gasification (British Gas/LURGI process, BGL gasification) had been completed, the first service trial of the new gasifier was performed successfully in January 2002. At that time the planned throughput of 30 tonnes of gasification material per hour was successfully demonstrated together with the planned admixture rate of 75% of waste material. Then, the plant was taken over by SVZ. Now, the plant will be operated continuously in the year 2002 and the new gasifier will be integrated in the SVZ facilities.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Development of the Chemical Recycling Technology of Glass Fiber Reinforced PA6 Parts

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermochemical recycling, Depolymerization of nylon to caprolactam

AUTHORS/CONTACTS:
Kaoru Inoue and Yuichi Miyake

ABSTRACT:
Recently, the plastic material is positively introducing for automotive parts due to the Needs of vehicle weight reduction and cost saving. On the other hand, the countermeasure for scrapped car is a big subject to need to consider as a car maker. Therefore, the development of recycling technology for plastic parts has been necessary. In this study, we tried to develop recycling technology for glass fiber Polyamide6 (PA6) which is applied to various automotive parts like an air intake manifold. As a recycling technique, we focused on the chemical recycling which can reclaim raw material of PA6 (ε caprolactams) from the post-consumer automotive parts. The chemical recycling we selected can be put on a higher priority because it has to utilize the limited resource repeatedly. As a result, we retain high purity of ε caprolactams using our following two techniques which make possible to recycle Polyamide 6 materials. One is to separate PA6 from glass fiber. To optimize pressure is important after decreasing the resin viscosity with optimized organic acid. Another is to depolymerize PA6 continuously using phosphoric acid which separated glass fiber. Recycled PA6 which we synthesized from using ε caprolactams from the above method showed same level of physical property as original PA.

REFERENCE:
Development of the Chemical Recycling Technology of Glass Fiber Reinforced PA6 Parts
SAE Paper 2001-01-0694

TITLE:
Recycling Process for Cross Member Composite Parts

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermochemical recycling, Catalyzed glycolysis

AUTHORS/CONTACTS:
Jiri E. Kresta, Abdul H. Molla, Han X. Xiap, Bhikhu Suthar and Daniel Klempner, Polymer Institute, University of Detroit Mercy
Jonathan Swindell, McLearn.Hart, Inc.

ABSTRACT:
The recycling of cross-member composite (CMC) parts was studied using partial decrosslinking of the polyurethane (PUR) composite matrix by catalyzed glycolysis. The decrosslinked material, containing reactive OH and NH_2 groups, was reacted with polymeric isocyanate in a molding operation to form a new composite product. In order to make the process economically feasible the smallest amounts or reactants (glycol, catalyst, isocyanate) were used in the process. The results of the laboratory study were verified in semi-pilot plant runs. The economic analysis showed that the process is feasible.

REFERENCE:
Recycling Process for Cross Member Composite Parts
SAE Paper 1999-01-0665

TITLE:
TwinRec: Energy & Material Recycling of End-of-Life Vehicles

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical conversion, TwinRec, Japan

AUTHORS/CONTACTS:
Dr. Christian Steiner, Dr. Adrian Selinger, Dipl.-Ing. Markus Bürgin, Dr. Edmund Fleck, ALSTOM Power

ABSTRACT:
ALSTOM's TwinRec technology is commercially available in full scale for ecological and economical treatment of shredder residues.

This status is impressively confirmed by the TwinRec reference plant in Aomori (Japan). This fully commercial plant has treated 46'000 t of shredder residues until January 2001 and has demonstrated the combination of energy recovery and material recycling without any prior treatment of the shredder residues after their generation at the shredding company. Moreover, the technology's flexibility to treat additional waste streams was demonstrated through sewage sludge and fly ash feeding.

While the national implementations of the new EU directive are still pending, it can be anticipated that the oncoming recycling and recovery quotas will be met after integration of the TwinRec process into the existing structure of dismantlers and shredders.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
The RESHMENT Process: Maximized Reuse, Recycling and Recovery from Automotive Shredder Residue

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical conversion, RESHMENT, Switzerland

AUTHORS/CONTACTS:
Martin Schaub, CT Umwelttechnik AG, Switzerland
Franz Christ, Thommen & Co AG
Jürgen Ritter, FPR Holding AG

ABSTRACT:
End of Life Vehicles (EL V) are usually shredded allowing the recycling of raw materials (mainly metals) of between 70 and 80% of the weight of the vehicles. The remainder, as called Automotive Shredder Residue (ASR) is a broad mixture of many different materials which are contained in a modern vehicles, i.e. glass, all kinds of plastics and rubbers, different types of tissues and filler materials. There is also a content of non separated metals and heavy metals. ASR is today mainly land filled, but a lot of mechanical and thermal processes have been developed and have been tested in order to fulfil the same regulations for ASR as are valid for other wastes like municipal solid waste. The RESHMENT process is a combined mechanical and thermal process which aims at maximising reuse, recycling and recovery of products and energy from ASR in order to fulfil the very challenging recycling quota stated in the most recent EU regulation for used car recycling.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
The THERMOSELECT High Temperature Recycling Technology for Automotive Shredder Residue

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical conversion, gasification, THERMOSELECT process

AUTHORS/CONTACTS:
Rudi Stahlberg, Thermoselect, Switzerland

ABSTRACT:
More than 10 years ago THERMOSELECT has introduced a new technology for waste management to process residual waste in an environmentally compatible manner.

The THERMOSELECT process was thus to realize the following objectives:

- An uninterrupted thermal waste treatment under such thermo-dynamic kinetic conditions to where
  - organic constituents are quantitatively converted into a clean synthesis gas containing mainly H_2, CO, CO_2,
  - waste moisture and water generated will be evaporated, purified and recovered for utilization,
  - inorganic constituents are converted into usable' mineral substances and metals by a complete melting and evaporation of the contaminants,
- utilization of pure oxygen instead of air in order to realize a faster transformation at sufficiently high temperatures and distinctly lower gas volume flow rates than those accruing from a conventional incineration. Shock cooling of the crude synthesis gas avoids denovo synthesis of dioxins and furfurans and causes. the removal of acidic pollutant constituents and saline components.
- The homogenized mineral and metal melts are granulated by cold water nozzles and may be utilized industrially.

No processes were implemented industrially worldwide - and this is still true 10 years later - in order to be able to eliminate the disadvantages of conventional waste incineration or pyrolysis.

The realization of the process in a relatively short period of time was poss'ible - since the industrial application of a gasification of coal and wood, the melting of ores and the alloying of metals as well as the production of glass or mineral wool from melts have already been state-of-the-art of technology for more than hundred years.

The THERMOSELECT technology has been proven on several stages. Thus a comprehensive experimental pre-testing in a facility built in an industrial scale (THERMOSELECT, Fondotoce, Italy) from 1992 on and the experience gained implemented in industrial facilities of EnBW (Energie Baden-Wurttemberg) in Karlsruhe (Germany) from 02/1999 on as well as in Chiba (Japan), of Kawasaki Steel Corporation, from 09/1999 on. A new plant is under construction in Ansbach (Germany) of the TAE (Thermische Abfallentsorgung Ansbach GmbH). For the facility in Hanau the permission was granted on February 23rd, 2000.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Feedstock – Recycling of Shredder Residue at SVZ Schwarze Pumpe GmbH

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical conversion, gasification, Schwarze Pumpe

AUTHORS/CONTACTS:
Dr. Hans-Joachim Sander Sekundärrohstoff -Verwertungszentrum Schwarze Pumpe GmbH, Germany

ABSTRACT:
Plastics show clear growth tendencies among others in the automotive industry and in the field of electrical and electronic appliances.

It is for example forecasted that the input of plastics in the automotive industry will nearly double in the coming 15 years. Parallel, new directives and guidelines on wastes will come into force in throughout Europe and therefore also in Germany.

(ELV, AltfahrzeugV, Abfallablagerungsverordnung) requiring solutions with regard to a materials and energetic utilization of waste streams rich in plastics coming from technical applications. Besides the recycling of metals, glass and operating liquids, the utilization of organic materials must also contribute to meet the quota according to the end-of-life vehicle directive (2006: 80% materials recycling, 85% recycling totally, 2015: 85% materials recycling, 95% recycling totally).

The particular demand for processes on the materials recycling in the automotive sector results from the following considerations:

- The most efficient way for recycling the quantitatively dominating metal fraction from end-of-life vehicles is to shredder it.
- Hereby, a materials stream being rich in plastics is yielded - the so-called shredder light fraction (SLF) - which has to be recycled according to the targets specified in the above-mentioned regulations.
- Regarding the limited overall quantity and in parallel the high heterogeneity of this plastic-rich material stream (up to 150 different plastics and/or plastic compounds), the development and the use of reliable mechanical separation methods for the materials recycling is only possible and economically reasonable to a limited extent.

Moreover, only a small portion of plastic components can be recycled via disassembling.

To fulfil the quota in the future, there will only be needed capacities for the materials recycling of SLF which are on the one hand economically reasonable and meet the fundamental waste-economical requirements in view to a recycling on the other hand.

A technical opportunity for a material recycling process is for example the high-temperature gasification as it is operated in the company SVZ Schwarze Pumpe GmbH.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Report on the Operating Trial with Automotive Shredder Residue (ASR)

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical conversion, gasification, THERMOSELECT, Germany

AUTHORS/CONTACTS:
U. Drost, F. Eisenlohr, B. Kaiser, W. Kaiser, R. Stahlberg

ABSTRACT:

Over the past decade, an innovative waste recycling technology - the THERMOSELECT process - has been developed, proven in a large scale demonstration facility and commercialised. Solid wastes, including municipal solid waste (MSW), are continuously processed in a fixed bed oxygen blown gasification and residue melting reactor to achieve a maximum recovery of recyclable raw materials, with simultaneous utilization of the chemical energy contained within the waste material and minimum impact to the environment. Commercial plants are in operation in Karlsruhe, Germany, in Tokyo-Chiba, Japan and in Mutsu, Japan. The Karlsruhe plant has a waste treatment capacity of 720 t/d, the Chiba plant of 300 t/d, and the Mutsu plant of 140 t/d. Currently, 4 further plants are under construction in Japan.

Automotive shredder residues, ASR, receive today special attention. Currently, ASR is mainly landfilled, but according to the European end-of-life directive for vehicles, the recycling rates must increase in future. In Germany, when the new T ASI legislation comes into effect in 2005, landfill disposal of the ASR will no longer be permitted.

Due to the large diversity of substances in this waste stream, and the ever increasing utilisation of complex composite materials, the demand for comprehensive, sustainable and environmentally friendly treatment methods becomes therefore increasingly higher. In this context, the rather high contents of heavy metals and chlorine in ASR require appropriate equipment.

In response to this demand, the THERMOSELECT high temperature recycling process has successfully demonstrated its capability to deal also with this type of input. During an extended trial operation in the waste treatment facility in Karlsruhe, approx. 400 tons of ASR have been processed during 3 days. The results of this trail operation are reported in this paper.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
The PyroArc® process, an economically and environmental friendly process for treatment car fluff

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical conversion, PyroArc, gasification

AUTHORS/CONTACTS:
Bengt Gustavsson, Managing Director, ScanArc
Sven Santen, Technical Director, ScanArc
Kjell Haugsten, Vice President Technology, EnviroArc
Per Morten Lefdal, Project Development Manager, EnviroArc

ABSTRACT:
The PyroArc process recovers energy and material from all kinds of waste including car fluff in a two-stage thermal process, based on gasification and plasma technology.

The first stage is a counter current melting gasifier. Solid waste materials are fed to the top of the gasifier and descend down the gasifier. The temperature at the top is 3-500°C and all moisture and volatile material evaporate. Pre heated air is injected in the bottom of the gasifier and the remaining carbon is gasified in the bottom at a temperature of about 1500°C. The incombustible materials like metal, glass and minerals melt and is tapped of as a metal alloy and a non-leaching slag.

Stage two is a plasma-powered reactor. Any gaseous or liquid waste to be treated is injected directly to the reactor and is mixed with the gas from the gasifier. The gas and liquid enters an air jet of high velocity and temperature (6-800 m/s and 3-5000°C) provided by a plasma generator. The air jet provides the necessary high temperature and immense dynamic power to decompose completely all hydrocarbons even halogenated hydrocarbons like PAH, furans and dioxins.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands, March 9-11, 2005.

TITLE:
RESHMENT® the Shredder Residue Solution For Switzerland

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical conversion, RESHMENT process

AUTHORS/CONTACTS:

Fried Sauert, VOEST ALPINE Industrieanlagen GmbH & Co (VAI), Turmstrasse 44, A-4031 Linz, fried.sauert@vaLat

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ABSTRACT:
In Switzerland, the construction of a plant for the final treatment of Swiss shredder residues according to the RESHMENT@ Process is currently being planned. The planning and building permission has been granted. The basic engineering is currently being carried out and the start of construction is scheduled for 2005. Startup shall take place in 2007.

After an initial separation of various valuable materials in the mechanical processing, the smelting metallurgical treatment makes it possible to separate the heavy metals, while at the same time destroying all poisonous organics, to transfer the mineral elements into an inert product and to recover the heat content. The RESHMENT@ Technology transfers almost the entire shredder residue and other waste into recyclable products.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands, March 9-11, 2005.

TITLE:
Conversion of Waste Polymers into Aromatic Species

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical conversion, Polyflow, pyrolosis

AUTHORS/CONTACTS:
Charles Grispin
ACM Polyflow, Inc.

ABSTRACT:
An anaerobic pyrolysis process has been developed that converts random mixes of plastic and rubber waste into lucrative petroleum products. The process produces a 50% increase in the number of benzene hydrocarbons than were present in the input (feedstock) material (Equilibrium near 80 mole-percent benzene rings). Three chemical engineering breakthroughs make the reclamation of energy resources from post-consumer plastics and rubber both practical and profitable. Data is presented which shows conversion of scrap tires, rubber, and polystyrene into light petroleum distillates, the majority of products are aromatic hydrocarbons, such as ethyl benzene, toluene, styrene, xylene, etc. The remainder is cycloalkanes and olefins. These products are established commodities consumed by the petrochemical industry. The patent-pending process operates at commercial scale (1000 100. charges) and meets strict EPA guidelines.

REFERENCE:
GPEC 2003, Proceedings of the 9th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 26-27, 2003, Detroit, MI.

TITLE:
Recycling Shredder Residue Containing Plastics and Foam Using a Thermal Conversion Process

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical Conversion Technology

AUTHORS/CONTACTS:
Gerald R Winslow, KBS Consulting, USCAR/Vehicle Recycling Partnership
Brian S. Appel and Terry N. Adams, Changing World Technologies
Nakia L. Simon, DaimlerChrysler, USCAR/Vehicle Recycling Partnership
Dr. Claudia M. Duranceau, Ford Motor Company, USCAR/Vehicle Recycling Partnership
Dr. Candace S. Wheeler, General Motor, USCAR/Vehicle Recycling Partnership
Dr. Vahid Sendijarevic Troy Polymers, Inc.

ABSTRACT:
Shredder residue is a complex mix of many different materials that includes plastics, rubber, polyurethane (PU) foams, glass, metals and other materials such as rocks and dirt. The metal recyclers create this shredder residue mix as part of a recycling process to recover metals. The actual input stream for metal recycling is end-of-life automobiles, white goods and a variety of other metal-intensive parts including industrial scrap waste. This shredder residue is currently landfilled and the European Union has implemented laws to reduce the amount of shredder residue from automobiles that can go into landfills. The Vehicle Recycling Partnership (VRP) is working with different collaborators to evaluate different technologies, including automated plastic recovery, as a means to reduce the amount of plastics that go to landfill in shredder residue.

A new technology that is under investigation by the VRP is Thermal Conversion Process (TCP) that was developed by Changing World Technologies (CWT). This process can convert hydrocarbons and organic materials into marketable high-quality, clean fuels and specialty chemicals for industrial and commercial use. The end products (recovered) are partly a function of feedstocks and partly a function of the specific combination of temperature, pressure and residence time utilized. CWT processed a small amount of shredder residue that was supplied by Troy Polymers, Inc. (TPI). This shredder residue contained PUR foam as well as polybrominated foam. CWT performed the depolymerization process as well as a number of specific tests on the output products and the results are presented in this paper.

REFERENCE:
SAE Paper 05 ENV-35.

TITLE:
Chemical Recycling of Mixed Polyurethane Foam Stream Recovered from Shredder Residue into Polyurethane Polyols

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical Conversion Technology

AUTHORS/CONTACTS:
Vahid Sendijarevic and Ibrahim Sendijarevic, Troy Polymers, Inc.
Gerald R. Winslow, KBS Consulting - Vehicle Recycling Partnership
Claudia M. Duranceau, Ford Motor Company - Vehicle Recycling Partnership
Nakia L. Simon, DaimlerChrysler - Vehicle Recycling Partnership
Candace S. Wheeler, General Motors - Vehicle Recycling Partnership

ABSTRACT:
Troy Polymers, Inc. (TPI) has developed a chemical process that can recycle polyurethane (PU) foam from shredder residue (SA). In stage one of this process, the polyurethane foam is subjected to glycolysis, followed by filtration of the liquid glycolyzed product. In stage two, the glycolyzed products are used as initiators in reaction with propylene oxide to prepare novel polyurethane polyols. A number of successful laboratory glycolyses were carried out utilizing two different types of PU foams recovered from shredder residue: (1) the best case scenario - hand-picked PU foams from shredder residue with >80% conversion into liquid initiator and (2) the worst case scenario - mixed PU materials separated by an automated separation process from ELV shredder residue with -50% conversion into a liquid initiator. Both TDI- and PMDI-based flexible foams were prepared from the novel recycled polyols prepared by propoxylation of the glycolyzed products (initiators) obtained from the mixed PU materials. Preliminary' economic analysis indicates that the commercial production of the polyols form the foam scrap can be cost effective.

The focus of this paper is on feasibility two glycolyse two types of PU foams, "dirty" and "clean", which were recovered from SA by SAL YP (Belgium) via an industrial scale process specifically designed to separate PU foams from SA based on technology developed by Argonne National Laboratory (ANL).

REFERENCE:
SAE Paper 05 ENV-36

TITLE:
RESHMENT® The Shredder Residue Solution for Switzerland

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical Conversion Technology

AUTHORS/CONTACTS:
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Martin Schaub, CTU - Conzepte Technik Umwelt AG, BOrglistrasse 29, CH-8400 Winterthur, martin.schaub@ctu.ch
Franz Christ, Metraux Services SA, Case Postale, CH-1037 Etagnieres, franz.christ@chemcare.net
Fede Karrer, Stiftung Auto Recycling Schweiz, Postfach 5232, CH-3001 Bern, info@stiftuno-autorecvclinO.ch

ABSTRACT:
In Switzerland, the construction of a plant for the final treatment of Swiss shredder residues according to the RESHMENT® Process is currently being planned. The planning and building permission has been granted. The basic engineering is currently being carried out and the start of construction is scheduled for 2005. Startup shall take place in 2007.

After an initial separation of various valuable materials in the mechanical processing, the smelting metallurgical treatment makes it possible to separate the heavy metals, while at the same time destroying all poisonous organics, to transfer the mineral elements into an inert product and to recover the heat content. The RESHMENT® Technology transfers almost the entire shredder residue and other waste into recyclable products.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands, March 9-11, 2005.

TITLE:
Process for chemical *recycling* of polyurethane-containing scrap

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical Conversion Technology

AUTHORS/CONTACTS:
Vahid Sendijarevic, Troy Polymers, Inc, Polyventure, Inc., Southfield, MI, USA

ABSTRACT:
A process of chemically recycling polyurethane-containing scrap. Polyurethane-containing scrap is subjected to a chemolysis reaction to produce chemolysis polyol products. The chemolysis polyol products are used as initiators in a reaction with alkylene oxide to produce oxyalkylated polyols for preparing polyurethanes.

CONCLUSION:

REFERENCE:
U.S. Patent No. 6,750,260, Sendijarevic, June 15, 2004

TITLE:
Apparatus for treating waste materials

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical Conversion Technology

AUTHORS/CONTACTS:
Reinhard Fuchs, Ewald Feuerstacke
Mannesmann Aktiengesellschaf, Dusseldorf, DE

ABSTRACT:
A method and apparatus for treating residual or waste materials that can be recycled energetically, especially light-weight refuse from shredders, which, reduced in size and classified, are stored in bunkers. The residual or waste material is fed by portions from the bunkers to a supply trough in a metal melting furnace, especially an electric arc furnace for melting steel. After a predetermined time, the residual material is placed by portions into a sluice that can be closed in a gas-tight manner. After the sluice is closed, the residual material is subjected to an oxygen-containing gas, the pressure of which is higher than the pressure at the furnace head of the metal melting furnace, until the pressure within the sluice exceed the pressure in the furnace head. The sluice output opening facing toward the furnace vessel bottom is opened after the pressure within the sluice exceeds the pressure in the furnace head and the residual material is conveyed pneumatically into the chamber part. Nozzles in the chamber part inject oxygen into the shaft to encourage combustion and to assist the acceleration of the residual or waste material through the chamber and into the bottom area of the furnace. The residual material is then submerged in the metal melt located in the bottom area of the metal melting furnace for complete conversion or incineration.

CONCLUSION:

REFERENCE:
U.S. Patent No 5,879,617; Fuchs, et.al., March 9, 1999

TITLE:
Liquefaction of wastes with product oil recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical Conversion Technology

AUTHORS/CONTACTS:
Hong-Paul Wang
National Science Council, Taipei, Taiwan

ABSTRACT:
A one-step thermal treatment process for liquefaction of solid wastes selected from the group consisting of printed circuit board wastes, plastic wastes, rubber wastes, scrap fires, used cables/wires, auto shredder residues, contaminated soils, and waste lubricating oils to recover valuable oil products. Apparatus is provided and includes a means for continuous feeding, an inclined screw liquefaction reactor(ISLR), and means for handling oils and gas products. Wastes are liquefied in used lubricating oils or recycled heavy oil product at relatively low temperatures, and the unliquefied inorganic materials are recovered.

CONCLUSION:

REFERENCE:
U.S. Patent No 5,836,524; Wang, November 17, 1998

TITLE:
Treatment of automobile shredder residue by vacuum pyrolysis

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-Chemical Conversion Technology

AUTHORS/CONTACTS:
Christian Roy
Universite Laval, Quebec, CA

ABSTRACT:
Metals are recovered from automobile shredder residue by subjecting the shredder residue to vacuum pyrolysis to produce non-condensable gases, condensable hydrocarbon vapors and water vapor, and a solid residue containing non-oxidized metals and a carbonaceous material. The vacuum pyrolysis is carried out at a temperature in the range of about 450.degree. to about 650.degree. C., under a subatmospheric pressure in the range of about 50 to about 200 mm Hg so as to thermally decompose and substantially completely vaporize organic matter adhered to the metals. At least one metal is separated from the solid residue, the metal being recovered in nonoxidized and substantially carbon-free form suitable for direct recycling.

CONCLUSION:

REFERENCE:
U.S. Patent No 5,451,297; Roy, September 19, 1995

TITLE:
Method for direct gasification of solid waste materials

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermo-chemical Conversion Technology

AUTHORS/CONTACTS:
Taylor, Robert A.

ABSTRACT:
Direct gasification of a high BTU content fuel gas from a hydrocarbon content solid waste material W which may include some glass content is effected by preheating heat carrier solids HCS in a flash calciner to a temperature capable of thermally cracking the hydrocarbon content of the solid waste material W directly into the high BTU content fuel gas. The HCS are separated from the products of combustion and fed into a gas sealed refractory lined horizontal axis rotary kiln retort concurrently with the solid waste W. Momentary contact and mixing of the solid waste W with the HCS in the rotary kiln in the absence of oxygen is sufficient to directly thermally crack the solid waste material into the high BTU gas product. Separated HCS are returned to the flash calciner for reheating. A trommel, coupled directly to the output of the rotary kiln retort and having a trommel screen with mesh openings smaller than glass agglomerates, but sized larger than the HCS, permits separation of the HCS and discharging of glass agglomerates from the downstream end of the trommel screen to prevent shut down of the direct gasification unit. Direct gasification of steel industry waste water treatment plant sludge, automobile shredded refuse ASR, municipal solid waste MSW and refuse derived fuel RDF and oil mill scale is effectively achieved, irrespective of glass content contaminant.

CONCLUSION:

REFERENCE:
U.S. Patent No 5,423,891; Taylor, June 13, 1995

Section 12
Energy Recovery Technology

TITLE:
Automobile Shredder Residue Treatment in Japan - Experience of 95'000 t ASR Recycling and Recovery available for Europe through TwinRec

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Thermal energy recovery, EBARA, TwinRec technology, Japan

AUTHORS/CONTACTS:
Genkichi Ando, Seinan Corporation, Japan
Christian Steiner, EBARA, Switzerland
Adrian Selinger, EBARA, Switzerland
Karl Shin, EBARA, Japan

ABSTRACT:
In Japan, the very limited landfilling capacity and increasing landfilling cost paved the way for development of ASR recycling technologies.

SEINAN, one of the larger shredder operators in Japan, has invested into modern technologies to improve recycling and reduce the environmental impact of the final residues. In addition to advanced mechanical shredding and separation equipment, SEINAN is operating a combined material and energy recycling plant since 2000.

Until January 2002, this plant has successfully recycled 95'000 t of Shredding Residues and operated for more than 11 '500 hours in continuous 24 hours operation mode. Shredding Residues from 5 shredding plants and 3 NonFerrous-Separation plants are brought to the plant and fed to the TwinRec gasifier without any further pre-treatment.

The TwinRec plant recovers ferrous and non-ferrous metals (especially copper and aluminium) in non-oxidised status, which are sold to the recycling market for further processing. The fine inert material is converted into a glass granulate, which fulfils the stringent Japanese regulations for recycling in the construction industry and is sold to be used in road construction. Zinc and lead rich fly ash from the process are recycled to the zinc-industry for further processing.

The energy content of the shredding residues is transferred to the flue gas, from which electricity is generated via a steam cycle. In this way, an impressive number of useful products can be gained from the shredding residues and the amount of rest products to be landfilled is minimised.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Automobile Recycling Loop

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Energy recovery, conditioning of shreddre residue for feed in electric arc furnaces

AUTHORS/CONTACTS:
Dr. Heinz-Leo Wertz
Wertz Handelsgesellschaft GmbH & Co. KG, Germany

ABSTRACT:
In 2000 847 million tons of crude steel were produced in the world /1/. As the steel industry especially in Europe is in a world-wide competition it is forced to produce high quality steel at low costs concerning the local factors. The cost-efficiency of the steel production is always closely related to the raw material costs /2/. Figure 1 /3/ shows the steel production and raw material consumption in the world.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
RESHMENT – An ASR Process for Maximized Recycling, Reuse and Recovery

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Energy recovery, RESHMET process

AUTHORS/CONTACTS:
Fried Sauert, VOEST-ALPINE Industrieanlagenlau GmbH & CO
Martin Schaub, CT Umwelttechnik AG
Franz Christ, Thommen + Co AG
Jurgen Ritter, FPR Holding AG

ABSTRACT:
End-of- life vehicles (ELVs) are usually shredded so that the raw materials, which are mainly metals comprising between 70 and 80% of the entire weight, can be recycled. The remainder is referred to as automotive shredder residue (ASR) and contains a broad mixture of many different materials in modern vehicles, such as glass, all kinds of plastics and rubbers, different types of tissues and filler materials. There is also a certain amount of non-separated-metals and heavy metals. ASR is usually landfilled, however a lot of mechanical and thermal processes have been developed and tested in order to meet the same requirements imposed by regulations for ASR which are valid for other wastes such as municipal solid waste. The RESHMENT process is a combined mechanical and thermal process which aims at maximizing reuse, recycling and recovery of products and energy from ASR in order to meet the challenging recycling requirements stipulated in the most recent EU regulations on used-car recycling.

REFERENCE:
RESHMENT – An ASR Process for Maximized Recycling, Reuse and Recovery
SAE Paper No. 2001-01-3757

TITLE:
The Reshment Process: Evolution in ASR Processing

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Energy recovery, RESHMET process

AUTHORS/CONTACTS:
Martin Schaub, CT Umwelttechnik AG, Switzerland
Franz Christ, Métraux Services, SA
Jürgen Ritter, FPR Holding AG

ABSTRACT:
The RESHMENT technology has been selected by the IGEA foundation for the treatment of the ASR produced in Switzerland. The plant will have a capacity of approx. 55.000tpa of ASR and offers the addition of an approximately equal amount of other, low calorific waste, particularly fly ash from municipal solid waste plants or other toxic waste streams.

The evolution of the process from technical and commercial view points will be highlighted, as well as its relation to the EU directive on ELV, where the treatment goals of ELVs and implicitly of ASR are defined.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
The THERMOSELECT High Temperature Recycling Technology for automotive shredder residue - Results and Perspectives

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Energy recovery, THERMOSELECT process

AUTHORS/CONTACTS:
R. Stahlberg, Thermoselect SA, Switzerland
W. Kaiser
G. Nyhuis
N. Mattsson
U. Drost

ABSTRACT:
Over the past decade, an innovative waste recycling technology -the THERMOSELECT process- has been developed, proven in a large-scale demonstration facility and commercialised by the THERMOSELECT S.A. company. Solid wastes, including MSW, are continuously processed in a fixed bed oxygen blown gasification and residue melting reactor to achieve a maximum recovery of recyclable raw materials, with simultaneous utilization of the chemical energy contained within the waste material and minimum impact to the environment. Commercial plants have recently been erected and put in operation in Karlsruhe, Germany, and in Tokyo-Chiba, Japan. The Karlsruhe plant has a waste treatment capacity of 225'000 Mg/a and the Chiba plant of 100'000 Mg/a. Tests have been carried out with shredder mixes, mainly consisting of automotive shredder residue, and municipal solid waste in different concentration. These tests were done in the Chiba plant in 2001.
The waste (automotive shredder residues together with household, commercial and industrial waste) is compacted in a high-pressure press and fed in discrete packages into a degassing channel. During a period of 1 to 2 hours -the time a package needs to travel through the channel being pushed by the subsequent packages- the material is dried and organic fractions are converted to gas and char. Downstream of the channel the material enters a high temperature reactor. The residence time of the gas in the high temperature reactor is 2 to 4 seconds and the gas discharges at 1200°C, ensuring that all organic compounds are decomposed.
The inorganic components of the feed are molten (Redox-process) at temperatures of 1600°C - 2000°C. The molten material flows through a homogenisation reactor and into a water quench bath where the material forms mineral chip and iron rich metal pellets which are magnetically separated for recycling outside the plant.
The hot synthesis gas passes into a rapid water quench in which it is cooled below laoC hence avoiding any re-formation of organic compounds. The gas is then purified by means of conventional scrubbing processes, being carefully designed to deal with chlorine, sulphur, lead, cadmium etc. In the Karlsruhe plant, the purified synthesis gas is used as fuel in a steam generator. A steam turbine produces enough electrical power to cover the needs of the plant as well as a surplus being injected into the local network. Furthermore, a large amount of heat is delivered to local district heating network. In the Chiba plant, the gas is used as fuel in the steel production.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
VAI Car Wreck Recycling – Master Plan

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Energy recovery, CONTOP process

AUTHORS/CONTACTS:
Muller Heinz, Ramaseder Norbert and Muller Johannes,
VOEST ALPINE Industrieanlagenbau GmbH & Co. (VAI)

ABSTRACT:
The current practiced recycling of car wrecks with shredders and by dumping the shredder waste is becoming more and more problematic due to the critical situation regarding dumping yards and the strongly increasing dumping costs. This paper describes a closed line for the complete recycling of every car type without disposition of material. Both ecological and economical aspects are considered. The special disassembly of old cars, additionally to metallurgical recycling, is an effective way for utilization. To implement this idea, future developments must be taken into account. VAI is in a position to present a complete recycling concept that ensures a considerable reduction of waste and emissions by utilizing the organic plastics as melting and heating energy, as well as for steam generation and binding of inorganic components in the slag. This plan also considers future developments in the automobile industry through input material recycling. The outlined technology is ideally suited to close the circle of steelmaking, continuous casting, and automobile industry.

REFERENCE:
VAI Car Wreck Recycling Master Plan
SAE Paper No. 2001-01-3746

TITLE:
ASR Recycling in Europe

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Energy recovery, Thermal recycling of shredder residue, Citron perspective

AUTHORS/CONTACTS:
Michael Brüggler, Citron SA, France

ABSTRACT:
As one of Europe's first ASR (Automobile Shredding Residues) recyclers, CITRON has tried to carefully listen to the automobile- and shredding industries in order to understand their future needs and goals.

The automobile industry would like to concentrate on building and selling cars in compliance with EU and national legislation. Beside this, automobile and shredding industry wants to find the most cost-effective solution that allows them to achieve the outlined EU targets and national legislation.

Dismantlers and shredders are traveling on a progressive cost curve as they dismantle higher percentages of cars or shred ASR down to smaller pieces in order to extract a few additional percentage points of metal from the ASR.

As the CITRON plant is able to handle zinc, lead, mercury, plastics, PCB, etc. it is not necessary to remove small pieces of no value from the car or try extracting every last percentage point of metal in the ASR. All these elements can be materially recycled in an industrial thermal recycling plant for reasonable cost.

Substantial money can therefore be saved if dismantlers and shredding companies are focusing on increasing the throughput rate rather than on increasing dismantling and sorting precision. As the recycling cost for ASR is comparable to incineration cost, dismantlers and shredding companies may increase their production and recycling rate while keeping cost down at the same time.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Energetic recovery of automobile shredder residual waste (RESH) in the refuse-fired cogeneration plant (MHKW[1]) / Wiirzburg (overhead transparency 1)

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Energy recovery, Wurzburg

AUTHORS/CONTACTS:
Ferdinand Kleppmann, ITAD, Germany

ABSTRACT:
The German end-of-life vehicle disposal directive stipulates that highest possible recycling rates are attained. In Würzburg, the medium-sized enterprise Johann Preuer GmbH[2] operates an automobile shredder, which dismantles reusable parts, removes fuels, oils, coolant, batteries and tires and shreds the remaining bodywork. This process results in various metal fractions, and besides, shredder residue.

Up to 1990, the shredder residue was deposited in landfills. Since the early 90s, the MHKW Würzburg has been processing shredder residue without any irregularities (4,000 - 5,000 tons per annum). The diagram presents business year 1996, which may be regarded as very typical for the past years. (overhead transparency 2)

The central question investigated in the studies was whether energetic recovery of shredder residue in the refuse-fired cogeneration plant bore ally effects on the functioning of the plant, gas-cleansing quality or on residue quality, and if so, which effects these were.

Meanwhile, we have also started examining incineration of RESH from Switzerland. (overhead transparency 3)

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Recovery of Automobile Shredder Residue (ASR) at Nissan Oppama Plant

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Energy recovery, shredder residue, Nissan, Japan

AUTHORS/CONTACTS:
Yo MATSUSHITA,General Manager, Vehicle Recycling Department, Nissan Europe SAS; Senior Manager, Recycling Promotion Department; Senior Manager, Technology Planning Department, Nissan Motor Co., Ltd.
Tadashi OKA, Senior Manager, Recycling Promotion Department, Nissan Motor Co., Ltd.
Teruo NAGATA, Manager, Recycling Promotion Department, Nissan Motor Co., Ltd.
Masaya ENDO, Recycling Promotion Department, Nissan Motor Co., Ltd.

ABSTRACT:
Nissan Motor Co., Ltd. began recovery of automobile shredder residue (ASR) in the fall of 2003 at its Oppama Plant in Yokosuka, Kanagawa Prefecture. Nissan rebuilt part of its waste incinerator for this purpose; marking the first time any carmaker has used existing incineration facilities at its own plant to process ASR.

The Automotive Recycling Law, which becomes effective from the beginning of 2005, will require car manufacturers to recycle/recover ASR either on their own or through an outside recycling firm. Nissan will continue to outsource ASR processing to existing recycling companies, but processing ASR at is own facilities will also allow Nissan to reduce the shortage of ASR treatment capacity in Kanto area (great Tokyo area) and obtain data for further study. Analysis of the data will be used to improve understanding of ASR processing, which could lead to reduce costs and better vehicle design.

The processing of ASR at Oppama plant was made possible by Nissan's "Waste Zero Emission" campaign, which significantly lowered the volume of waste generated by the plant, freeing up the surplus furnace capacity required for recovery of ASR.

ASR consists primarily of plastics and rubber, and currently most of this residue ends up in landfills. Finding effective disposal methods other than land filling is an important challenge. In addition, due to the heat generated by the thermal recovery process and the difficulty of regulating that heat, problems occurs with adhesion and accumulation of burnt waste on the inside of the furnace and on the surface of boiler steam pipes. Nissan experimented with ASR incineration from 1997 to 1999 using a direct molten furnace, resolving a number of problems that arise in the shredder residue energy recovery process.

The technology and know-how adopted by Nissan could be applied at other waste incinerators, and Nissan is working to share its expertise. Moreover, rebuilding existing facilities is expected to require just one-twentieth of the investment that building new ones would require. A patent has been filed for this technology.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
The Use of Automotive Shredder Residue and Plastics as a Reductant and Fuel in Steel Mill Blast Furnaces

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Energy Recovery, ASR blast furnace

AUTHORS/CONTACTS:
Michael M. Fisher, American Plastics Council, Inc.
Donald Barnett, Economic Associates, Inc.
Fred Edgecombe, Canadian Plastics Industry Assoc.
Donald G. Tate and Alan Underdown, Competitive Analysis Centre, Inc.

ABSTRACT:
Integrated steel mills offer a potential option for the recovery of plastics from end-of-life vehicles (EL V s). Building on initial studies in Germany using post-consumer packaging plastics, the American Plastics Council (APC) initiated a preliminary feasibility study of the opportunity in North America to use processed automotive and appliance shredder residue (ASR) and other plastics as a reductant and fuel in steel mill blast furnaces to replace coke.

Work to date has explored ASR processing, steel mill requirements, logistics, and economics. System economics look favorable on the basis of very high ASR processing throughputs and reasonable coke replacement ratios.

Corrosion of the blast furnace train due to residual chlorine and the presence of residual zinc and copper in the upgraded ASR are the principal technical concerns of the steel mills. Process research directed at reducing halogen and heavy metal content in the upgraded ASR is warranted. The very high temperatures and reducing environment of the blast furnace minimize dioxin and furan emissions.

REFERENCE:
ARC ’99 Quality is the Answer, 6th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 9-11, 1999, Detroit, MI.

TITLE:
The PyroArc® Process, an Economically and Environmental Friendly Process for Treatment Car Fluff

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Energy Recovery Technology

AUTHORS/CONTACTS:
Bengt Gustavsson, Managing Director, ScanArc
Sven Santen, Technical Director, ScanArc
Kjell Haugsten, Vice President Technology, EnviroArc
Per Morten Lefdal, Project Development Manager, EnviroArc

ABSTRACT:
The PyroArc process recovers energy and material from all kinds of waste including car fluff in a two-stage thermal process, based on gasification and plasma technology.

The first stage is a counter current melting gasifier. Solid waste materials are fed to the top of the gasifier and descend down the gasifier. The temperature at the top is 3-500°C and all moisture and volatile material evaporate. Pre heated air is injected in the bottom of the gasifier and the remaining carbon is gasified in the bottom at a temperature of about 1500°C. The incombustible materials like metal, glass and minerals melt and is tapped of as a metal alloy and a non-leaching slag.

Stage two is a plasma-powered reactor. Any gaseous or liquid waste to be treated is injected directly to the reactor and is mixed with the gas from the gasifier. The gas and liquid enters an air jet of high velocity and temperature (6-800 m/s and 3-5000°C) provided by a plasma generator. The air jet provides the necessary high temperature and immense dynamic power to decompose completely all hydrocarbons even halogenated hydrocarbons like PAH, furans and dioxins.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands, March 9-11, 2005.

Section 13
Advanced Vehicles and Materials Recycle Technology

TITLE:
Recyclability of Fuel Cell Power Trains

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Advanced vehicle recycling, fuel cell analyses

AUTHORS/CONTACTS:
Joyce Smith Cooper. Department of Mechanical Engineering, University of Washington

ABSTRACT:
This paper presents an analysis of the recyclability of fuel cell power trains based on material flows for three PEM fuel cell stack designs. The analysis considers the compatibility of materials in recycling, the separability of recyclable materials, and the fraction of material that can be recycled cost effectively. The fuel cells are designed with graphite, stainless steel, and composite bipolar plates and the stacks, batteries, transmission, and supporting equipment are sized to replace an example IC power train. Recyclable material flows are estimated on the basis of material intensities for the fuel cell power trains and are compared to the flows for the IC vehicle.

REFERENCE:
Recyclability of Fuel Cell Power Trains
SAE Paper 2004-01-1136

TITLE:
Recycling of New Generation Vehicles

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Advanced vehicle recycle, aluminum, composites

AUTHORS/CONTACTS:
Sujit Das and T. Randall Curlee, Oak Ridge national Laboratory

ABSTRACT:
The composition of New Generation Vehicles under the Partnership for a New Generation of Vehicles (PNGV) program is anticipated to be significantly different from the typical automobile available now on the market. A spreadsheet cost model of the automobile recycling infrastructure was developed to estimate the potential effects of New Generation Vehicles on the future economic viability of the recycling industry. On the one hand, the higher value of aluminum is likely to cause a positive impact on the three distinct players in the recycling industry, if some technical issues are overcome. On the other hand, the economic viability of the current recycling industry may be diminished by the substitution of composites.

REFERENCE:
Recycling of New Generation Vehicles
SAE Paper 1999-01-0673

TITLE:
A Process to Recover Carbon Fibers from Polymer-Matrix Composites in End-of-Life Vehicles

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Advanced materials recycle technology, PMC

AUTHORS/CONTACTS:
Bassam J. Jody, Joseph A. Pomykala, Jr., Edward J. Daniels, and Jessica L. Greminger

ABSTRACT:
Because of their high strength-to-weight ratios, carbon-fiber-reinforced polymer-matrix composite (PM C) materials are being evaluated for use in the automotive industry. The major barriers to their widespread use are their relatively high cost and the uncertainty about whether they can be recycled.
A process to recover carbon fibers from obsolete PMC materials has been developed at Argonne National Laboratory. The process was tested using PMC samples made with different thermoset or thermoplastic substrates. For most mixtures of PMCs, the process can be energy self-sufficient using the polymer substrate as an energy source. An evaluation of the recovered samples found that the fibers appear to have retained good properties and characteristics and are suitable for short fiber applications. This paper describes the process and the characteristics and properties of the recovered fibers.

REFERENCE:
Journal of Metals, Vol. 56, No. 8, August 2004.

TITLE:
Recycling of Aluminum and Magnesium Parts from Used Cars: Legislative Frame and Consequences for Metallurgy and Material design

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Aluminum and magnesium recycle

AUTHORS/CONTACTS:
H. Antrekowitsch, G. Hanko and P. Paschen, Dept. for Nonferrous Metallurgy, University of Leoben

ABSTRACT:
The final version of the European guidelines on used cars has been published. It has a strong influence on the design and production of automobiles. The automotive industry is expected to use more recycled material to extend the market for recycling materials.

The most important prescription from the standpoint of automobile producers and motor vehicle importers is certainly the obligation to take back old vehicles with cost. This is a strong reason for an increase in using aluminum and magnesium in vehicles because of the high value of these metals. Another is the reduction of fuel consumption by reduction of weight. Engine, running gear, set frames, etc. have been increasingly made of light weight metals. In the future it depends on production technology like construction, processing, coating and joining methods how fast aluminum and magnesium can substitute other materials in the automobile. As a result these mentioned forces lead to an increasing amount of light metal scrap, which has to be recycled.

One of the focal research activities of the Department of Nonferrous Metallurgy is recycling of aluminum and magnesium scrap. Different materials like coated components, alloys with high content of alloying elements and composites are investigated. Further consideration is taken on the reduction of specific energy consumption. Trends in the processing and recycling of light metals with respect to furnace development are also shown.

REFERENCE:
Recycling of Aluminum and Magnesium Parts from Used Cars: Legislative Frame and Consequences for Metallurgy and Material Design
SAE Paper No. 2001-01-3778

TITLE:
Car Recycling and Automation: Future Developments

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Advanced materials recycle technology, X-ray sorting, Delft University

AUTHORS/CONTACTS:
T.P.R. de Jong, J. Zimmerman, M.B. Mesina, H.U.R. Kattentidt, W.L. Dalmijn, M.A. Reuter, Technical University Delft, Netherlands

ABSTRACT:
In 2002 about 300.000 cars will be recycled by ARN in the Netherlands. The recycling percentage of the materials brought back into the different materials cycles is at the moment 86%. The remainder of the material of the recycling process, currently 14%, is landfilled. The New EC legislation to be implemented in the Netherlands in 2003 means that 85% has to be recycled, of which a maximum of 5% by thermal processing. In 2007 the Dutch law requires the EC recycling targets of 2015 to be implemented in the Netherlands.

The means a recycling percentage of 95% has to be attained of which a maximum of 10 % by thermal processing and a maximum of 5% by landfilling. In the ARN system either the material recycling percentage has to be increased to 95% or alternatively. a new approach to thermal processing in the Netherlands has to be implemented. The different options will be discussed and research work carried out at the Delft University of Technology, the Netherlands will be presented.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 12-14, 2003.

TITLE:
Recycling Proton Exchange Membrane (PEM) Fuel Cell Systems

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Advanced materials, fuel cell membranes

AUTHORS/CONTACTS:

Stella Papasavva, General Motors R&D Center
Richard Paul, American Honda Environmental Consultanf
Angelika Coyle, Delphi Corporation
Renato Legati, Ballard Power Systems
Robert Privette, Umicore

ABSTRACT:
In 1999, the Society of Automotive Engineers (SAE) established a Committee for Fuel Cell Standards (FCSC), which is developing consensus industry Standards and Recommended Practices for the design, performance and end-of-life treatment of fuel cells in the automotive industry. The Committee is organized into subcommittees that address issues such as Safety, Performance, Interface, Emissions and Fuel Consumption, and Recycling. The mission of the Recycling subcommittee was to develop a recommended practice document, SAE J2594, that incorporates existing recycling practices and identifies technical, and environmental sustainability issues and applies them to proton exchange membrane (PEM) fuel cell (FC) systems.

Recyclability should be considered early in the product engineering design/development process in order to enhance its potential of reuse or recycling at the end of its lifetime. This document provides a comprehensive list of materials currently used in fuel cell systems and it incorporates tools intended to help the designer enhance the recyclability of a fuel cell vehicle and/or fuel cell system components.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Implications of BMC Thermosets in Fuel Cells and the Environment

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Advanced materials, fuel cells, BMC thermosets

AUTHORS/CONTACTS:
Wil Conner
Bulk Molding Compounds, Inc.
Southfield, MI

ABSTRACT:
ls will have a major impact on the environment in terms of reducing green house gases, , using renewable sources of fuel, increasing energy efficiencies, and extending the life of current energy resources. Thermoset composites are playing a major role in the development of fuel cell technology to reduce cost of key components such as the flow field and end plates. The technology for recycling thermosets in fuel cell applications and the impact of fuel cells on the environment will be discussed in this paper.

REFERENCE:
GPEC 2002, Proceedings of the 8th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 13-14, 2002, Detroit, MI.

TITLE:
Thermal Decomposition of PMC for Fiber Recovery

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Advanced materials, PUC, thermal decomposition, Argonne National Laboratory

AUTHORS/CONTACTS:
Bassam J. Jody
Ed J. Daniels
Joseph Pomykala

Argonne National Laboratory

ABSTRACT:
This paper describes efforts by Argonne National Laboratory to develop a process 'to recover carbon fibers from polymer matrix composite (PMC) materials. The polymer material in the matrix may be a thermoplastic or a thermoset. Samples of panels containing PMC fibers were obtained and used in our bench-scale testing program. We tested three different methods for recovering these PMC fibers: thermal treatment, chemical degradation, and cryogenic methods (thermal shock treatment). The first two methods were effective in separating the carbon fibers from the polymeric substrate; the third method was not satisfactory. Carbon fibers separated from the polymer substrate using the thermal treatment method were submitted to Oak Ridge National Laboratory for analysis and evaluation. The results indicated that the carbon fibers had been cleanly separated from the polymer matrix. Their intrinsic density was 1.8473 g/cm^3 and. their electrical resistivity was 0.001847 ohm-cm, compared to an intrinsic density of 1.75-1.9 gm/cm^3 and an electrical resistivity of 0.0002-0.002 ohm-cm for virgin fibers produced from polyacrylonitrile (PAN). Although we were not sure that the samples we processed were originally produced from PAN, we used the PAN fibers for comparison. It was also demonstrated that the surface of the recovered fibers could be reactivated to energy levels equivalent to those of reactivated virgin fibers from PAN. A comparison of the mechanical properties of the recovered fibers (without surface treatment) with those of surface-treated virgin fibers from PAN revealed that the ultimate tensile strength and the elongation at brake values are about 1/3 the values for the virgin fibers. The modulus for the recycled fibers (31.4 million pounds per square inch [psi]) was about the same as that for the virgin PAN fibers (31.2 million psi). The reason for the lower tensile strength and elongation is not clear: we plan to investigate it further as part of the process improvement study that is now underway. Process economics appear very promising, and a payback of less than two years is likely.

REFERENCE:
ARC '99 Quality is the Answer, 6th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 9-11, 1999, Detroit, MI.

TITLE:
Catalytic Process for Carbon Reclamation

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Advanced technology, carbon fiber composition, Adherent Technology

AUTHORS/CONTACTS:

Ronald E. Allred
Lincoln D. Busselle
John M. Shoemaker

Adherent Technologies, Inc.
Albuquerque, NM 87123

ABSTRACT:
The depolymerization of thermoset carbon fiber-reinforced epoxy matrix composites was studied to determine the significant reaction parameters, mechanistic reaction model, and fiber quality produced by a catalytic reclamation process. This process was designed to recover valuable carbon fiber and an organic fraction from the depolymerization of carbon/epoxy composites. Design of experiments was used to determine a regression model including terms for temperature, time, and agitation to estimate the purity of the carbon fiber produced from the reaction. Depolymerization of the composites appeared to follow a progressive conversion model similar to a solid catalyst reaction during the majority of the' reaction. Significant feedstock parameters that will affect the rate of reaction were the surface area available for reaction and the thickness of the composite. The carbon fibers reclaimed from the reaction reached 99.8% carbon values, i.e., 0.2% residual resin, which is sufficient to meet the market specifications for reuse in conductive molding compounds. The fiber tensile strength showed a 8.6% reduction in strength after reclamation indicating that the process had little damaging effect on the fiber. Potential applications for the recycled fibers include thermoplastic and thermoset molding compounds and nonwoven sheet reinforcements. An economic analysis of a recycling business based on the catalytic depolymerization process showed that it should be profitable provided that adequate scrap composite feedstock can be obtained.

REFERENCE:
ARC ’99 Quality is the Answer, 6th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 9-11, 1999, Detroit, MI.

TITLE:
A Process to Recover Carbon Fibers from Polymer-Matrix Composites in End-of-Life Vehicles

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Advanced Materials Recycle Technology

AUTHORS/CONTACTS:
B. J. Jody, J. A. Pomykala, Jr., E. J. Daniels, and J. L. Greminger
Argonne National Laboratory, Argonne, IL, USA

ABSTRACT:
Because of their high strength-to-weight ratios, carbon-fiber-reinforced polymer-matrix composite (PMC) materials are being evaluated for use in the automotive industry. The major barriers to their widespread use are their relatively high cost and the uncertainty about whether they can be recycled. A process to recover carbon fibers from obsolete PMC materials has been developed at Argonne National Laboratory. The process was tested using PMC samples made with different thermoset or thermoplastic substrates. For most mixtures of PMCs, the process can be energy self-sufficient using the polymer substrate as an energy source. An evaluation of the recovered samples found that the fibers appear to have retained good properties and characteristics and are suitable for short fiber applications. This paper describes the process and the characteristics and properties of the recovered fibers.

CONCLUSION:

REFERENCE:
Journal of Metals (JOM), Vol. 56, No. 8, August 2004, pp 43-47

TITLE:
Method and apparatus for separating mixed plastics using flotation techniques

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Advanced Materials Recycle Technology

AUTHORS/CONTACTS:
Edward J. Daniels, Bassam J. Jody., Joseph A. Pomykala, Jr.
Argonne National Laboratory, Argonne, IL, USA

ABSTRACT:
A method and apparatus are provided for separating mixed plastics using flotation techniques including a first stage initial washing tank for washing of incoming plastics and providing a first separation process and at least one separation module. The first stage initial washing tank includes a perforated basket to hold heavy materials, such as metals, glass, and the like. Each separation module includes a separation tank, a feeding section for feeding of mixed stream into the separation tank; and a collecting section for collecting of the separated mixed plastics including floaters and sinkers from the separation tank. The separation tank has no moving parts. Each separation tank and the first stage initial washing tank is a standard off-the-shelf circular tank with a flat bottom. Washing and drying steps are eliminated between separation stages. Batch processing is replaced with generally continuous operation. An integrated vibrating screen and air classification system is provided.

CONCLUSION:

REFERENCE:
U.S. Patent No. 7,255,233; Daniels et.al., August 14, 2007

TITLE:
DE-XRT Imaging for Automatic Particle Sorting

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Advanced Materials Recycle Technology

AUTHORS/CONTACTS:
T. de Jong

ABSTRACT:
The concept of imaging based on dual-energy X-ray transmission (DE-XRT) for automatic article sorting was developed by Delft University of Technology since 2000. Applications in the sorting of metal alloys, recycle glass and electrical and electronic wastes are today available for industrial application. This technique can also be applied for the concentration of certain types of polymers as well as for the removal of halogen and heavy-metal containing components from organic mixtures prior to thermal treatment. Examples are the removal and concentration of PVC and flame retardant resins from plastic mixtures and the removal of critical contaminants from solid recovered fuel (SRF). Today state-of-the art automatic X-Ray sorters are equipped with DE-XRT technology and are capable of processing large volumes of material. These features make X-ray sorting an economically attractive option for waste processing. Experimental data on the separation efficiency of metals and chlorine or bromine containing polymer from mixed shredder residue are presented and discussed.

CONCLUSION:

REFERENCE:
TMS EPD Congress, 2007

Section 14
Other Technology

TITLE:
Two problems – one solution – ASR/plastic composites

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Mechanical separation of shredder residue, molding of plastics concentrates

AUTHORS/CONTACTS:
Jack Lazareck, Xpotential Products Inc., Canada
www.xpotentialproducts.com

ABSTRACT:
Presently state-of-the-art auto-shredding yields approximately 75% ferrous and non-ferrous metals and approximately 25% by weight of ASR (I shall use the term ASR to include SR throughout). Advances in metal shredding and non-ferrous metal separation technologies turned my company's attention to ASR as a potential revenue source or at least markedly reduce the cost of disposal. This abundance of nuisance ASR was in our view a potential resource, as derelict autos and white goods were similarly perceived 40 years ago. As owners of General Scrap & Car Shredder Ltd. In Western Canada we faced significant disposal costs for 4 shredders. This journey began over 10 years ago and took many twists and turns until a final course of action was chosen. The recovery of the metallic portion of vehicles and white goods has reached technological maturity and attempts to add value is now achievable only in very small increments.

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Use of Raman Spectroscopy to Identify Automotive Polymers in Recycling Operations

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Materials identifaction, SpectraCode

AUTHORS/CONTACTS:
Sumeet Kumar, Computer-aided Engineering Technology, Inc.
Edward R. Grant, SpectraCode, Inc.
Claudia M. Duranceau, Ford Motor Company

ABSTRACT:
To support its recycling efforts Ford Motor Company is using a Raman based instrument, the RP01, co-developed with SpectraCode Inc. to identify unknown polymeric parts. Our recycling initiative involves detailed dismantling of our vehicles into individual parts, calculating the percentage of recyclability and making recommendations for the future use of recycled polymers. While Ford has voluntarily adopted the SAE J1344 marking protocol for identifying part material composition, a large number of unmarked parts still exist and require identification. This identification is being done with the help of RP-1. To facilitate this identification, we have generated an accurate reference library of Raman spectra for comparison to those unknown materials. This paper will describe the techniques that were used to develop and refine the RP-1 reference library to identify automotive polymers, especially black/dark plastics. The specific techniques under study include strategies for grouping polymer types characterization of the effect of higher laser power, as well as that of laser exposure, the binning of the scattered light on the detector and the use of masking techniques for the controlling the spectral region used for identification. The Raman based RP-1 is not affected by surface roughness, which is a previously noted shortcoming of spectra reflectance infrared devices. Future work will concentrate on identifying and quantifying fillers, and determining the percentage of each polymer in a blend using this nondestructive technique.

REFERENCE:
Use of Raman Spectroscopy to Identify Automotive Polymers in Recycling Operations
SAE Paper 2000-01-0739

TITLE:
Conditioning, identification and automatic sorting of plastic automotive parts for productive recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Near Infra-red sorting of plastcis

AUTHORS/CONTACTS:
Christian Stollberg, DaimlerChrysler AG, Germany

ABSTRACT:
- The Work
  - Materials and parts
  - Applied technologies for reprocessing, identificat
- The Theory
  - Processing technologies
  - The automatic NIR sorting process
- Sorting
  - Automatic sorting at the semi - industrial level
- Summary
  - A look ahead

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Blending of Post Industrial ABS with PMMA for Automotive Use

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Blending of recycled materials

AUTHORS/CONTACTS:
Michell J. Mikulec, Tony Brooks, J. Sutton, S. Schultz and J. Podolak, Visteon

ABSTRACT:
The recycling of post industrial ABS and PMMA was investigated. A material compound consisting of 100% post industrial (PI) recycled ABS and multicolored acrylic (PMMA) scrap from a manufacturing plant was blended and extruded. Test samples were injection molded and the test results were correlated to virgin material. Additionally, the material was used in injection molding of rear lamp housings in black and grey colors. The test results and economics are promising.

REFERENCE:
Blending of Post Industrial ABS with PMMA for Automotive Use
SAE Paper 2000-01-0743

TITLE:
Recycling Technology for Metallic Substrates: A Closed Cycle

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycling of catalytic converter materials

AUTHORS/CONTACTS:
Clemens Hensel, Demet Recycling AG
Roman Konieczny and Rolf Bruck, Emitec GmbH

ABSTRACT:
Emissions during usage phase of vehicles are of increasingly interest in environmental protection, and consequently, there is considerable interest in exhaust systems. The automotive exhaust system including the catalytic converter is, because of the precious metals in the catalyst, of particular interest for the recycling of automotive parts. This paper will describe the recycling technology of ceramic and metal catalyst substrates. The process will be analyzed in detail with the example of metal supports. As a result the complete life cycle and the recycling efficiency are presented.

REFERENCE:
Recycling Technology for Metallic Substrates: A Closed Cycle
SAE Paper 2000-01-0596

TITLE:
Recycling of metallic substrates

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Catalytic converter recycling

AUTHORS/CONTACTS:
Peter Lenz
Demet Deutsche Edelmetall Recycling AG & Co., Germany

ABSTRACT:
1. Demet - Full Service Partner for precious metal recycling

2. Why is recycling of precious metal containing waste necessary and profitable?

3. How to collect catalytic converters

4. How to recycle metallic converters - an example

5. How to get the precious metals for industrial reuse

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Masticated Rubber: A Recycling Success Story

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Tire rubber recycling

AUTHORS/CONTACTS:
Andrew Haber, NRI Industries, Inc.

ABSTRACT:
The term Masticated Rubber has been synonymous with a mixture of recycled rubber and fiber derived from passenger car tires.

Masticated Rubber has been used for over 15 years by a variety of OEMs for air & water management applications in the transportation industry. Its success is a result of being able to offer value-added solutions to recycling car tires and low price/high performance characteristics.

The objectives of this paper are to provide an update on the advances made in the manufacture of Masticated Rubber compounds, to present data for typical applications and to present data showing the environmental benefits associated with using this material. Not only are fewer passenger car tires being burned for fuel or sent to landfills, but factory greenhouse gas emissions are also reduced when compared to other rubber manufacturing processes).

REFERENCE:
Masticated Rubber: A Recycling Success Story
SAE Paper No. 2001-01-0698

TITLE: Improvements in Lubricating Oil Quality by an On Line Oil Recycler for a Refuse Truck Using in Service Testing

TOPIC/TECHNOLOGY/SUBJECT MATTER:
On-board recycling of lubricating oil

AUTHORS/CONTACTS:
Gordon E. Andrews and Hu Li, The University of Leeds
M. H. Jones, Swansea Tribology Services Ltd.
J. Hall, A. A. Rahman and P. Mawson, Top High UK Ltd.

ABSTRACT:
A method of cleaning lubricating oil on line was investigated using a fine bypass particulate filter followed by an infra red heater. Two bypass filter sizes of 6 and 1 micron were investigated, both filter sizes were effective but the one micron filter has the greatest benefit. This was tested on two nominally identical EURO 1 emissions compliance refuse trucks, fitted with Perkins Phazer 210Ti 6 litre turbocharged intercooled engines and coded as RT320 and RT321. These vehicles had lubricating oil deterioration and emissions characteristics that were significantly different, in spite of their similar age and total mileage. RT321 showed an apparent heavier black smoke than RT230. Comparison was made with the oil quality and fuel lubricating oil consumptions on the same vehicles and engines with and without the on-line bypass oil recycler. Engine oils were sampled and analyzed about every 400 miles. Both vehicles started the test with an oil drain and fresh lubricating oil. The two refuse trucks were tested in a different sequence, the RT320 with the recycler fitted and then the later fitted and the RT321 with the recycler fitted and then removed later in the test both without any oil change. The RT320 was also the one with the finer bypass filter. Test mileage was nearly 8,000 miles both trucks. The amount of fresh oil top up was monitored and the results corrected for this dilution effect. The results showed that the on line bypass oil recycler cleaning system reduced the rate of fall of the TBN by 23% and 49% for two trucks respectively. A 73% reduction in the rate of increase of the TAN incurred for one of the trucks. The soot in oil was reduced by ~70% on average for both trucks. The reduction in the rate of carbon accumulation in oil was 55% for the refuse truck with heavy smoke emissions. There was a 56% reduction in iron. The rate of oxidation, nitration and sulphation of oils was significantly reduced. There was an improvement of the fuel economy of about 3%. The lubricating oil consumption was reduced by 40% for 1 micron recycler filter and 30% for the 6 micron filter.

REFERENCE:
Improvements in Lubricating Oil Quality by an On Line Oil Recycler for a Refuse Truck Using in Service Testing
SAE Paper No. 2001-01-0699

TITLE:
New Recycling Industrial Projects: Vinyloop for PVC Composites Parts / Recafuta for HDPE Fuel Tanks

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other Technology, solvent extraction, Vinyloop process

AUTHORS/CONTACTS:
Jean Marie Yernaux, Solvay R&D, Belgium

ABSTRACT:
Today, the plastic industry is more and more concerned by the products after use or after their lifetime. Previous solutions, like landfilling is now rejected by citizens and politicians.

The SOLVAY Company has decided a few years ago to develop a R&D activity in the plastics recycling area in order to find innovative solutions to the wastes problems.

Two processes have been developed and their industrialization is underway.

The VINYLOOP process is a new technique to recover pure PVC compounds from composites like coated textiles, cables wastes, dashboards...' This process is based on the selective dissolution of PVC used in composites materials. After removal of insoluble parts like metals, rubber or other polymers, the PVC is re-precipitated with all additives by introduction of a non-solvent component which will form with the selective solvent an azeotropic mixture.

The RECAFUT A process permits to recover high density polyethylene from used fuel tanks which have been dismantled from old cars. The technique is able to remove coatings,. residual fuels absorbed in the walls of the tanks and after readditivation to give a product good enough to be reused for the production of new tanks. .

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Recent Technical Advanced and Economic Evaluations in Automotive Seat Recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other techology, polyurethane foam, Mobius Technologies

AUTHORS/CONTACTS:
Robert Villwock, Ph.D. and Bryan Martel, Mobius Technologies, Inc.
Paul Berthevas, Dow Europe S. A.

ABSTRACT:
The focus of this paper is mechanical recycling of flexible polyurethane foam by means of the Mobius process. This process involves grinding the foam finely enough so that it can be mixed into polyols and used to offset costs in the production of new molded car seats. The important physical properties are maintained within automobile manufacturer's specifications. The economics are promising and show the potential for reductions in the manufacturing cost of new foam.

Molded automobile seats have been manufactured with recycled contents of 10%. We present the performance properties of these new foams and the economic evaluation of the recycling process on a commercial scale. Significant reductions in grinding costs combined with appropriate formulations result in . major improvements toward a cost-effective recycling solution for the automotive industry.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 5-7, 2001.

TITLE:
Optimising the Recycling of Automotive Catalysts – First Results of a Research Project Supported by the German Federal Ministry of Education and Research

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, catalytic convertors

AUTHORS/CONTACTS:
Dr. Christian Hagelüken, OMG AG & Co. KG, Hanau
Dr. Matthias Buchert, Beate Schmitt, Dr. Hartmut Stahl, Oko-Institut e.V., Darmstadt

ABSTRACT:
Catalytic converters for the purification of automotive exhaust gases make use of the special catalytic properties of the Platinum Group Metals (PGM) Platinum (Pt), Palladium (Pd), and Rhodium (Rh). On a global basis, 31 % of Pt, 57% of Pd, and 84% of the Rh net demand have been used in 2002 for the manufacture of automotive catalysts (fig 1). At average 2002 market prices this represents a metal value of some 2.4 billion US-$/a. In the past 20 years this application has been the driving force for a significant increase in mine production of the PGM. However, in terms of fine metals produced, mine production is small, and - considering the high density of the PGMs - the total 2002 primary supply of 425 t would fit into a room of 14m2 only (fig. 2).[3]

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 12-14, 2003.

TITLE:
Thermal Tyre Recycling in the Swiss Cement Industry

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, tire recycle, Switzerland

AUTHORS/CONTACTS:
Dr. Michel B. Montell, environmental co-ordinator, Holcim (Schweiz) AG

ABSTRACT:
Holcim is one of the world's leading suppliers of cement, as well as aggregates (gravel and sand), concrete and construction-related services. From its origins in Switzerland, the Group has grown into a global player with strong market presence in over 70 countries on all continents. The Group employs more than 45,000 people.

Holcim has taken a leading role in the cement industry in its response to sustainable development. As a member of the World Business Council for Sustainable Development (WBCSD), and an active partner in the Cement Sustainability Initiative, it has influenced the overall direction of the cement industry in tackling challenges from climate change to community involvement.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
End of Life Tyres in Europe

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, tire recycle, Belgium

AUTHORS/CONTACTS:
Joël Pouget (BLIC (European Association of the Rubber Industry), Belgium

ABSTRACT:
Created in 1959, BLIC is the official and unique interlocutor appointed by the European rubber industry; it represents all national rubber industry associations of enlarged European Union (16+)

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Tyre Recycling in the EU: An Emerging Industry

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, tire recyle, France

AUTHORS/CONTACTS:
Dr. Valerie Shulman, ETRA (European Tyre Recycling Association), France

ABSTRACT:
Artificial turf and artificial reefs, battery housings, baseballs and bridge abutments, carpet underlay and construction bales, drainage filters, embankments, floor tiles, gaskets, harbours, insulation and industrial coatings, livestock mattresses and landfill engineering, marinas, playground surfaces and furniture, roofing materials and road surfaces, shoe soles and solid wheels, sound barriers, tennis courts, and vibration mats. What does this diverse array of products and applications have in common? The raw materials from which they are all produced - post-consumer tyres.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Praxis Report about Metal Separation and Two Years Experience with Sensor Based Metal Sorting

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, sensors, metals

AUTHORS/CONTACTS:
Dr. Ing. Ulrich Kohaupt, Director Sales, STEINERT Elektromagnetbau GmbH

ABSTRACT:
Metal sorting is the economical backbone of the shredder industry. The smallest loss is direct connected with financial disadvantages. The praxis shows that advanced and approved technique is the best basis to avoid this losses. Underfed magnetic drums with a strong and wide field are required as well as a self protecting eddy current separator with an eccentric pole system for the Non Ferrous recovery. Permanent magnetic pulleys or drums in the ECS feed are reducing the volume and increase the capacity and productivity of the process. The adjustability of the ECS process to the changing needs due to the material changes needs flexible processes at each step. The latest invented process of sensor sorting after the ECS had increased the profitability of shredder process very much. Substitution of hand picking had doubled the out come for stainless steel e.g.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Scrap Tires to Crumb Rubber: Market and Production. Issues for Processing Facilities

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, tire recycle

AUTHORS/CONTACTS:
Nongnard Sunthonpagasit,
Michael R. Duffey

Department of Engineering Management and Systems Engineering, School of Engineering and Applied Science, George Washington University

ABSTRACT:
Crumb rubber (CR) processing is an emerging recycling application which currently accounts for about 12% of annual discarded ~crap tires (ST). However, CR markets are quite complex and still in a very dynamic evolutionary stage. While CR markets will likely expand in the future, they will probably continue to experience a high degree of variability. For CR producers, there appears to be a pattern that many companies start up, often with state subsidies of some type, but fail to maintain markets and are forced out of business over a relatively short time period. To be successful, CR processors must carefully consider customer needs and CR quality specifications, competitors' products and pricing sensitivities, projected markets, government policies, and uncertainties of operating and capital costs.

REFERENCE:
GPEC 2003, Proceedings of the 9th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 26-27, 2003, Detroit, MI.

TITLE:
Post-Consumer Tires Integral Recovery Model for Spain

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, tire recycle, Spain

AUTHORS/CONTACTS:
Avelino Encina Canal
Pascal Haxaire

ABSTRACT:
Recuperacion Materiales Diversos S.A. is the European leading company for cables recycling for copper, aluminum and plastics granulates production. In the year 2001 it has processed more than 35.000 tons of cables.

In 2001, with the recycling of 15.000 tons of scrap tires (production of rubber granulates and steel recycling), RMD also became the main actor of the Spanish market and one of the leading European companies.

The company was founded in 1991 and since then has increased its staff from 5 to 100 and its turnover from 0.15 to more than 35 millions Euros.

RMD main activities are :
1. Cables recovery: recycling with production of aluminium and copper granules.
2. Scrap tires integral recovery : Recycling and electricity production.
3. Engineering: In relation with recycling and waste-to-energy sector: R&D, design, construction, assembly, start-up. Environmental permits, projects, economical studies...

REFERENCE:
GPEC 2003, Proceedings of the 9th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 26-27, 2003, Detroit, MI.

TITLE:
Recycled Rubber Based Thermoplastic Elastomers – An Unusual Opportunity to Cut Cost

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, tire recycle, Eco-tech

AUTHORS/CONTACTS:
Edgar A. Gonzalez
Eco-Tech, Inc.

ABSTRACT:

The environmental and health problems associated with scrap tires are well known. Whole tires in landfills "float" to the surface. Tire piles catch fire and are ideal breeding grounds for mosquitoes and rats. For these reasons, methods have long been sought to utilize these waste tires in such a way that an optimum is obtained between as low as possible cost to produce on the one hand and technical applications of the highest possible quality on the other hand.

This paper describes several applications where a recycled rubber based thermoplastic elastomer has replaced virgin thermoset rubber with a balance of performance, processability and value. It will include a discussion of performance properties required vs performance achieved and cost benefits.

REFERENCE:
GPEC 2003, Proceedings of the 9th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 26-27, 2003, Detroit, MI.

TITLE:
Recycling Tire Derived Scrap Rubber into Automotive Parts

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, tire recycle

AUTHORS/CONTACTS:
Andrew Haber, NRI Industries, Inc., Toronto, Ontario

ABSTRACT:
Over 250 million tires and millions of pounds of industrial scrap are disposed of in the United States annually. Rubber is a difficult material to recycle because it is vulcanized and tires are designed to resist destruction. This paper reviews the recycling efforts at NRI Industries. The technological, environmental and economic benefits of using post-consumer and post-industrial tire derived materials are demonstrated by reviewing a variety of Air & Water Management and Noise & Vibration applications. Data and applications are also presented for a novel TPE material containing 50% post-consumer tire derived material.

REFERENCE:
GPEC 2002, Proceedings of the 8th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 13-14, 2002, Detroit, MI.

TITLE:
VINYLOOP®, The New Process That Regenerates PVC Compounds Out of PVC Composite Residues

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, Vinyloop, solvent extraction

AUTHORS/CONTACTS:
Jean-Marie Yernaux,
Patrick Crucifix

Solvay S.A.
Brussels - Belgium

ABSTRACT:
Vinyloop® is an original patented recycling process for the regeneration of PVC waste materials into new precipitated PVC compounds.

The three main steps of the process are:

- Selective dissolution ofthe PVC compound in a mixture ofsolvents which are completely recycled within the process
- Separation of the non soluble materials
- Precipitation of a pure PVC compound with unique characteristics (homogeneity, grain size distribution,...) and directly suitable for the target applications (thanks to the possibility to complete the formulation within the process)

The Vinyloop® process is suitable for all types of PVC composites, but it is especially efficient in the recovery of PVC from products in which the compound is intimately attached to other materials. The quality of the regenerated PVC compound is such that it can be reused in most of the applications of the virgin one.

Since Solvay patented Vinyloop® in 1998, a pilot plant has been operated in Brussels, and a first industrial facility (10,000 tons/year) has started end of2001 in Ferrara (Italy). The status of this start-up and the other projects in Europe, Canada and Japan will be presented during the conference. .

REFERENCE:
GPEC 2002, Proceedings of the 8th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 13-14, 2002, Detroit, MI.

TITLE:
Plastic separation of automotive waste by superfast near-infrared sensors

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, near IR sensors

AUTHORS/CONTACTS:
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Lutz Kreuchwig
Arnold Uhl

LLA Instruments GmbH, Schwarzschildstr. 10, 12489 Berlin, Germany
www.LLA.de

ABSTRACT:
Superfast near-infrared sensors for the fractionation of pure plastics from used automotives have been developed by LLA, utilised in a separation plant for shredded waste. The complete separation technology was developed in co-operation with the car producers DaimlerChrysler, Ford and BMW, and with the plant builder Steremat.

The conventional recycling for used cars will be more and more difficult due to the increasing portion of plastics, which is expected to be 25% in the year 2005. The large variety of polymeric material, around 40 different types will commercially be used in automobiles, is an additional problem. The required purity cannot be achieved by manual dissection.

The new sensors are involved in a recycling technology, covering all processes from dismantling, shredding, chemical removal of lacquers, identification and mechanical separation up to reuse of separated plastics. Using two different near-infrared sensors the detection and identification of plastic material is performed by analysis of their characteristic spectra.

The two-step sorting technology starts with a sensor of high productivity of more than 1 ton/hour for the detection and sorting of bright and coloured polymers, as well as for black polypropylene. Subsequently, in the second step a long-wavelength-NIR sensor detects other black material like PC, PMMA, ABS, PC/ABS blends and others.

REFERENCE:
GPEC 2002, Proceedings of the 8th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 13-14, 2002, Detroit, MI.

TITLE:
Automotive Plastics Recycling: Successful Projects

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, additives, Ciba

AUTHORS/CONTACTS:

Margot Clauss
Heinz Herbst
James H. Botkin*

Ciba Specialty Chemicals Inc., CH-4002 Basel – Switzerland
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ABSTRACT:
The success of automotive plastics recycling will be dependent on the development of economically viable high value target applications for recyclates. After their first lifetime in automotive applications plastic recyclates show evidence of depleted stabilizer content, impurities, as well as thermo- and photo-oxidative by-products. These alterations lead to a reduction in mechanical properties and to diminished processing, weathering, and heat aging performance. As a consequence, plastic recyclates are not currently suitable for use in high-value applications. Results from selected successful automotive plastics recycling projects demonstrate the features and benefits of tailor-made additive systems to improve recyclate performance. Recent inquiries into the post-consumer recycling of battery cases, TPO bumpers, and fuel tanks have yielded data on the processing and weathering stability of recyclates, and on the influence of paint residues. Ciba's new additive systems enable the use of recyclates in demanding high-value applications.

REFERENCE:
GPEC 2002, Proceedings of the 8th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 13-14, 2002, Detroit, MI.

TITLE:
The V-Stat Triboelectric Separator Plastics/Plastic Separation and Reality

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other Technology, V-stat triboelectric separator

AUTHORS/CONTACTS:
Dr. Eric Yan and John Elder, Outocamp

ABSTRACT:
As new and more complex plastics are introduced to the marketplace, the recycling of these materials along with the recycling of the existing polymers are challenges for the recycling industry today. The increased amount of end-of-life electronics, the introduction of the plastic beer bottle and the increased use of plastics in automobiles are only some examples of these current challenges.

The V-Stat triboelectric separator is able to assist in these very difficult tasks. Capable of separating ABS/HIPS, PET/Nylon, PET/PVC and many other plastics at high throughput rates and recovery/rejection, the V -Stat has proven itself in many types of plastic separations.

This paper will demonstrate the capabilities of the V -Stat triboelectric separator and its applications in plastics processing.

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
Electrostatic Separation of Mixed Plastics

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, electrostatic separation

AUTHORS/CONTACTS:
Dr. Robert Meier-Staude and Dr. Rainer Koehnlechner, hamos GmbH, Penzberg/Germany

ABSTRACT:

With the newly developed hamos electrostatic separator it is possible to separate plastic mixtures from automotive production with high purities of +99.5% of the final products.

- the physical background of the electrostatic separation technology for the recycling of plastic mixtures is described
- the construction of a production machine is shown
- separation results will be presented like:
  - separation of taillights (ABS/PMMA)
  - separation of dash-boards (PVC/ABS or similar)
  - cable residues (PVC/PE)
- The economics of this recycling technology is shown

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
Technology for Integral Recycling of Automotive Interior Trim Scrap

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, interior trim scrap, compression forming, University of Detroit Mercy

AUTHORS/CONTACTS:
Girma M. Gebreselassi, LEAR Corporation, Advance Manufacturing Group, Southfield, MI
Vahid Sendijarevic, Jordi Garriga, Daniel Klempner, and Kurt C. Frisch, Polymer Institute, University of Detroit Mercy, Detroit, MI

ABSTRACT:
This paper describes an integral approach to recycling automotive interior trim scrap. In this process, offal from a variety of interior parts, which are composed of thermoplastic as well as thermosetting plastics (polyurethanes, polyureas, etc.), glass fibers, foams, and woodmat offal can be recycled. The scrap is first ground to a particle size smaller than 25 mm followed by compacting into compressed sheets, with or without addition of binder, which are then thermoformed into automotive interior trim parts of complex geometry. The thermoplastics as well as the flexible polyurethane foam provide enough flow in the compressed sheet to allow thermoforming. The foam partially depolymerizes under thermoforming to provide flow in addition to the molten thermoplastic. The unique feature of this technology is that a variety of thermoplastic and thermosetting scrap materials can be recycled on the same production line.

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
Novel Technology for Recycling Mixed Plastic Waste: The Transition to Commercial Scale

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, solid-state shear, Northwestern University

AUTHORS/CONTACTS:
Dr. Klementina Khait, Erin G. Riddick and Prof. John M. Torkelson
Robert R. McCormick School of Engineering and Applied Science, Department of Chemical Engineering, Polymer Technology Center, Northwestern University, Evanston, IL

ABSTRACT:
A novel, green technology for mixed plastics recovery which is under development at Northwestern University is now being transitioned to the commercial scale. This process, called Solid State Shear Pulverization (S3p), can handle commingled pre- or post-consumer polymeric waste without sorting by type or color. This continuous, one-step process converts polymeric feedstock into uniform, light colored powders of variable fineness suitable for further conventional plastic fabrication methods. The process offers a new route for recycling ordinarily incompatible polymers commonly found in the post-consumer waste stream without the addition of compatibilizing agents.

The Polymer Technology Center of the Department of Chemical Engineering at Northwestern University has two complete lines to demonstrate the process on the laboratory and production scales. S^3Pis currently in the transition to the production scale. This paper presents results on multicomponent, post-consumer plastic mixtures made by S3p on both the laboratory and production scale. Exceptional impact properties and good processability were obtained with a five component plastic blend representing the post-onsumer plastic film waste stream. When commercialized, S^3Pwill facilitate recycling and foster the development of value-added products made from recycled plastics.

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
WOODTRUDER™(Patents Pending)
System for Extrusion of Wood Fiber Polymer Composites

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, WOODTRUDER

AUTHORS/CONTACTS:
D. S. Dardenne, Davis-Standard Corporation, Technical Center, Pawcatuck, CT

ABSTRACT:
This paper gives insight on techniques that are critical to the efficiency of processing wood fiber and polymers on a fully intermeshing counter rotating twin screw (WoodTruder) extruder designed for wood fiber extrusion with an initial moisture content of the wood fiber higher than I % and below 8%.

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
Vision Sort – Automatic and Flexible Sorting of Recyclables

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, color-sorting

AUTHORS/CONTACTS:
Dr. Volker Rehmann, Real Vision Systems GmbH, Koblenz, Germany

ABSTRACT:
Vision Sort is a system for automatic identification and sorting of recyclables. Its unique feature is a combination of computer driven color image analysis and NIR (Near-Infrared) spectroscopy allowing for a flexibility never seen before. Vision Sort is able to sort objects both according to their material properties and according to visual criteria such as color and shape. All materials are identified at once, Vision Sort is not specialized for one material. By simply clicking on a touch screen the user can determine which fraction is to be sorted. At the moment the following materials are identifiable: FE, PP, PS, EPS, PVC, PET, PET-G, FA, Paper and liquid cardboards. The fractions can be combined with each other and with further characteristics from the color image analysis. Thus, the system is able to sort out e.g. PE in the morning and PET in the afternoon, or clean a mixed paper input from all non-paper objects. A lot of different other combinations are possible with always the same system.

The objects are identified in a completely contactless process using belts from 1000mm to 2000mm width. The economy of the system is guaranteed by means of the mass transportation and the high speed of the conveyor belt (up to 3 m/s). Depending on the input material a throughput up to 7th is possible (sorting of only plastics bottle with a 200Omm system.

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
Electrostatic Separation of Mixed Plastic Scrap from Automotive Manufacture

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, electrostatic separtion, Plas-Sep

AUTHORS/CONTACTS:
James D. Brown, Plas-Sep Limited, London, Canada

ABSTRACT:

When two dissimilar materials come into contact charge will be transferred and one of the materials will become positively charged, the other negatively charged. For insulating materials such as plastics, the charge transfer occurs only at the point(s) of contact and the charge remains on the particles after separation. This is the basis of an electrostatic separation process for plastics invented at the University of Western Ontario. Commercial scale units are now in daily operation.

The polarity and the quantity of charge transferred during contact between materials depend on the relative position of the two materials in the so-called triboelectric series. A brief form of that series is shown in Table 1. To illustrate how this series applies, PVC when contacted with PE will charge negatively since it lies lower in the Table. However PVC when contacted with Teflon will charge positively since it appears above Teflon in the Table. Thus depending on the total composition of a mixture, specific polymers can acquire either positive or negative charge.

Table 1 A triboelectric series for some plastics

acrylic	Positive charging
Lexan	V
PET, polyethylene terephthalate	V
PS, polystyrene	V
PP, polypropylene	V
PE, polyethylene	V
PVC, polyvinyl chloride	V
PTFE, Teflon	Negative charging

For binary mixtures, there is no ambiguity since any contact always produces the same polarity of charging on the same polymer. (Contacts between particles of the same polymer type produce no charge transfer). By falling through a strong horizontal electric field, the charged particles can then be separated. The positively charged particles will be drawn toward the negative electrode while the negatively charged particles will be attracted toward the positive electrode. In this way the polymers can be separated.

Mixtures of more than two polymers would seem to present difficulties since the same polymer may attain either a positive or negative charge depending on which component in the mixture it contacts.
However, in any mixture, there will be a dominant positively charging species (the one closest to the top of the triboelectric series) and a dominant negatively charging species (closest to the bottom).
These will be highly charged and can be removed during the first pass through the process. If the remaining mixture is then recharged triboelectrically, the charges found on the specific polymers will have changed (contacts are now between different polymers than in the original mix) and other components of the mix can be separated. Thus either by repeated passes through the process or through a cascade of units even complex mixtures can be separated.

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
An Innovative Separation System for Plastics Flake Providing Enhanced Markets and Processing Efficiency

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, color sorting

AUTHORS/CONTACTS:
Garry R. Kenny and Felix Hottenstein, MSS, Inc.

ABSTRACT:
Separation of plastics at the flake level has been confined to PVC and PET resin and to color sorting for PET and other resins. A new system provides for separation of multiple resin types as well as color and hydrocarbon-contaminated flakes in a single system. The proposed separation system also features an innovative feed system which provides higher throughput as well as multiple separations in one system.

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
Manufacturing with Co-mingled Plastics Through the Process of Thermokinetic Compounding

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, thermokinetic compounding

AUTHORS/CONTACTS:

ABSTRACT:
The term thermokinetic can be broken into thermo and kinetic. Thermo is the combining form of the word thermal which means "of or having to do with heat; determined, measured, or operated by heat." The term kinetic means "of or having to do with motion; caused by or resulting from motion." Thus, the resulting term, thermokinetic, means "operated by heat caused by motion."

Thermokinetic compounding is the process of combining plastics through heating the particles by motion. Essentially, old plastic is chipped into pieces by a grinder and then accelerated in a mixing chamber. The acceleration of the pieces causes them to collide with each other and the chamber walls to create heat. Once the material is heated, it is removed from the chamber and formed into a part through either compression molding or extrusion.

This process is vastly different than most plastic processing. Injection molding, blow molding and extrusion heat the plastic to melting through electrical heat bands and pressure before it is processed. The process of thermoforming heats sheets of plastic through radiation and then is vacuumed over a mold for shaping. Rotational molding uses heat produced from combustion of natural gas in an oven for heat. Other plastic forming processes, particularly of thermoset materials, use chemical reactions for the processing of the material. Because of the unique heating process of thermokinetic compounding, there are several advantages and a few disadvantages of this process.

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
Carbon-Dioxide-Based Microsortation of Postconsumer Polyolefins and Its Effect on Polyolefin Properties

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, sink-float, carbon-dioxide

AUTHORS/CONTACTS:
Eddy Karmana
Sindee Simon
Robert Enick

Department of Chemical & Petroleum Engineering, University of Pittsburgh

ABSTRACT:
Postconsumer polyolefin flake has been sorted using liquid carbon dioxjde as a float:-sink medium. This separation of PP and LDPE from HDPE was conducted at ambient temperature and a pressure that yielded a CO_2 specific gravity of 0.955, causing the HDPE to sink and the LDPE and PP to float. Although this process provided a high-purity (99+%) HDPE product stream, the effect of immersing the plastics in liquid carbon dioxide at these conditions was not previously measured. Therefore, six HDPE samples, two LDPE samples, and five PP samples were exposed to high-pressure carbon dioxide for 20 min. After this exposure, the polyolefins did not foam when the carbon dioxide was rapidly vented from the vessel. The weight reduction averaged 0.17%, which was attributed to the dissolution of low-molecular-weight additives or contaminants present on the surface of the plastics. No significant change in the melting point or latent heat of melting was observed, indicating that the degree of crystallinity was not affected by the exposure to carbon dioxide. No reduction was observed in the temperature at which the onset of thermal degradation occurred, because of the low solubility and degree of extraction of thermal stabilizers during the immersion in carbon dioxide. These results indicated that no deleterious effects on the polyolefin properties were associated with this separation technique.

REFERENCE:
Polymer-Plastics Technology and Engineering, 38(3), 433-444 (1999), Marcel Dekker, Inc. NY.

TITLE:
Recovery and Re-Use of Automotive Shredder Residue Flexible Polyurethane Foam

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, PUF recovery and washing, Argonne National Laboratory

AUTHORS/CONTACTS:
G. Ron Blain
Woodbridge Foam Corporation, Woodbridge, Ontario, Canada

ABSTRACT:

The polyurethane foam (PUF) portion of automotive shredder residue (ASR) can be separated relatively easily from the other ingredients, since it has much lower specific gravity than the other components. ASR consists of various plastics, e.g. PU, ABS, Nylon, Phenolic, PP, residual metals, glass, rubber and dirt particles. The portion of PUF in ASR will vary from one shredding operation to another. It also depends on the composition of the shredder feedstock. For instance, if this feedstock consists of a high proportion of autos with plastic bodies, then the portion of the ASR from the shredded total will increase. Similarly, the ASR composition will be influenced by the inclusion of other non-automotive shredded goods such as white goods (washers, fridges, etc.).

Bonsignore, Jody and Daniels (1) have indicated that from a three kilogram sample of raw ASR, they obtained about 0.28 kg (9.3%) of contaminated PUF. After solvent and detergent washing they were able to obtain about 0.18 kg (6%) of cleaned ASR PUF for subsequent conversion to rebond. Thus about 65% of the contaminated PUF was converted to clean ASR PUF,

In this study ASR PUF was obtained from a major Canadian shredder by hand picking fist size and smaller foam pieces directly from the ASR pile. This ASR PUF was extremely discolored, oily and/or wet, odiferous and contaminated with dirt, sludge, etc.

This foam was firstly weighed, washed with a water/detergent solution, dried and the new mass obtained. Both the washed foam and the non-foam residue were examined. The foam from this operation was used in this study to determine the viability of ASR PUF in molded foam products.

REFERENCE:
ARC ’98 Building the Technology Bridge to Plastics Recycling, 5th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 11-13, 1998, Chicago.

TITLE:
VINYLOOP®
A New Process to Recover Pure PVC Compounds from Composites Like Coated Textiles, Flooring or Cable Wastes

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, solvent extraction, Vinyloop

AUTHORS/CONTACTS:
J-M. Yernaux
Solvay R&D, Brussels

ABSTRACT:

The VINYLOOP® process is based on the selective dissolution of PVC used in composites applications like cable insulation, flooring, tarpaulins, blisters... After removal of insoluble parts like metals, rubber or other polymers, the PVC is reprecipitated with all additives by introduction of a non-solvent component which will form with the selective solvent an azeotropic mixture. By using typical conditions, the process is able to recover a pure PVC compound powder ready for use without any additional treatment like melt filtration or a new pelletization (specific characteristics of the powder are: average diameter of 400 microns and bulk density above 600 kglm3). All the solvents used are completely recycled and reused.

PVC compounds recovered in the VINYLOOP® process can be reused in a closed loop recycling scheme or processed in a large variety of high value applications in calendering, extrusion or injection.

REFERENCE:
ARC '99 Quality is the Answer, 6th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 9-11, 1999, Detroit, MI.

TITLE:
Processing and Properties of Automotive Shredder Residue/Polyethylene Prototypes for Building Applications

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other technology, construction materials from ASR, New Jersey Institute of Technology

AUTHORS/CONTACTS:
M. Xanthos
U. Yilmazer
S. K. Dey
S. Mitra
C. Feng

New Jersey Institute of Technology, Newark, NJ

ABSTRACT:
Automotive Shredder Residue, (ASR), was evaluated as a potential additive in polymer composites for building applications. Prototype blocks were prepared by the "intrusion" process using various ratios of ASR and Low Density Polyethylene, (LDPE), and evaluated for their leaching characteristics, mechanical and thermal properties. The leachable heavy metal and total organic carbon contents of as received ASR as well as of ASR/LDPE prototype blocks were determined at different pH values. Encapsulation of ASR by LDPE during molding significantly reduced the leachable content. In an effort to reduce the leachable content furt11er, the ASRILDPE pellets were processed in two stages by precompounding in a devolatilizing twin-screw extruder. Devolatilization and homogenization decreased the leachable heavy metal content by 98 % on the average in comparison to the as received ASR.

REFERENCE:
ARC ’99 Quality is the Answer, 6th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 9-11, 1999, Detroit, MI.

TITLE:
Development of Paint Removal Technology for "Bumper to Bumper Recycling"

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other Technology

AUTHORS/CONTACTS:
Christian Schultze, Mazda Motor Europe GmbH, Germany
Kazuhisa To & Kenji Moriwaki, Mazda Motor Corporation, Japan

ABSTRACT:
Each company in Japan is recycling collected, damaged bumpers from the marketplace to reuse the materials for undercovers, etc. due to the rise of a concern about environmental problems in recent years. From 2001, Mazda has been depainting bumpers to a high degree and reusing the materials for bumper reinforcements and grained bumpers. However, in order to use these materials for no-grain bumpers (standard) it's necessary to completely remove all paint from the material in order to guarantee high quality paint appearance (See Table 1). At this time, in order to realize "bumper to bumper recycling", Mazda has developed new paint removal technology. And we introduced reclaimed bumper materials to new vehicle's bumpers in production.

Requirements / Applications for the reclaimed material	Strength Rigidity	Dimensional stability	Paint quality	
			Paint film performance	Surface appearance
Undercover. etc	*	*	–	–
Bumper reinforcement	**	**	–	–
Grain surface bumper	**	**	**	**
Bumper (without grain)	**	**	**	**

** Full requirement * Partial requirement – No requirement

REFERENCE:
Proceedings of the 6th International Automobile Recycling Congress, Amsterdam, Netherlands, March 15-17, 2006.

TITLE:
New Developments in Glass Recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other Technology

AUTHORS/CONTACTS:
Lieve Declercq, Managing Director
Maltha Glassrecycling

ABSTRACT:
In Europe, each year approximately 15 million cars reach the end of their useful lives. A typical European car contains 33 kg of glass, which is 2.9%. Typical glazing consists of glass together with functional materials such as pvb interlayers in laminated safety glass, ceramic inks, silver printed electrical connectors, encapsulation materials, fixing clips and others like rain detectors, ... In general mirrors don't enter the glass recycling process, because of the small amount on tonnage involved in comparison with effort to separate the mirror from its plastic encapsulation.

REFERENCE:
Proceedings of the 6th International Automobile Recycling Congress, Amsterdam, Netherlands, March 15-17, 2006.

TITLE:
The Automation of Automobile Recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other Technology

AUTHORS/CONTACTS:
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ABSTRACT:
After shredding, ferrous and non-ferrous metals from automobiles can be recycled at high efficiency and relatively low costs. Another fact is that the costs of prior dismantling of non-metallic fractions for specific treatment are high. Unfortunately industrial processing of the postshredder non-metals mix requires considerable effort. Its products have up till now low economic value and there remains residue to be disposed against costs. When high recycling rates are required it provides an incomplete alternative to prior dismantling. On the other hand the objective of the car industry is to recover the maximum amount of materials from end-of-life (EOL) cars. This can only be achieved against acceptable costs when the best possible match between supply of EOL cars and demand on the various raw materials markets is found. The treatment can be subdivided into dismantling, metal recovery and (non-metallic) residue treatment. Of each operation costs can be reduced by maximising returns on the extracted fractions and minimising process costs by process control and newly designed equipment.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands,
March 9-11, 2005.

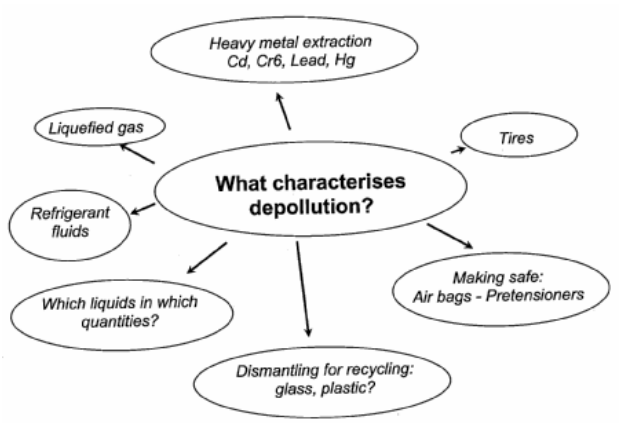
TITLE:
New Requirements of ELV Depollution and Pre-Treatment

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other Technology

AUTHORS/CONTACTS:
Manuel BURNAND
CFF Recycling
Environment - Research and Development Department

ABSTRACT:
Since the first text of Directive 2000/53/CE about ELV treatment, operators have had questions concerning the effective actions that should be practiced.

As far as French shredders are concerned with ELV de pollution and treatment of ELVs without spare parts value, CFF Recycling has conducted different tests and studies on the matter.



Different points must be clarified as potentially pollutant: either electronic devices extraction or heavy metal extraction. The required dismantling level must also be defined in order to reach the recovery targets.

The French ELV law has obliged shredders to accept ELVs with no cost for the last owner. As a result shredders must know the required operations precisely.

Through various experiments on recent and old vehicles, CFF Recycling gathered ideas of the operations required as well as the constraints that were associated with them.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands, March 9-11, 2005.

TITLE:
Management of Used Tyres in the E.U. – Tyre Producers' Response. Used Tyres: A Valuable Resource with a Wealth of Potential

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Other Technology

AUTHORS/CONTACTS:
Serge Palard, BLIC/Michelin, France

ABSTRACT:
Every year about 3,200,000 tonnes of used tyres (part worn + end of life tyres) are generated in Europe, of which 2,500,000 tons are end-of-life tyres for which value recovery has to be maximized. Tyres coming from End of Life Vehicles represent around 10 % of this amount. (source: BL/C).

The EC Landfill Directive (1999/31 IEC) forbids landfill of shredded end-of-life tyres at the latest by July 2006 in all European Community countries including Candidate Countries- and the End-of-Life Vehicles Directive (2000153/EC) limits the disposal routes for end-of-life tyres coming from scrap cars and vans.

Currently, several end-of-life processing routes are being developed to create environmentally friendly solutions. Amongst the different tyre recycling options, prevention remains the priority. Thanks to intensive research from tyre producers, several developments have been made to increase tyre wear resistance, improving its durability and have reduced its environmental impact.

REFERENCE:
Proceedings of the 5th International Automobile Recycling Congress, Amsterdam, Netherlands, March 9-11, 2005.

Section 15
Case Studies of Materials Recycled for Auto Applications

TITLE:
TPE Radiator Components from Post Consumer Tires

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Tire rubber recycling

AUTHORS/CONTACTS:
Monica H. Prokopyshen and Mark E. DeAngelis, DaimlerChrysler Corp.
Andrew Haber and Al Zander, NRI Industries

ABSTRACT:
Over 250 million tires are scrapped in the United States each year. Tires have been a problematic scrap because they been designed to resist destruction, and have a tendency to float upwards in landfills. Improper storage has resulted in tire fires –an even more problematic environmental concern that unsightly piles which can serve as breeding grounds for insect vectors. A better solution is to recover materials for use in new components. Not only does this resolve the landfill issue, but it also serves to conserve resources, while returning an economic benefit to society.

This paper traces the introduction of tire material recovery at NRI Industries and DaimlerChrysler Corporation (DCC), the development of the infrastructure and materials, and the launch of the Jeep Grand Cherokee thermoplastic elastomer (TPE) radiator seals, and economical feasibility of post-consumer tire material is demonstrated with a case study of the benchmark automotive TPE. The technical challenges of the product, performance characteristics and environmental benefits are discussed

REFERENCE:
TPE Radiator Components from Post Consumer Tires
SAE Paper 2001-01-3763

TITLE:
Development of Automotive Rubber Parts with New Recycling Technology

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Rubber recycling, Shear flow stage reactor technology, devulcanization

AUTHORS/CONTACTS:
S. Otsuka, M. Owaki and Y. Suzuki, Toyota Motor Corporation
H. Honda and K. Nakashima, Toyoda Gosei Co., Ltd.
M. Mouri and N. Sato, Toyota Central R&D Labs. Inc.

ABSTRACT:
Rubber is a thermosetting material and as such is generally considered difficult to recycle; therefore there is a demand for development of rubber recycling technology to protect the environment and conserve resources. Some technologies exist to recycle vulcanized rubber, but none of these has high enough productivity to produce reclaimed rubber, and re-vulcanized rubber does not have the same properties as virgin rubber.

Now a new recycling technology, called Shear Flow Stage Reactor, has been developed for rubber reclamation. This new technology has high productivity and can achieve the same properties as virgin materials. Automotive parts have been and are being produced with recycled Ethylene-Propylene-diene Rubber (EPDM) based on this technology. The performance of the developed parts is the same as the parts made from virgin materials. This new technology can be applied to other rubber materials, such as Natural Rubber (NR), NR/Styrene-butadiene rubber (SBR), and Butyl rubber (IIR) with appropriate reclaim conditions and will be an important new technology for rubber recycling.

REFERENCE:
Development of Automotive Rubber Parts with New Recycling Technology
SAE Paper 2000-01-0015

TITLE:
Recycling of Automotive Tail Lamp Assembly

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Tail lamp recycling

AUTHORS/CONTACTS:
Chi-Hoon Choi, Tae -Wook Yoo, John-Hee Hong, and Yang-Soo Lim, Hyundai Motor Co.

ABSTRACT:
A new recycled material has been developed by using the scrap of tail lamp assembly, made of poly(methyl methacrylate) (PMMA) for the lens and acrylonitrile-butadiene-stryene terpolymer (ABS) for the housing. Lamp scrap was extruded in a twin-screw extruder, and mechanical properties of the scrap were compared with ABS, PMMA, and an ABS/PMMA (60/40) blend. The recycled material from 100% tail lamp scrap has similar modulus to the 60/40 blend, however, notched izod impact strength and thermal resistance were lower than that of the blend, probably due to the presence of hot melt adhesive and silver paint. Scrap/virgin polymer mixtures showed improved thermal resistance and impact strength. The effects of composition and type mixed polymer on mechanical properties were also investigated.

REFERENCE:
Recycling of Automotive Tail Lamp Assembly
SAE Paper 970417

TITLE:
Status on the Recycling of Automotive Carpeting

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Auto carpet recycling

AUTHORS/CONTACTS:
Claudia Duranceau and Amos Golovoy, Ford Motor Co.
Don Backenstow, Lear Corporation, Masland Division

ABSTRACT:
EcoPlus™ Automotive Carpet Systems, are sued in trunks, on floors, for throw in mats, and more and contain many different thermoplastics polymers in various forms. New technologies are being developed to recycle complex carpet systems. One system has been evaluated at the Vehicle Recycling Partnership using a 'remelt' recycling process which can be used on a wide variation of thermoplastic materials, or blends of thermoplastic materials. The remelt process takes normally incompatible thermoplastic polymers and makes them compatible in a homogenous mix. This proprietary process yields a useable plastic. Plastic made from automotive carpet systems can be used to manufacture new automotive parts or other plastic articles of commerce.

REFERENCE:
Status on the Recycling of Automotive Carpeting
SAE Paper 970149

TITLE:
Accepting the Challenge of Carpet Recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Auto carpet recycling

AUTHORS/CONTACTS:
Donald R. Cartwright, Wellman, Inc.

ABSTRACT:
This paper will take us on a three-year journey on how a Ford idea was turned into reality through a supplier/customer partnership with Well and Bosch. We will examine how a process was developed that exceeded Ford's quality and cost requirements.

The over view will begin with a collection and take us through the development of a PCR (post consumer) nylon engineering resin. Why EcoLon was placed in the 1996 Windstar fan and shroud program will be presented. We will look at how the fan and shroud program was expanded as Ford drives to increase post-consumer content in the vehicles. highlighted also will be the growth of EcoLon into additional applications at Ford.

Finally, we will look into the future as to how the percentage of post-consumer nylon from carpet can be increased in existing and new applications. The objective will remain the same—meet or exceed quality standards while providing a lower cost material. "Carpet to Car Parts"—yesterday's dream has become today's achievement.

REFERENCE:
Accepting the Challenge of Carpet Recycling
SAE Paper 2001-01-1091

TITLE:
Stake Digester Process for HDPE Fuel Tank Recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Plastic fuel tank recycling

AUTHORS/CONTACTS:
S. Hunter W. Brooks, Brooks Associates, Ltd.
Claudia M. Duranceau, VRP/USCAR (Ford Motor Company)
William W. Gallmeyer, VRF/USCAR (Gallmeyer Design & Development)
Ronald L. Williams, VRP/USCAR, (General Motors Corporation)
Gerald, R. Winslow, VRP/USCAR (DaimlerChrysler/KBS Engineering)

ABSTRACT:
A research project to determine the feasibility of utilizing polyethylene post-consumer automotive fuel tanks as a source of raw material funded by Visteon, ExxonMobil, and was conducted by Brooks Associates. Brooks Associates launched this project in the last quarter of 2000 to demonstrate the feasibility of utilizing high-density polyethylene (HDPE) post-consumer fuel tanks in combination with wood fiber to create a new material suitable as an automotive substrate. The concept for the project was based on proven technology that processes wood into fiber utilizing steam explosion. The steam explosion process was commercialized to form wood fiber as a raw material for 'Masonite'. The product of the explosion process has also been made into a mat for further processing. This mat process is generally referred to as the 'air-lay' process. The purpose of this project was to add an equal part of post-consumer engineering-grade polyethylene from automotive fuel tanks to determine the viability of HDPE fuel tanks as a raw material source. A trial immediately preceding this work demonstrated that plastics taken from a general post-consumer source did process successfully into fiber mat. That mat was formed into an automotive interior door panel. This trial was designed to determine the feasibility of using post-consumer fuel tanks as the plastics source for this process.

REFERENCE:
Stake Digester Process for HDPE Fuel Tank Recycling
SAE Paper 2003-01-1371

TITLE:
Post Consumer Plastic Fuel Tank Recycling

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Plastic fuel tank recycling

AUTHORS/CONTACTS:
Pamela M. Graham, Solvay Automotive Co.
J. M. Yernaux, S. Dupont and Jean DeCanniere, Solvay Central Laboratory

ABSTRACT:
Coextruded plastic fuel tanks containing 27% post consumer recycled material were produced. The recycled material was high-density polyethylene recovered from end-of-life vehicle fuel tanks. Recovered fuel tanks contain residual fuel inside the tank and absorbed in the rank well. The mechanical recycling process was effective at removing the residual fuel. Mechanical properties of the regenerated material are similar to mechanical properties of virgin High Density Polyethylene (HDPE). The regenerated material was successfully molded into plastic fuel tanks with minor adjustments to the process.

REFERENCE:
Post Consumer Plastic Fuel Tank Recycling
SAE Paper 2000-01-1093

TITLE:
Analysis of Bumper Paint Removal and Development of Paint Removal Equipment

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Paint removal, bumper recycling

AUTHORS/CONTACTS:
Atsushi Mizutani, Tsutimo Nishida and Hiroo Onodera, Nissan Motor Co. Ltd.
Takeo Takase, Takase Synthesis Chemical Co. Ltd.
Taiichi Hikikata and Toshihisa Komori, Shintokogoi Co., Ltd.

ABSTRACT:
This paper deals with the development of plastics recycling technology, which is one key to resolving environmental and natural resource problems and encouraging recycling activities. Bumpers are among the heaviest plastic auto parts, so the technology for recycling bumpers is strongly required. Paint remaining on bumpers causes the strength of the recycled material to decline and degrades its surface quality. Therefore, unless the paint is removed, it is impossible to use recycled material to manufacture new bumpers. This hampers recycling efforts and results in low-value recycled material. Consequently, it is essential to develop a simple paint removing without chemical substances for practical plastics recycling at low cost. Two topics are discussed in this paper. The first concerns the mechanism of paint removal and the development of a technique for utilizing that mechanism. The analysis of recycled materials obtained with the developed technique confirmed that there were no strength surface quality problems. The second topic deals with the development of mechanical paint removing equipment.

REFERENCE:
Analysis of Bumper Paint Removal and Development of Paint Removal Equipment
SAE Paper 2000-01-0740

TITLE:
Profitable Recycling of Automotive Wiring Harnesses

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Wiring harness recycle, PVC

AUTHORS/CONTACTS:
Wolfgang Diegman, Frank H. Adam and Ruediger Tiedeck, Delphi Automotive Systems
Werner Hoffmanns, University of Wuppertal

ABSTRACT:
Legal requirements, especially in the European Union, rising concern about our environment and economic reasons force us to look at the End of Life (ELVs) more critically. This paper describes some projects where recycling technologies have been developed showing clearly that recycling of Polyvinyl Chloride (PVC) insulation in automotive wiring, a separation technology for different plastic materials by melting point, the treatment of laminated materials like flexible printed circuits, some ideas of fastening systems, suited for disassembly and several basic rules for making recycling easier and profitable.

REFERENCE:
Profitable Recycling of Automotive Wiring Harnesses
SAE Paper 2000-01-0736

TITLE:
Development of Compounding Procedures for Recycled Polyamide for Use in the Automotive Industry

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Compounding

AUTHORS/CONTACTS:
J. Ramón Dios, Fundación GAIKER
Edorta Larrauri
Rafael Miguel
Sixto Arnaiz

ABSTRACT:

REFERENCE:
Proceedings of the International Automobile Recycling Congress, March 13-15, 2002, Geneva, Switzerland.

TITLE:
Development of Recycling Technology for Water-Borne Paint
- Development/Practical use of Recyclable Paint for Parts -

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Paint recovery and recycle

AUTHORS/CONTACTS:
Seiji Yokoi, Takeshi Bessho and Tadayuki Sakai, Toyota Motor Corp.

ABSTRACT:
The transfer efficiency for painting processes utilizing water-borne materials is low, and the residual paint is disposed of as waste. In This study, we focused on a recycling system to collect and dissolve the paint over-spray in the booth water, and to concentrate and regenerate it by means of an ultra filter (UF). Paint adaptable to the recycling system has been developed by providing compatibility between high hydrophilicity of liquid paint and the high hydrophilicity of the paint film, in order to ensure the recyclability and the high-corrosion performance required of paint on automobiles underbody parts. This recycling technology is used in an actual propeller shaft painting process and provides large waste reduction and a decrease in painting costs.

REFERENCE:
Development of Recycling Technology for Water-Borne Paint
- Development/Practical use of Recyclable Paint for Parts -
SAE Paper 2001-01-0361

TITLE:
From Painted "Scrap" to Painted Production Parts

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Recycle of painted industrial plastic scrap

AUTHORS/CONTACTS:
Veronica Mitchell and Matt Carroll, General Motors Corp.

ABSTRACT:
Saturn currently injection molds and paints PPE+PA66 exterior body panels in its Spring Hill, TN facility. These manufacturing operations result in a continuous stream of waste material that needs to be responsibly and economically managed. This paper will summarize the process that General Motors and Saturn used to evaluate and validate the use of post-industrial painted PPE+PA66 reprocess material in Saturn and General Motors' wheel trim applications (wheel covers). Not only did this project increase the amount of recycled content in General Motors' vehicles, but it also provided Saturn Corporation with a favored outlet for an internal waste stream.

REFERENCE:
From Painted "Scrap" to Painted Production Parts
SAE Paper 2000-01-0024

TITLE:
Joint DuPont/Toyota Program to Demonstrate Feasibility of Closed-Loop Recycling of Polyamide-6 Air Intake Manifolds

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Case study, nylon-6, intake manifolds, Toyota, DuPont

AUTHORS/CONTACTS:
Jan Stouffer, DuPont Engineering Polymers, USA
Yasushi Miyamoto, Toyota Motor Corporation, Japan
Katsuhiko Nakajima, Toyota Motor Corporation Japan
Primo Penone, DuPont de Nemours, Italy

ABSTRACT:
Toyota Motor Corporation and DuPont have collaborated to demonstrate the feasibility of closed-loop recycling of polyamide 6 air intake manifolds, a large component that if recycled can help automakers meet some of the End-of-Life-Vehicle legislation challenges. The team used DuPont Composite Recycling technology to remove contaminants and fillers from used resin, then rebuild the molecular weight of the polyamide to that of virgin material. The recycled polyamide was then compounded in the same formulation used for virgin material in the end-use application. Toyota has moulded air intake manifolds and tested them for performance properties. This paper announces the successful results of this joint technology program and discusses the overall environmental footprint and the sustainability of the economics of this process compared to the economics of creating virgin material.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
ELV Recovery and Recycling Polyurethane Seat Cushion Recycling Options

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Case study, polyurethane foam, DOW Europe

AUTHORS/CONTACTS:
Frank E. Mark, DOW Europe
Axel E. Kamprath, Recticel n.v.

ABSTRACT:
Polyurethane is now one of the key materials in automotive production. It is used in a wide variety of applications in a car and end-of-life considerations should be addressed at the higher volume parts.

The polyurethane raw material and converting industry through its industry associations ISOPA and Euro-Moulders respectively has evaluated best practices for recycling of seat cushions within the European End of Life Vehicle (ELV) Directive. The different aspects of ELV compliance, technical, investment, market, quality requirements of products and chain deficit were addressed and evaluated from a stake holder industry point of view.

The reason for addressing mainly the recycling route is due to the stringent 85 % reuse and recycling quota for the End of life vehicle (EL V) to be met in 2015.

REFERENCE:
International Automobile Recycling Congress Proceedings Book, Geneva, Switzerland, March 10-12, 2004.

TITLE:
Injection Molding with Recycled Polypropylene from Shredder Residue Into a Structural Support Battery Bracket

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Case studies, 21st Century, Salymp, PP

AUTHORS/CONTACTS:
Richard Abell, President 21 st Century Polymers Inc.
Mark Conant, Account Manager Mayco Plastics Inc.

ABSTRACT:
A new, commercially viable method for recovering plastics from shredder residue has been developed for processing shredder residue. Salyp NV located in Belgium, Europe developed this technology and equipment needed to process shredder residue, and 21st Century Polymers & Associates is the exclusive agent to market and sell Salyp's equipment and technology in North America. This process leads the way for metal recyclers to create a low cost high volume stream of recycled plastics that can be re-used in automotive and durable goods industries at significant cost savings compared to virgin plastics. One of the plastics that can be recovered using the Salyp process is polypropylene. 21st Century, working with Mayco Plastics, compounded this material, tested and trial-molded a production part application. Because of the structural requirements on the selected production part, glass fibers were added in the injection molding process to enhance the physical properties. This process is also required with the virgin plastic material application.

An explanation of Salyp's technology, equipment and processes, together with the molding trial of a battery bracket using recycled plastics, is presented in this paper. The favorable economics of these processes will also be discussed.

REFERENCE:
GPEC 2003, Proceedings of the 9th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 26-27, 2003, Detroit, MI.

TITLE:
Care Car II Demonstration of Recycled Resins From End-Of-Life Vehicles Applied to DaimlerChrysler Grand Cherokee's

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Case studies, CARE Car, Daimler Chrysler

AUTHORS/CONTACTS:
Gerald R. Winslow, Consultant to DaimlerChrysler
James Mitchell, DaimlerChrysler 800 Chrysler Drive, Auburn Hills, MI 48326

ABSTRACT:
The CARE (Concepts for Advanced Recycling and Environmental) Car II demonstration vehicles are a result of the Chrysler's group effort in supporting research in automated recovery and separation of plastics from Automotive Shredder Residue (ASR). Since 1996 Chrysler has been conducting research on various technologies for separation of mixed automotive plastics. This research began after extensive hand dismantling of Chrysler vehicles whereby it was determined that hand dismantling and removal of plastics from vehicles would not be the most viable and economical approach to recycling. Additionally, Chrysler realized early the need to work closely with our suppliers who currently mold most of the plastic parts which go into our vehicles. This program is our latest effort to better understand the total process including the technical performance of different recycled plastics, plastic processing and molding parameters and part performance. A number of companies and suppliers were identified to support the infrastructure required to fully evaluate the total process and to aid in the creation of demonstration vehicles. This paper and presentation will outline DaimlerChrysler's approach that was used which included the following companies and their efforts.

DaimlerChrysler contracted Recovery Plastics International located in Salt Lake City Utah to develop the technology and equipment to demonstrate automated plastic separation of targeted plastics from shredder residue. Shredder residue is created as a byproduct of recycling and recovering the metals that are contained in End of Life Vehicles (ELV). Most vehicle plastics as well as other organic and inorganic substances comprise the left over ASR. The companies that do the auto shredding are referred to as metal recyclers. DaimlerChrysler approached two respected and well established metal recycling companies to seek participation and support this program. The recyclers agreed to join with us because they realized the economic value of this type of technology, given that they own the shredder residue. The two participating metal recyclers are: the David J. Joseph Company and the Hugo Neu Corporation. The results to date, inclusive of identifying part and systems changes, suppliers and plastic material suppliers are presented in this paper. Additionally, the creation details of the CARE Car II demonstration vehicles are discussed.

REFERENCE:
GPEC 2002, Proceedings of the 8th Annual Global Plastics Environmental Conference, Society of Plastics Engineers, Feb. 13-14, 2002, Detroit, MI.

TITLE:
From Carpet to Car Parts

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Case studies, carpet recycle

AUTHORS/CONTACTS:
Steven R. Dunkle, Wellman, Inc.

ABSTRACT:
The use of nylon from recycled carpets has increased in popularity due to the versatility of products made from this huge and relatively untapped raw material source. This paper presents an overview of the recycling of carpets from collection, through product development and qualification, and finally goals for the next certify. This paper will take us on a three-year journey on how a Ford idea was turned into reality through a supplier/customer partnership' with Wellman and Bosch. We will examine how a process was developed that exceeded Ford's quality and cost requirements.

The overview will begin with the collection of used carpet and take us through the development of several PCR (post-consumer resin) nylon engineering resins. Why WELLAMID® EcoLon™ was placed in the 1996 Ford Windstar fan and shroud program will be presented. We will look at how the tan and shroud program has expanded as Ford drives to increase post-consumer content in their vehicles. Also highlighted will be the growth of EcoLon into additional applications at Ford.

Finally, we will look into the future as to how the percentage of post-consumer nylon from carpet can be increased in existing and new applications. The objective will remain the same - meet or exceed quality standards while providing a lower cost material. "Carpet to Car Parts" - yesterday's vision has become today's reality!

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
Recycled TPO Skins for Automotive Interior Trim

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Case studies, post-industrial TPO

AUTHORS/CONTACTS:
Carlos Vieira, TMG Automotive, Campelos, 4800 Guimaraes, Portugal

ABSTRACT:
A lot of attention has been given, on the way to deal with the industrial plastic waste in an economic and ecological manner.

This work is focused on the reutilization of the waste produced from the edge trimming in the extrusion of TPO sheets and the final inspection of TPO skin/ XL PE foams laminates.

Different analysis techniques were carried out in order to evaluate the effect of the recyclate into the final product performance. The DMA results show no significative changes on the viscoelastics properties for different percentages of recyclate. Adding TPO/ XL PE foam scrap into the virgin TPO will cause a significative increase on the viscosity of the compound. .

Results from the OIT (oxidation induction time) measurements shows that over 50 percent of recycled material we may have some failure in thermal stability of the compound.

Therefore, recycled TPO skin can be reutilised on the sheet extrusion process, without affecting the functionality and quality of the final product performance.

The incorporation of TPO/PE foam laminates into some injection moulding applications has proven to be a cost effective way improving the impact. resistance of plastic applications of the car, like the wheel arch cover.

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
Physical Property Effects due to Recycle Content in Multi-Layer TPO Structures for Thermoforming

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Case studies, TPO thermoforming

AUTHORS/CONTACTS:
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ABSTRACT:
Data on a multi-pass extrusion study for a TPO are presented at three different recycle levels. Results are also presented for a soft touch multi-layer sheet structure consisting of a TPO skin, PE foam, an adhesive layer and a rigid TPO substrate. Finally results on a DuPont™ clear film laminated to a metallic mold-in-color TPO are presented. In all cases, good retention of properties at typical recycle rates for thermoforming are achieved for MFR, stiffness, impact, heat distortion temperature, tensile strength and elongation,

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
Value-Added Automotive PP Compounds with Post-Consumer Plastics (PCR)

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Case studies, PP, Ferro Corp.

AUTHORS/CONTACTS:
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ABSTRACT:
Due to the high consumption of plastics in the automotive market today and its continuous usage growth in the future; recycling of plastics has been a subject of great interest in the management circles of the "Big Three." The high number of cars being scrapped each year (> 10 million) in the US brings up serious environmental concerns, which include management of landfill and non-toxic substances.

For the past several years, Ferro Corporation, Filled & Reinforced Plastics Division, has been a leader in developing a variety of filled and reinforced polypropylene (PP) products that utilize post consumer recycle content (PCR). These products have been suggested for numerous under-the-hood applications, such as AC Heater Housings, Climate Control Ducts, Structural Ducts, Fan Shrouds and Carbon Canister Brackets. New opportunities for PCR-containing polypropylene products are continuously being pursued.

In this presentation, technical data will be shared to demonstrate the versatility of polypropylene compounds, recyclability of polypropylene, and ease of formulating to target applications requiring various end-use demands. Also, a discussion will follow to explain how consistency of high quality PCR feed stock is incorporated to meet and exceed customer specifications.

REFERENCE:
ARC 2000 Where Innovative Ideas Merge with Reality, 7th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 8-9, 2000, Dearborn, MI.

TITLE:
Recycled Plastics Applied to DaimlerChrysler CARE Cars

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Case Studies, CARE Cars, DaimlerChrysler

AUTHORS/CONTACTS:
Gerald Winslow, KBS Consulting Engineering

ABSTRACT:
DaimlerChrysler initiated the CARE (Concepts for Advanced Recycling and Environmental) Cars project. The intent of this project was to demonstrate technically design for the environment concepts with a major emphasis on using recycled plastics and materials. Two special Dodge Stratus were assembled and the sedans are rolling laboratories in recycling innovation. The demonstration vehicles front fascias have shiny new plastic on the outer surface but the interior core of the fascia are made of ground-up, reformulated plastic from old fascias. The tires include rubber recycled from old tires. The wheel balances are made of recycled plastic, not lead.

Components throughout the vehicles, from interior trim and seats to tail lamps, outside mirrors, door handles, steering wheel, engine cooling and heating systems, air induction systems and fuel tanks are designed to use recycled plastics. Only the car's metal parts already recycled were in most cases not changed. The goal of these cars was to present concepts that could be introduced into production within 5 years.

REFERENCE:
ARC ’99 Quality is the Answer, 6th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 9-11, 1999, Detroit, MI.

TITLE:
Recycling of Post Industrial ABS and Acrylics for Lamp Housings

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Case Studies, Post-industrial ABS, PUMA, Michigan State University

AUTHORS/CONTACTS:
Michelle MIkulec
Anthony J. Brooks
Jason Sutton
Stephanie Schultz

Visteon

Jeremy Podolak, Michigan State University

ABSTRACT:
An economical way to reuse the waste stream in a US manufacturing plant is described in this paper. For a recycling project to be successful, the following objectives should be accomplished:

1) Provide financial reward to the material reprocessor and the part manufacturer
2) Reduce waste streams in the plant
3) Prove the performance of the re-processed material and part to the required specifications.

A material compound consisting of 100% post industrial (PI) recycled ABS and multicolored acrylic (PMMA) scrap from the Sandusky manufacturing plant was blended and evaluated, and the test results were correlated to virgin material. The injection molded rear lamp housings were analyzed for material and part performance, and moldability. The test results and economics are promising, and are discussed in this publication.

REFERENCE:
ARC '99 Quality is the Answer, 6th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 9-11, 1999, Detroit, MI.

TITLE:
Recycling Plastic Fuel Tanks from End-of-Life Vehicles

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Case Studies, Plastic fuel tank recycling

AUTHORS/CONTACTS:

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ABSTRACT:
Coextruded plastic fuel tanks containing 27% post consumer recycled material were produced. The recycled material was high-density polyethylene recovered from end-of-life vehicle fuel tanks. Recovered fuel tanks contain residual fuel inside the tank and absorbed in the tank wall. The mechanical recycling process employed was effective at removing residual fuel and restoring material properties similar to fresh material levels. The regenerated material was successfully molded into plastic fuel tanks with minor adjustments to the process.

REFERENCE:
ARC ’99 Quality is the Answer, 6th Annual Recycling Conference Proceedings Book, Society of Plastics Engineers, November 9-11, 1999, Detroit, MI.

Section 16
Lightweighting Materials

TITLE:
Dynamic Processes for Recycling of Low-Quality Charge Materials

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Lightweighting Materials

AUTHORS/CONTACTS:
S. Lekakh, D.G.C. Robertson, V. Rimoshevsky, L. Tribyshevsky, B. Tribyshevsky

ABSTRACT:
Melting processes may be classified into two groups – stationary and dynamic. In stationary processes (e.g. a reverberatory furnace), the pile of solid charge is more or less fixed in position, and any liquid motion is the result of natural convection. In dynamic processes there is active motion of the solid charge and melt inside the furnace caused by mechanical or electromagnetic forces. Each type of process was analyzed from the point of view of metal recovery and energy efficiency when charge materials of different metallurgical quality were used. The stationary processes minimize the oxidation of high quality charge materials (ingots, large size scrap) while dynamic melting processes have the possibility of increased metal recovery from low-quality scrap with high specific and oxidized surface, such as aluminum turnings and dross, with effective separation of melt from slag by the use of special fluxes. The parameters of melting low quality charge materials in a dynamic rotary furnace were experimentally studied and computationally modeled. Technical results will be presented of using 0.5 t rotary furnace for recycling locally sourced low-quality aluminum charge materials. The furnace has been used over a period of several years.

CONCLUSION:

REFERENCE:
Proceedings of the TMS EPD Congress, 2008.

TITLE:
Elemental Analysis and Chemical Composition Based Material Separation

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Lightweighting Metals

AUTHORS/CONTACTS:
Adam Gesing

ABSTRACT:
The need for elemental analysis and chemical-composition-based material separation will be demonstrated for scrap metal alloys, including aluminum alloys. Sorting of a few known alloys in the manufacturing scrap stream will be compared to the batching of a secondary alloy from an unknown mixture of post-consumer scrap. The capabilities of LIBS, XRF and PGNAA (neutron activation)
for quantitative elemental analysis will be compared. The analytical capability requirements of process control and high-speed sorting will be contrasted. Examples of successful sorting applications using each of the three technologies will be discussed.

CONCLUSION:

REFERENCE:
TMS EPD Congress, 2007.

Section 17
Environmental/Energy Benefits

TITLE:
Automotive Recycling in the United States: Energy Conservation and Environmental Benefits

TOPIC/TECHNOLOGY/SUBJECT MATTER:
Environmental/Energy Benefits

AUTHORS/CONTACTS:
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ABSTRACT:
In 2006, the United States produced a total of 56.6 million tons of plastics (45.2 million tons thermoplastics, 4.4 million tons of thermosets, 1.3 million tons of engineering plastics and 5.7 million tons of others). These were used in a number of applications including the transportation industry, the home appliances industry, electronics industry, construction industry packaging, furniture industry, textile industry and medical applications. Production and use of polymers has also been growing and is expected to continue to grow and new types are likely to continue to emerge. Production of metals from ores is also on the rise because of increasing demand. For example, in 2002 over one billion tons of iron ore were produced worldwide, in addition to recycled iron. Transportation, home appliances, electronics and construction industries consume most of these metals. For example, metals constitute over 75% of a vehicles weight and polymers constitute another 7%. Eventually, goods made with polymers and metals reach the end of their useful lives and become obsolete. Each year more than 50 million vehicles reach the end of their service life throughout the world, 15 million of them in the U.S. alone. More than 95% of the vehicles enter a recycling infrastructure that includes auto parts dismantlers, re-manufacturers and scrap recyclers (shredders). Today, over 75% of automotive materials are profitably recycled via parts re-use, parts and components remanufacturing and, ultimately by the scrap processing (shredding) industry.

CONCLUSION:

REFERENCE:
“Automotive Recycling in the United States: Energy Conservation and Environmental Benefits,“ The Journal of Metals, Vol. 59, No. 11, Nov. 2007, PP 41-45.