Process Evaluation Section

Froth Flotation for Separation and Recovery of Thermoplastics

Problem/Opportunity

Each year, increasing volumes of mixed-plastics wastes from a variety of sources, such as obsolete appliances, consumer electronics, and cars, are being generated and landfilled. Although existing technologies (such as gravity separation and hydrocyclones) are effective in separating certain thermoplastics, the purity and yields achievable with these technologies limit their cost-effectiveness. Existing technologies are not effective in separating plastics of equivalent densities.

Approach

Under a collaborative research and development agreement (CRADA) with the Appliance Recycling Center of Amercia (ARCA, a commercial remanufacturer and recycler of obsolete appliances), a project was undertaken to develop a process for effective separation and recovery of high-quality acrilonitrile butadiene styrene (ABS) from the mixed-plastics wastes generated in ARCA's appliance-recycling operation. The critical separation required for a cost-effective process is the ability to separate the ABS from high-impact polystyrene. The mixed-plastics waste stream generated from obsolete appliances is about 70% ABS, 20% HIPS, and 10% other plastics. The ABS and the HIPS are readily separable from the other plastics, but they are not readily separable from each other as they have the same densities and physical properties.

Research was undertaken to adapt froth flotation technology from the minerals processing industries to effect the separation of the ABS from the HIPS.

In this process, aqueous solutions are used to effect critical separations of particles based on the relative hydrophobicity or hydrophilicity of the particles. Bench-scale research successfully identified a set of solution conditions (including density, pH, and surface tension) that allowed for an air bubble to attach to the hydrophilic HIPS and thereby decrease its apparent density relative to the ABS. This allowed the HIPS to float away from the ABS, which sank in solution.

Results

A large-scale (1000 lb/h) pilot-plant was built and operated at ARCA's facility in Minneapolis to confirm process economics and the effectiveness of the process. ABS was successfully recovered at purities in excess of 99% and at yields of more than 80%. ABS recovered from this operation was successfully used to injection-mold automotive parts, thus confirming the feasibility of using obsolete post-consumer plastics (in some cases, plastics more than 15 years old) to meet the performance requirements of parts produced for this industry today.

Future Plans

The basic process for separating and recovering ABS from HIPS has been patented. Licensing of the technology is being pursued. Argonne has since adapted the basic process to critical separations of plastics from other mixed-waste streams, including the separation and recovery of

ABS / polycarbonates from the mixed-plastics found in consumer electronics and separation of polyethylene from the polypropylene plastics found in auto shredder residues.

Automotive headlamp backcans were successfully injection-molded by using 100% post-consumer ABS recovered from obsolete appliances.