



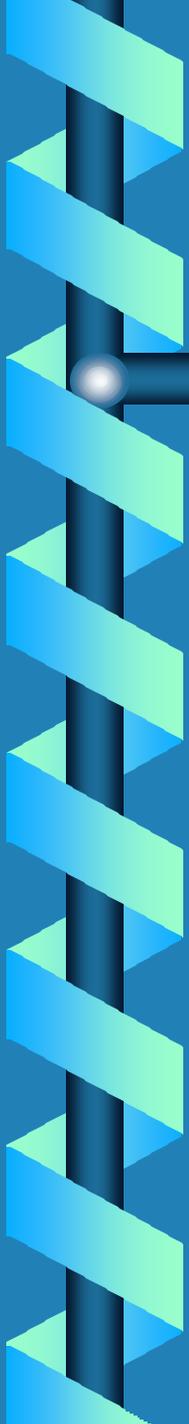
A Process to Recover Fibers From Polymer Matrix Composites

Joe Pomykala

B. J. Jody

E. J. Daniels

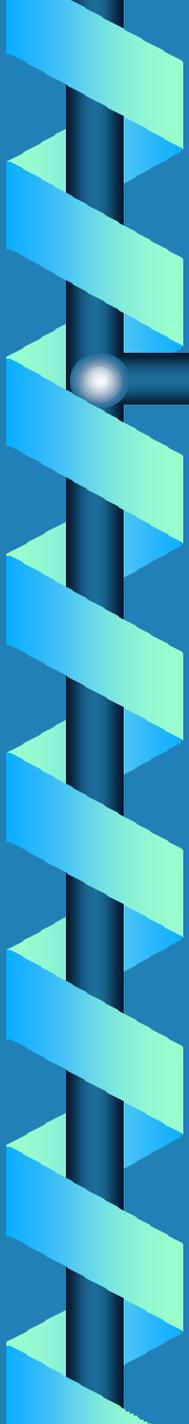
Argonne National Laboratory



Introduction

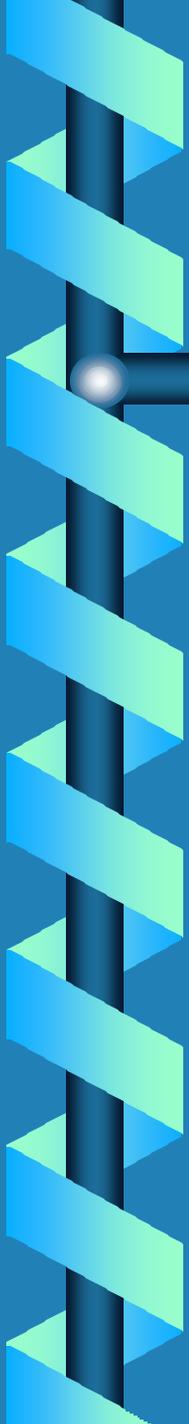
❖ PMC applications

- Aerospace
- Automotive industry
 - High cost
 - Ability to be recycled?



Objective

- ❖ Develop a cost effective process for recovering high value carbon fibers from PMC's
- ❖ Assess the fibers potential for recycling them into useful products



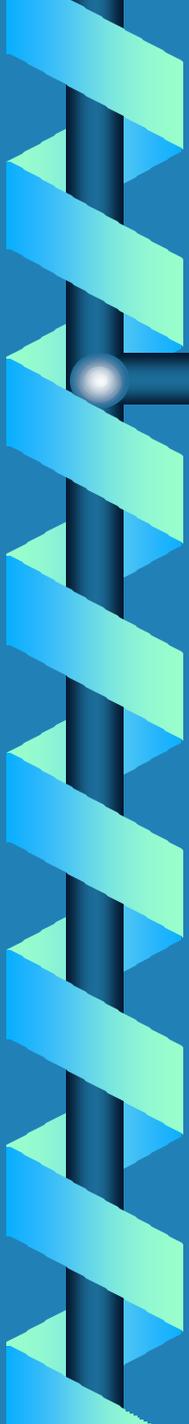
Tested Two Potential Processes

- ❖ Thermal treatment method

- Most promising

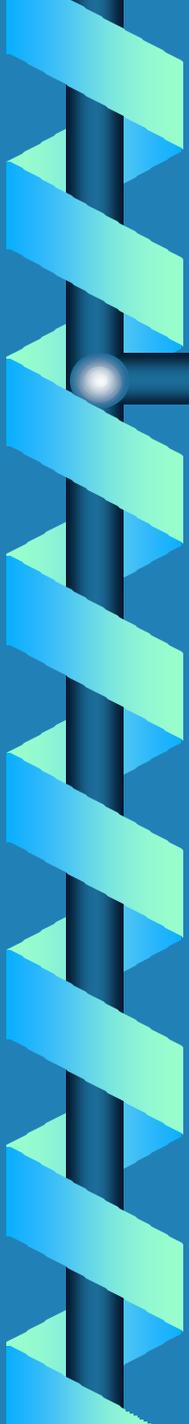
- ❖ Chemical treatment method

- Questions regarding economics



Thermal Treatment Method Technical Issues

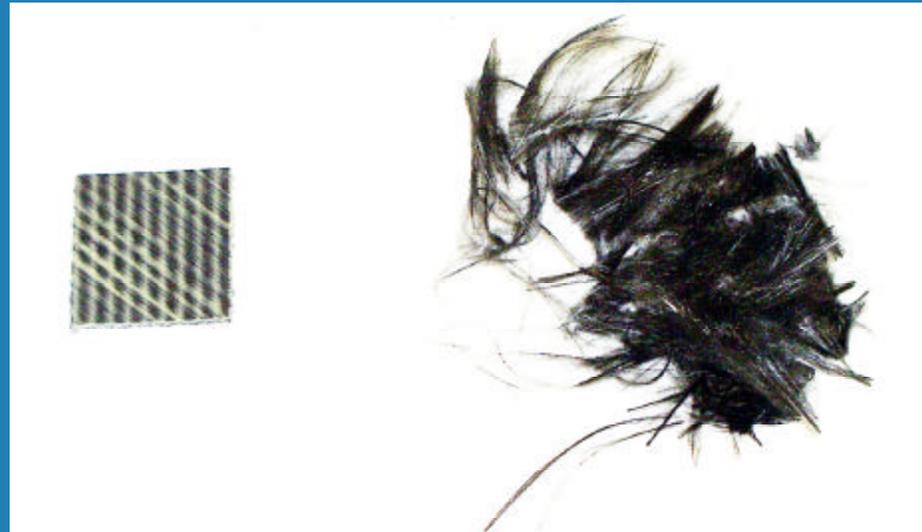
- ❖ Temperature range and residence time
 - 175 to 850°C
- ❖ Effluent streams
- ❖ Product recovery

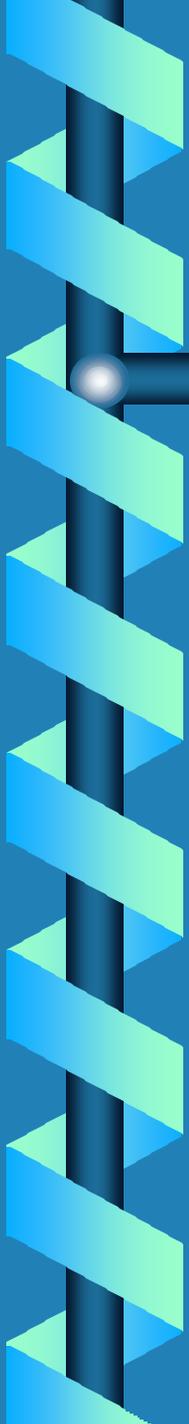


Thermal Treatment Method Product Recovery

- ❖ Carbon fibers freed from substrate
 - $>275^{\circ}\text{C}$ for urethane based polymer substrate
 - $>400^{\circ}\text{C}$ for epoxy based substrate
- ❖ Confirmation of fiber stability for the process conditions

Thermal Treatment Method Product





Thermal Treatment Method Product Analysis

- ❖ Submission to Oak Ridge National Laboratory for evaluation and testing
 - Intrinsic density of 1.8473 g/cm^3
 - Electrical resistivity 0.001847 ohm-cm
 - Comparison to PMC produced from PAN
 - Mechanical properties



Thermal Treatment Method Effluent Liquid Stream Recovery

- ❖ Processing conditions
- ❖ Composition
 - About thirty semi-volatile organic species



Thermal Treatment Method Effluent Gas Stream Recovery

- ❖ Processing conditions
- ❖ Composition
 - N_2 , O_2 , CO_2 , and CO
 - Trace amounts of hydrocarbons



Pilot Testing

- ❖ Thermal treatment method selected
- ❖ Continuous thermal reactor installed
- ❖ Parameters to be investigated
 - Confirm process performance
 - Design data for full-scale system
 - Data for economic analysis for full scale system

Continuous Thermal Reactor

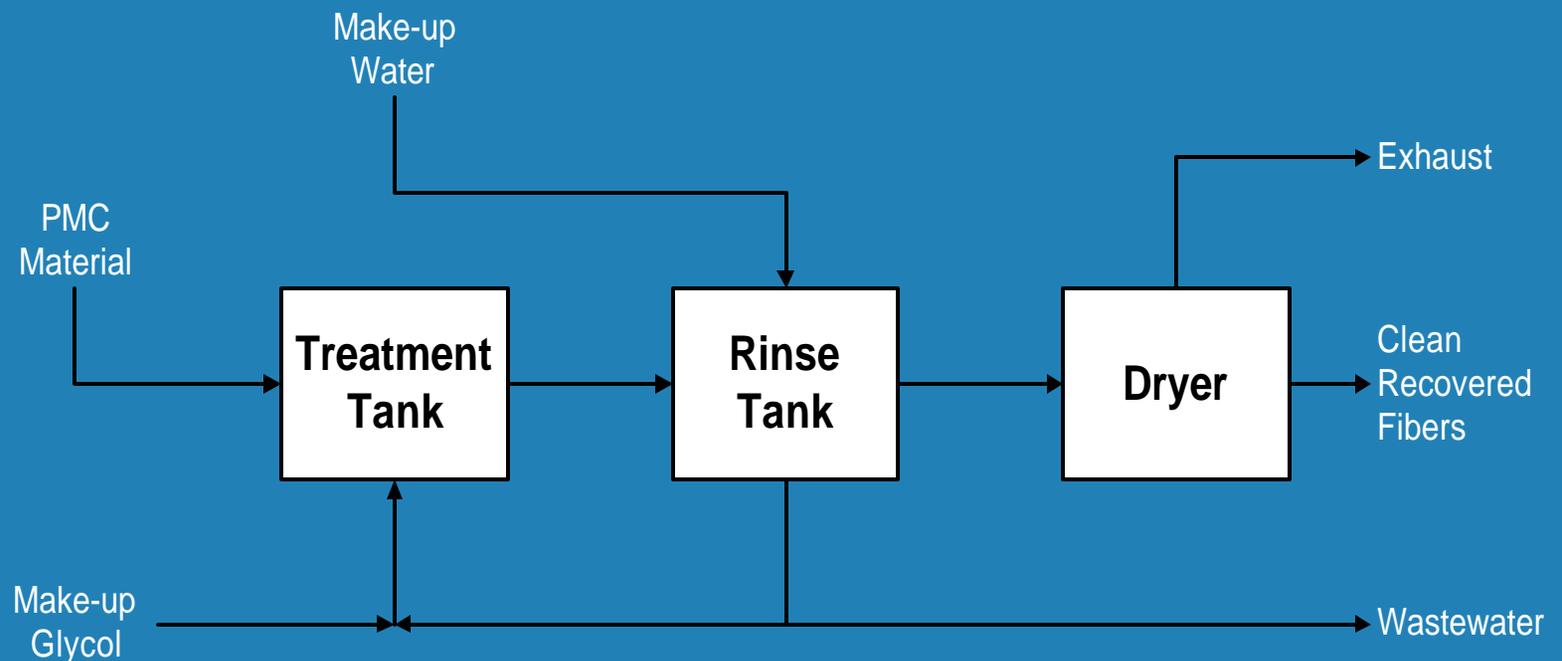




Chemical Treatment Method

- ❖ Process conditions
- ❖ Product analysis

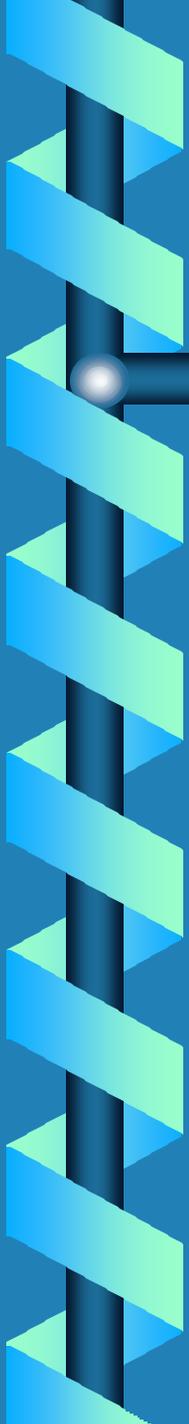
Chemical Treatment Process





Related Recycling Activities

- ❖ Fiberglass insulation
- ❖ Integrated electronic circuit boards



Preliminary Economic Analysis

- ❖ Thermal treatment method
 - 1,000,000 lb/yr thermal processing plant
 - Payback in one year
- ❖ Chemical treatment method
 - Increased expense to implement
 - Less environmentally attractive



Conclusions

- ❖ Recovering fibers is technically feasible
 - Product used for short fiber applications
- ❖ Economically attractive
 - Payback about one year for thermal process
- ❖ Applicable to other fiber containing waste
 - Including fiberglass