SESSION 8

COMPOSITES RECYCLING: A COST EFFECTIVE SOLUTION FOR A CHANGING WORLD

Recycling Thermoset Composites in the United States

J. P. SIMMONS

Abstract:

High Temperature Cured Systems

Automotive efforts to recycle thermoset composites have appeared to decrease, but the movement toward recycling continues in several areas behind the scenes. The year of 1998 will be an important one for automotive recycling of thermosets.

While automotive applications have progressed slowly other thermoset composite formulators and users have been taking a careful look at the use of recyclate and have found economic and property improving benefits.

Each of the major vehicle manufactures in the United States have stepped up their efforts to understand how recycled content and recyclability of vehicles can be improved. The major force behind this renewed energy is the European community demands that auto manufacturers take responsibility for vehicle recycling and disposal at the end of the vehicles life.

Room Temperature Cured Systems

Room temperature cured polyester and vinyl ester systems have progressed slowly, but on the basis of economics only. The diversity of applications and the composite content make a single system for recycling the spray up scrap materials unlikely. Low cost systems are available for individual manufacturers to set up that allow trim scraps to be processed and reused as fillers, reinforcements, or both.

Several major issues have held this segment from incorporating more recycled systems into their manufacturing:

1. The major spray equipment manufacturers have not developed the best equipment for the spraying of materials that include short fibers. The demand for the equipment is not high enough to justify the development. We are faced with the classic case of what will come first the demand or the product to create the demand.

2. Room temperature cured scrap may vary a great deal in quality. Under cured or over catalyzed scrap creates a significant problem if introduced into a manufacturing operation as a raw material.

3. Each set of economics for individual facilities may be different. Different amounts of capital equipment may be needed to change a manufacturing process to be able to use recyclate at a cost benefit.

Marketing Manager, The R. J. Marshall Company.

4. The diversity of types of parts being produced will require more complete testing of the individual systems.

Room temperature cured systems containing recyclate are starting up in the United States. The driving force for each of these applications is economics at acceptable physical property levels.

Open or Closed Loop Recycling

Closed loop recycling has been the focus of most of this years research in thermoset composite recycling in the United States. European recycling efforts have been evenly split between both closed and open looped recycling. There are advantages to both and possibly even an evolution toward one or the other depending on the long term goals of the industry involved. Closed loop recycling has been fostered by the need to have recycled content. The result is that closed loop recycling is more public. Some closed loop and most open loop recycling is being driven by only economics. In these cases manufacturers may not want their competitors to know of the benefits of using recyclate. Open loop recycling is receiving much less publicity in the United States, than closed loop recycling.

Closed loop recycling has one significant political advantage. It demonstrates recyclability of the thermoset composite part and the ability to utilize recycled materials. In the early stages of recycling this can be a big advantage to several reasons.

Open loop recycling may lead to higher values for the recyclate materials. These higher values will allow for quicker development of recycling facilities and the development of infrastructure needed to collect post consumer scrap from salvage operations.

A Single Piece of The Puzzle

The United States development of thermoset composites is only a single piece of the global puzzle of changing political environments, technology and economics. Just as new composite materials are being developed for traditional applications, new concepts and processes are developed to change the scope of thermoset recycling. By picking the best developments from around the world and fitting them into our industrial environment, the recycling of thermoset composites will continue to offer both challenges and opportunities to our industry.

Recycling of Post Consumer Composites in Europe

PETER SCHAEFER

Abstract:

This section presents the progress which has been made by the composite industry in building-up the ERCOM system for recycling post-consumer industrial parts. New ways of handling the composite business had to be initiated - namely collection, recycling and reuse of a new secondary raw material - in order to start a new era, saving resources in the long run.

In addition, the political and legal background for recycling of plastics -- in general, in Germany, and the European Union (EU) will be reviewed.

European Legislation for Recovery and Recycling

The so called Packaging Loop Recycling Law in Germany has been in force since 1994. For example, in 1996 alone, 550,000 tons of post-consumer materials have been collected from households and given a second life in new products. The material is reprocessed by a mechanical or chemical route; waste incineration is not considered to be enough energy efficient. The basis for this legislation is the producer's responsibility for his products from "cradle to grave". Given the present cost structure of virgin materials, the so called "polluter pays" principle applies, as many recycling loops will not provide enough profits to sustain the reuse of materials.

European Union Directive for "End of Life Vehicles"

In July 1997 a project group submitted its proposal to the European Parliament after several years of intense discussion and lobbying by political and industrial groups. It is expected to become law throughout the EU within a year.

Composite Recycling on a Production Scale

The composite industry in Germany has recognized early that action had to be taken to demonstrate the recyclability of composite materials. Contrary to common belief that composites do not melt, as do thermoplastics, recycling is impossible. This led to the foundation of ERCOM in 1991.

Product Development

It was early recognized that recycling of filler material alone would not be economically attractive. Special emphasis was given to develop a fiber fraction which can be spread on an SMC machine or continuously delivered to a thermoplastic compounding machine, replacing part of the required virgin glass fibers. In addition, the processing plant allows the addition of other post-consumer or secondary glass fibers which can then be processed to a high quality

Managing Director, ERCOM Composites Recycling GmbH.

level. This technique of co-recycling glass from composites and waste fiberglass has been very successful in these thermoplastic compounding industries specifically:

-production of plastic composite lumber for marine applications via extrusion

-PA and PP compounding for injection molding. During the compounding step, modifiers can be added to improve the adhesion of glass fibers to the matrix.

Automotive

Mercedes-Benz has set up a dismantling and collection system (MeRSY) for car repair shops in Germany. So far 1,100 repair shops participate from a total number of 1,400.

The plastic parts are dismantled in several centrally located sites assuring a clean product stream for PP, PC, PUR, SMC. For example, Mercedes, in conjunction with its logistic partner, Renz, has built special containers assuring effective transportation. In 1996, Mercedes spent 6 Mio DM for this system. Most importantly Mercedes supports the use of recyclate in its purchase requisitions to suppliers for new automotive parts -- a key requirement to close the cycle. In fact, this is one of the main demands of the pending EU directive for end-of-life vehicles.

Conclusion

Thermoset/composite recycling for post-consumer material is being carried out on a production scale. The compatibility of different resins, glass fibers and fillers has proven an advantage in thermoset recycling assuring the necessary volume. More than 3 million SMC parts containing recyclate are now used in primary applications for automotive and electrotechnical parts. About 25% of the recyclate stems from post-consumer material. The addition of secondary glass fibers has opened new markets for this product.

An Automotive Company View of Thermoset Recycling

HERMAN PHLEGM

Abstract:

The automotive manufacturers have a substantial interest in recycling of all the component materials used in their vehicles. Thermoset composites components have receive a great deal of attention throughout the world by automotive manufacturers. The versatility of sheet and bulk molding compounds has made it a key ally of the design engineers, while the lack of infrastructure to recycle the materials has been a troublesome question for the environmental groups at each automotive manufacturer.

The Reality of Recycling Thermoset Composites

General Motors has specified recyclate in a number of parts over the last several years. These parts have ranged from spoilers to the 3800 valve cover. There are many reasons for the slow start up, including:

1. **Platform managers had many more important priorities than testing recyclate containing materials at no cost savings.**

2. **Phoenix Fiberglass was operating as the primary recycler of thermoset composites. There product represented a cost increase and a formulation problem for SMC and BMC compounders.**

3. **SMC and BMC compounders had reduced staffing levels and had more productive projects to support than recyclate containing compound.**

4. **Automotive purchasing did not appear to give recyclate containing materials a preference at equal costs.**

General Motors Need For Recycled Thermoset Composites

The vehicles General Motors designs today will be sold around the world three to five years in the future. This requires that the components meet or exceed the anticipated requirements of the major markets that will be serviced. Recycling requirements are focused on the European future standard. This forward thinking approach requires that the thermoset parts have the ability to be recycled at the dismantling stage of a vehicles life cycle. The key is to find methods in the future to economically justify the dismantling, separation, collection, and processing of thermoset composite parts. The resulting recyclate product must have a commercial value in a proven application. Without this type of proven recyclability, General Motors may end up being liable for the disposal of all the non recyclable components.

Engineer, General Motors Corporation.

Recyclability

The ability of a part to be recycled a complex issue dealing with part design, composition of the part, and recycling technology. The automotive design engineers need to understand the whole process so that parts can be designed in a manner that insures ease of dismantling and processing the highest quality recyclate.

Recycled Content

The amount of recycled materials incorporated into new parts is one of the strategic objectives of most vehicle manufacturers. The desired level appears to be in the range of 25-30% of the total weight of the new parts. There is additional value of specifying the type of recyclate to be used. The best type of recyclate would be one coming from automotive scrap that are currently going into land fills as shredder fluff.

Post Industrial Versus Post Consumer Scrap

The ultimate goal of the automotive manufacturer is to have the total vehicle dismantled and recycled at the end of its life cycle. This requires that post consumer scrap be a focal point of any program developed for thermoset composite recycling. While the goal is for post consumer scrap to be used, the immediate needs are for closed loop recycling of post industrial scrap. The incorporation of post industrial scrap in the 3800 valve covers moved programs ahead, showing both recyclability and the ability to incorporate recyclate without compromising high quality.

Thermoset Composite Recycling: A Successful Case Study

WIL CONNER

Abstract:

The development of recyclate containing valve covers for General Motors is on ongoing industrial example of recycling thermoset composites without compromising properties or adding costs.

Technology Developments

The compound for manufacturing valve covers is a aluminum trihydrate filled BMC compound. While the partial replacement of the ATH was possible at various levels, it was determined that a level of up to 6% would offer the best economics for a system with physical properties that are certified to be equal to those of virgin glass containing compounds.

Recycling Thermosets: A Three Legged Stool

The recycling of valve cover scrap was a process involving three separate companies. The scrap from the molding operations was generated at one location, the processing of the recyclate at another, and the compounding of new compound at still a third location.

Each location had specific tasks and quality checks to insure that the final product would meet the tight quality specifications of General Motors.

The recyclate processor had run several test grinds to determine what specification could be met within the desired specifications. The compounder had gone through extensive research to determine the optimum level of recycling and the type of physical properties that could be achieved. The molder had to test the new compound and be assured it would work efficiently in a production environment.

The Benefits of Closed Loop Recycling at Cytec

The most obvious benefit of the closed loop recycling is that thermoset composite scrap is not going to the land fill. Materials that were considered of no value are be successfully reused without cost penalty. The other general benefit to the industry is the advancement of recycling technology at the molder, the compounder, and the recyclate processor.

The benefit to the automotive manufacturer is that their vehicle now has a higher recycled content and an established process for recycling parts at the end of their life cycle. The need for post industrial scrap to produce recyclate needs is expected to quickly outstrip the supply. The developing need for thermoset composite recyclate will lead to post consumer recycling to fill this demand.

Automotive Product Manager, Cytec Industries, Inc.

The benefit to the compounder is that formulation experience and technology is being developed with one very specific recyclate stream. The closed loop recycling produces a recyclate that is better known and easier to formulate into a quality part.

Valve Covers

The use of recyclate in the manufacture of valve covers demonstrates how recycling of thermoset composites can be done on a profit basis. There is 6% recyclate being incorporated into new parts today. These valve covers are currently in use on nine different cars.

The valve cover experience is repeatable today with other thermoset composite parts. The need for active programs of specifying recyclate at the design levels have been slow.

The Future of Recycling: Composites Recycling Development

JOSEPH S. McDERMOTT

Abstract:

The future of composite recycling is a complex blend of management commitment, technology, and public support. Each of these aspects has an influence on the direction and speed of the movement. By looking at each of the areas that influence composite recycling individually, it becomes easier to understand the movement as a whole. As each of us attempts to forecast the near future of recycling issues , the job can be made considerably easier by focusing on these three areas:

TECHNOLOGY
PUBLIC AFFAIRS
MANAGEMENT BUSINESS DECISION

Technology

Each specific material system will need to absorb the lessons from the pioneers, but then engineer its own optimized recycling sequence. What works for large SMC transportation parts will not necessarily work for long-fiber or manual-processed parts, much less for glass mat thermoplastics.

There is work for each recycling system to build on, but special interest groups will need to expand existing technology and tailor recycling systems to meet the needs of each material, production method, and markets being served.

Each of these technologies are being moved forward by some group at a differing rate. Some of them are held back by the complexity of the technology; others by commitment or resources. Each of them is going forward, and each will be an important part of the composite industry of the future.

Public Affairs

The need to prevent composites from ending up in landfills is focused on by many. Some of these efforts help recycling and others put some brakes on the movement. The most important influences to understand are:

1. **Recycling will continue to be cost-driven, and undertaken only when cost-effective.**

President, Composite Services Corporation.

2. Minimization/elimination of production waste takes precedence over post-use recovery.

3. As manufacturing techniques improve, ever smaller volumes of salvage will go into original products; the end of "secondary products" for recycling sake is foreseeable.

4. Post-consumer recycling will continue to be important to industry representation:

   a. Technology exists, and has been demonstrated.

   b. If demand is verified, it can be implemented....

   c. ....but requires sound cost/benefit planning, which may require supplier/user/government/public sharing to cost the risk.

Management

Without a firm business decision from authoritative management, neither the technical effort nor the public affairs steps will be successful. Top management commitment to integrating recycling, as a phase of standard production, must be so great that it is communicated to all functions of the organization.