RECYCLED WOOD AND PLASTIC COMPOSITES FIND MARKETS

Research into using wood as a filler for plastics provides the technology improvements needed for the creation of new companies and products.

Brian Lavendel

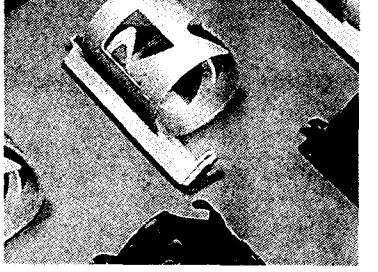
Wood residuals have begun finding their way into high value-added products that extend the useful life of the wood fiber. Utilizing research conducted by the U.S. Department of Agriculture's Forest Products Laboratory (FPL) in Madison, Wisconsin (see sidebar) companies have begun compounding wood with injection molded and extruded plastic to manufacture automobile parts, window frames, paint brushes, and even toys.

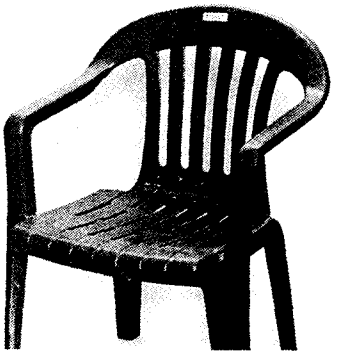
"It was the work of the FPL that convinced us this was a viable technology," says Mike Ford, vice president of marketing for Natural Fiber Composites (NFC) in Baraboo, Wisconsin. Ford and several colleagues joined together in July, 1996 to found NFC, a company whose main product is wood and plastic composites. Commercial developments like this also can be traced to a Wisconsin Department of Natural Resources program to develop a market for wood residuals and divert it from landfills. In 1994, the Wisconsin DNR awarded the USDA FPL a grant through the Solid Waste Reduction and Recycling Program to generate large scale commercial interest in wood-filled plastic composites.

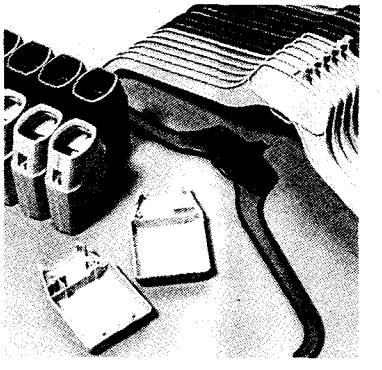
In NFC's case, the company spent 18 months conducting market and product research and in October began mixing plastic resin with wood fiber in their own plant. "The technology has been used in Europe for some time, but it is relatively new for us," says Ford. "It is currently used in the automotive industry for door panels, chime boxes, and other parts, but there is a whole range of possible applications. The market is growing rapidly." NFC intends to carve out a niche as supplier of the composite raw material, and custom blend it for manufacturers. The company plans to produce 10 million pounds of composite raw material annually. At the same time, the firm will have diverted some 2,750 tons of wood from landfills over the next three years.

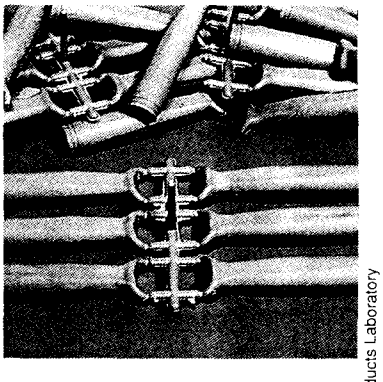
SUPPLY LINES

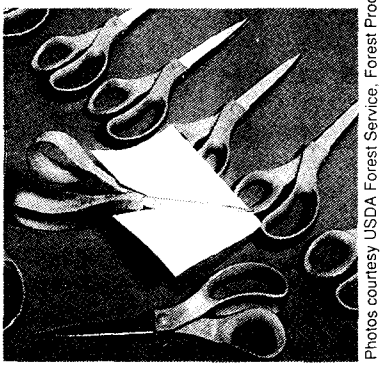
The wood residuals that NFC is using in its manufacturing processes are being supplied by American Wood Fiber (AWF), located in Schofield, Wisconsin. AWF, which was founded in 1919 and today has eight major plants and 150 employees, collects wood residuals from manufacturers using its own fleet of trucks. The material for NFC, will come mainly from door and window manufacturers throughout Wisconsin and the Midwest. The wood, which generators must keep clean and separated by type of species, is vacuumed into waiting semitrailers that are regularly picked up and taken to AWF plant for unloading by conveyor belt. There, the material is separated into shavings (for animal bedding) and sawdust and splinters











Products made with wood and plastic composites include bicycle bottle holders, chairs, hangers, paint roller handles and scissor grips.

Photos courtesy USDA Forest Service, Forest Products Laboratory

According to the Forest Product Lab, in addition to the 138 million metric tons per year already accounted for, 38 million metric tons of wood residuals are still available for recovery annually.

RESEARCH AND DEVELOPMENT FOR FOREST PRODUCTS

ALTHOUGH Americans use only half as much wood per person as they did in 1900, according to the U.S. Department of Agriculture Forest Service, demand for wood resources continues to grow because the U.S. population has tripled in that time. In light of this increased need, the USDA has launched a research and development initiative to make use of wood and paper residuals. The agency's Forest Products Lab, in Madison, Wisconsin — founded by the USDA Forest Service in 1910 — is the largest forest products research laboratory in the world. The facility is staffed by 275 people whose main role is to improve the use of wood so as to help conserve and manage wood resources. Lab researchers have developed technologies and tested prototypes (such as wood-plastic composites) that allow wood residuals to be fed into manufacturing processes, analyzed the economic feasibility of these technologies, and helped develop standards and codes for the use of recycled products.

David McKeever, Research Forester at the lab, has analyzed the supply of residual wood generated nationwide. Using figures from 1994, the most recent data available, McKeever reports that of 176 million metric tons of wood residuals produced annually, 138 million metric tons are already recovered, burned, or are unrecoverable. According to McKeever's calculations, that leaves an additional 38 million metric tons potentially available for recovery. For more information and a list of publications, contact the FPL, One Gifford Pinchot Dr., Madison, WI, 53705-2398. (608) 231-9248. *http://www.fpl.fs.fed.us/.*

for processing into "wood flour."

According to Kathy Seehaefer, a manager at AWF, NFC uses wood flour (particle sizes from 75 to 2000 microns) that is delivered in bulk bags holding up to 11,000 pounds each. At the NFC plant in Baraboo, the wood will be combined with plastic resin and formed into composite pellets according to the specifications of the manufacturing plant.

CHALLENGES OF COMPOSITE MANUFACTURING

The use of wood fiber as a filler for plastics does present some special problems. Issues that came up during the testing process include feeding the wood filler into the manufacturing process, management of moisture content, and the optimum configuration of processing conditions.

At the FPL, researchers found that because wood fiber has a lower bulk density than the thermoplastic with which it is mixed, it is necessary to make some adjustments to the manufacturing process. Instead of using fiberized paper, for example, which tends to be light and fluffy and therefore requires special "crammers" to force the material into the extruders, researchers tried using paper pellets made from hammermilled paper. Unfortunately, the pellets themselves were so dense that they did not break apart and disperse in the plastic and so did not form a tight bond. Best results were achieved with paper platelets — produced by cutting rather than hammermilling — which dispersed more easily. The platelets are around 40 mesh in size with a consistency and texture not unlike graphite. They provided a higher bulk density than the hammermilled fibers and therefore flowed more easily into the raw material feed stream. To achieve the platelet structure, material was processed in a "Szego mill" which utilizes a series of spinning disks within a drum to provide the cutting action between the disks and drum.

Because the plastics manufacturing process tolerates very little water, it is critical that the composite's moisture content be carefully managed. During molding, for example, excessive moisture causes foam to form in the final product. To prevent this, the wood fiber is predried to a moisture content of less than one-tenth of one percent before suction is applied to remove almost all of the remaining water.

Researchers also found that wood feedstock that is dried reabsorbs moisture over time. For this reason, it is necessary to improve feedstock storage techniques or insure that the dried material be used promptly.

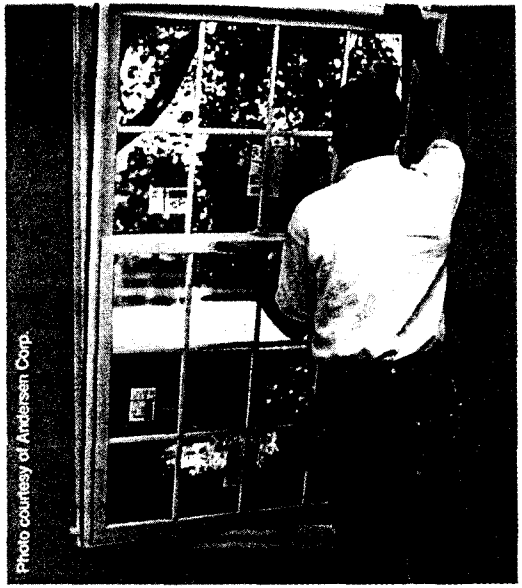
Another concern when adding wood fiber to plastics for molding is the temperature at which the material is melted. High temperatures caused smoking and degradation of the final product due to the fact that wood fiber burns at lower temperatures than plastic. This tendency for wood fiber deterioration was addressed by lowering the temperatures of the production process.

WOOD AND PLASTIC PRODUCTS

Wood-filled plastic exhibits qualities that suit it for use in the building industry. Andersen Corporation, a window and door manufacturer located in Minnesota, makes use of the composites in the "Renewal by Andersen" line of doors and windows. The products use 40 percent wood residues, mixed with vinyl, as a framing material for glass windows or for door jambs. "The composite performs even better than wood," says Senior

Andersen Corporation is recycling their mill trimmings and sawdust and adding vinyl to create a composite used in the Renewal line of window and door frames.

Manufacturers have welcomed wood-plastic composites partly because the supply of virgin wood is getting more expensive and overall appears to be of a lower quality than in the past.



Research Engineer Mike Deaner. "There's no water absorption and, as a result, less warping and decay." In short, Andersen found that the composite combined the weatherability of vinyl with the strength and stability of wood.

Although the Renewal product line is only 16 months old, it reflects a corporate commitment on the part of Andersen to operate with environmental concerns in mind. "Environmental stewardship has always been part of our corporate ethic," says Deaner. Research and development for the Renewal line, a joint project of Andersen and Aspen Research Corporation, began five years ago with product formulation and initial testing of qualities such as compression resistance, screw retention, freeze and thaw resistance, decay resistance, temperature cycling, and thermal insulating value. In February, 1993, Andersen used the composite as a sub-sill component in French doors. Having had success with the door application, the company proceeded to test the material as a window frame component by manufacturing several hundred windows and placing them in service for two years. Positive results led to the full-scale production and sale of the Renewal windows at several Andersen outlets beginning last year.

Deaner welcomed the composite material in part because he found the supply of virgin wood getting more expensive at the same time it was getting lower in quality. Best of all, it's a much better use of resources, according to Deaner. The composite allows Andersen to recycle the mill trimmings and sawdust from their own wood product operations. Furthermore, any residual trimmings of the new composite can themselves be ground up and reused. Eventually, as production and application of the composite grows, Andersen might need to use external sources for its wood fiber, he says, but for now the company relies on its own supply. Although the Re-

newal products currently represent only a tiny portion of the company's line, "most of our window components could be made from the composite," Deaner says.

"Consumers aren't interested in knowing the product is made from recycled wood," he says. What's important is that the product be stable, strong, weather resistant, and a good insulator. "The composite material delivers all the qualities you look for in a window," reports Deaner.

Brent English, Industrial Specialist at the FPL, points out that a variety of manufacturers could make more use of the wood filler. He notes that "the plastics industry is receptive to wood filled composites, but it has to be in a form they can work with." Because plastics manufacturers typically use pelleted feedstock, English found that the plastics industry preferred the composite material be produced in pelleted form. Another challenge faced by the FPL was convincing manufacturers that wood and plastic work well together and that plastics machinery is not damaged by wood fiber.

BENEFITS OF THE COMPOSITE

In fact, through the addition of wood fiber to the plastics feedstock, manufacturers experience several benefits. Of course, "manufacturers can lower production costs because they'll use less polymer," says Ford, of NFC. But perhaps more surprisingly, production time can be reduced by 25 percent because the wood/plastic composite forms more quickly than the 100 percent plastic product. And because the composite forms at a lower temperature, the material does not need to be heated as much, resulting in a 20 percent energy savings on average.

There are additional economic and environmental benefits to the use of the composites, according to English. The use of wood fiber, a renewable resource, as a filler for plastics extends the use of nonrenewable plastics. And because wood is lighter (when measured by volume) than plastic or other fillers, it reduces the weight of final products. Use of the composite reduced the weight of automotive components by more than one third. "If you shave a few pounds off every car, you'll have fuel savings and reduced pollution," says English. "It's not going to save the world, but it's a small step in the right direction." Another reason to make use of the wood residuals is that the supply is ample. "There is 10 to 100 times as much wood available as the plastics industry could ever use," reports English. It's also relatively easy to capture this feedstock, he says. Leftovers from wood manufacturing processes can be collected at a single location and are more likely to be free of contaminants often found in curbside or construction site discards. ■

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