

SPECIAL NEWS & VIEWS REPORT: Recycled Plastic Lumber and Woodfibre Composites

March 2003

Markets for plastics lumber products continue to grow

“Recycled Plastic Lumber” is a new technical report published by the Environment & Plastics Industry Council (EPIC) and the Corporations Supporting Recycling (CSR). The report details the uses of plastic lumber, charts the growth of the industry since the early 1990s, and assesses the capabilities of the production processes used to manufacture many of the plastic lumber products now on the market. The report describes, in some technical detail, production lines using recycled plastics to manufacture woodfibre composite deck boards from recycled polyethylene film, one that makes pure polymer plastic deck boards from recycled HDPE milk jugs, and a new flow mold system designed to produce railway ties and other large dimension plastic timbers. The report can be downloaded from the EPIC website at www.cpia.ca/epic.

Imagine a stylish new deck built onto the back of your house, a deck that you will never have to paint or stain or repair. A deck that won't rot or deteriorate, that won't crack and dry out under the harshest weather conditions; a deck that will never fall victim to carpenter ants or termites, mould or mildew. Imagine a deck that will continue to look as good as the day you built it ... year after year after year. A deck that good has got to be a plastic lumber deck. Last year, plastic deck boards and railings — some made of the plastics collected from municipal and industrial recycling programs — captured more than 11 per cent of the residential deck-building market across North America. According to a recently-released technical report by the Environment & Plastics Industry Council (EPIC) and the Corporations Supporting Recycling (CSR), the sale of plastic deck building products in N.A. totaled some \$395 million (US) in 2001. And that impressive

number is expected to more than double — to an estimated \$845 million (US) — by 2005.

This growth in consumer demand has attracted a number of new manufacturers to the market. While most of the entrants make their products from new resins, several large producers offer decking made from plastic milk jugs, polyethylene shopping bags, or the industrial stretch wrap used to ship goods to local factories and retailers. These products can also be formulated from mixes of recycled plastic and wood fibres to make composites that offer superior strength and aesthetic properties.

Last year, plastic deck boards and railings captured more than 11% of the residential deck market across North America. According to a technical report by EPIC and CSR, the sale of plastic deck building products is expected to more than double to an estimated \$845 million (US) by 2005.

In the short-term, you'll likely pay a premium for plastic lumber, compared to the cost of conventional wood decking. Plastic lumber made from recycled stock is typically twice the price of wood, while products formulated from virgin resins can cost three times as much. However, once you've factored in its longer lifespan and lower maintenance costs, plastic lumber becomes



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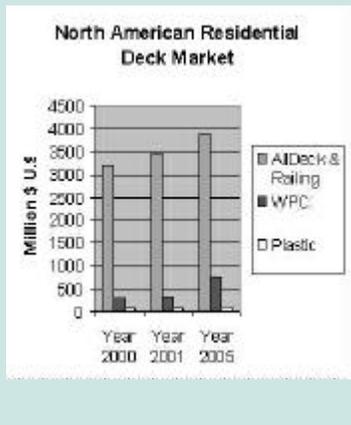
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New generation of plastic lumber products

Plastic lumber products are making major inroads into the North American deck market. The first line, for each year in the graph below, shows the sale of all deck products. The second marks those deck boards and railings made of woodfibre-plastic composites. And the third, shows those made purely from plastic (either recycled or from virgin sources). The N.A. market for plastic deck boards should more than double to some \$845 million by the year 2005.



very cost competitive over the long-term.

Plastic lumber isn't just for building beautiful outdoor decks, gazebos and boardwalks. Recycled plastic and woodfibre-plastic composites are also being used to fabricate doorjambes and window casings, outdoor siding, roofing shingles, moldings, playground equipment, railway ties, pilings, posts and fencing products. Every day brings new reports of innovative and stylish plastic wood products coming onto the building and construction market.

Canadian success stories abound

The EPIC/CSR technical report on plastic lumber is full of Canadian success stories, including companies that are helping to divert plastic from local landfills back into the marketplace. For example, Amity Plastics Ltd. in Clyde, Alberta, manufactures posts and parking curbs from recycled HDPE herbicide and oil bottles. Then there's Syntal Products Ltd. in British Columbia, which uses a flow mold process to transform mixed plastic, including HDPE and PE film, into deck boards and other plastic lumber products. ELB Construction in Frankford, Ontario, makes a whole line of products — including portable road signs, mail box supports, composters and bird feeders — from recycled plastic lumber, while Everwood International down the highway in Tilsonburg, Ontario, recycles the HDPE recovered from empty herbicide containers into fence posts for farmers. And Nova Plastics Products Inc. in

Corner Brook, Newfoundland, is a major consumer of PE film and mixed plastic in the Maritime provinces, which Nova uses to make large plastic timbers for ferry bumpers and other marine applications.

From its launch in the early 1990s, the plastic lumber industry in North America was based, largely, on the use of recycled plastics. Today, the industry is divided between those companies extruding foamed HDPE profiles and those manufacturing woodfibre-polyethylene composites (WPCs). The plastic-wood composite products make up about 80 per cent of the plastic lumber produced, while the pure polymer sector is responsible for about 20 per cent (which includes the smaller niche products, such as railway ties and marine applications). In recent years, manufacturers have also been producing premium plastic lumber products containing virgin polymers to complement the existing recycled plastic and WPC product lines.

Smart and good looking

The new generation of plastic lumber products are practical, durable and can be worked with conventional carpentry tools. They are also highly attractive and can be manufactured to meet a wide variety of design and appearance specifications. When wood or some other natural fibre source is incorporated into the material, many plastic lumber products can be painted or stained. Alternatively, they can be formulated with the right mix of blue, gray or red pigments to simulate any of the popular outdoor

Forward-thinking Canadian companies

wood stains available. However, some buyers prefer to leave their WPC decks alone and let them age to a natural gray hue that matches weathered cedar planks. Recycled plastic lumber and WPCs provide great value too. You not only save on annual maintenance and repair costs — you won't be replacing damaged boards and re-staining the rest every couple of years — plastic lumber has a useful lifespan of two or even three times that of wood.

Sector continues to grow

The expansion of the plastic lumber industry was very rapid in the 1990s, with growth rates of up to 50 per cent per year and suppliers often unable to keep up with consumer demand. This period of growth has been followed by a year or two of consolidation, concurrent with the general economic slowdown in 2000-2001. Some of the major industry players had to idle production equipment due to the temporary dip in demand and the accumulation of higher inventories by suppliers. In spite of this, the long-term outlook for the plastic lumber business is still high and the industry remains a growing force in the construction and building sector.

A number of forward-thinking Canadian companies have launched plastic lumber products in the past two years. Even some of the traditional wood lumber companies are investing in new facilities to produce woodfibre-polyethylene composites. The recent agreement between the U.S. Environmental Protection Agency (EPA) and the American lumber industry to phase out toxic chromated copper arsenate (CCA) compounds from

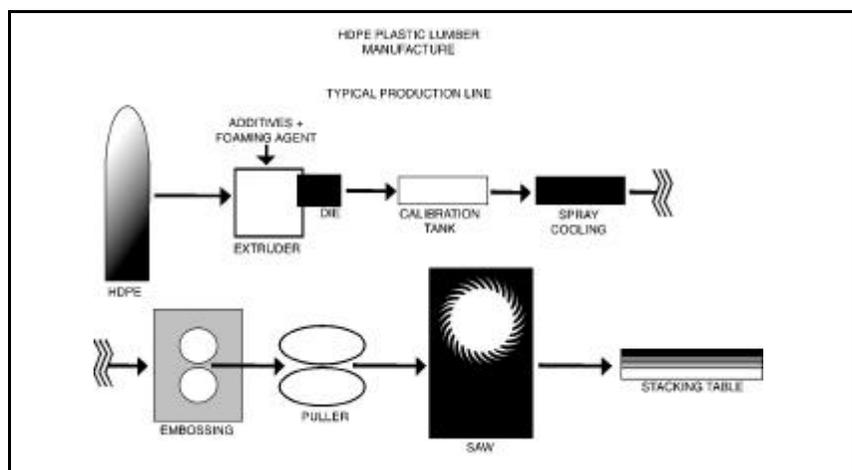
pressure treated wood is expected to further support the future health of the plastic lumber sector. The largest of the domestic woodfibre-plastic lumber manufacturers include Composite Building Products International Inc. (Barrie, Ontario), Brite Manufacturing Inc. (Bolton, Ontario), GSW Thermoplastics Co. (Barrie, Ontario), and Nexwood Industries Ltd. (Brampton, Ontario). Together with Royal Plastics Inc. (Woodbridge, Ontario), which produces a vinyl deck board system, these companies hold the dominant share of the decking systems being manufactured in Canada and sold in major retail outlets. All of these manufacturers use virgin polymers for their products — except one, which uses natural HDPE bottles — and are not major purchasers of post-consumer recycled content. None of them use curbside collected PE film.

New options for recyclables

Much of the recyclable polyethylene (cont.. on page 5)

Setting a new standard

Over the past five years, a number of ASTM standards have been issued to define test procedures and assist engineers in the design of structures that utilize recycled plastic lumber. The currently issued ASTM plastic lumber standards were developed, primarily, by the Plastic Lumber Trade Association and focus on single polymer recycled plastic lumber (RPL). Standards under development will address the properties of polyethylene woodfibre composites, along with structural RPL that uses fibreglass reinforcement.



Ontario firm revolutionizes flow mold technology

The SPS process is ideally suited to making large cross-section plastic composite timbers, such as railway ties, landscaping timbers, marine timbers for ferry bumpers and even marine pilings. The railway tie is a market with huge potential. The plastic composite railway ties have double the service life of wood ties, eliminate the leaching of creosote into the environment and offer cost savings to the railway.

SPS Inc. of Tilsonburg, Ontario, has developed a high productivity flow mold process that has made it cost-effective and practical to manufacture large cross section-plastic composite timbers for use as railway ties and marine bumpers and pilings. The large diameter molds permit the use of mixed plastics or plastic films with higher levels of contamination at much lower processing costs. The new flow mold process also can accommodate sophisticated composites that utilize glass fibre, nylon fibre, woodfibre or rubber in mixtures that use about 50 per cent PE film to achieve the structural properties needed for demanding applications. The process has been successfully used to manufacture plastic composite railway ties that are now approved for use by North American railways.

The new process reduces shrinkage and voiding and can produce parts with reproducible dimensions. The system employs a unique mold design that maintains pressure in the cavity during cooling to eliminate large voids and surface shrinkage. High productivity is achieved by use of a unique filling station that employs a diverter valve system to fill and switch molds without interrupting the melt flow from the extruder. The valve design eliminates extruder back-pressure swings during the mold fill and switch cycle. The molds are transferred to a cooling bath by an automated carriage system that moves them sequentially through the cooling process. The system utilizes multiple molds to achieve very high throughputs. An automated line to produce railway ties can be run by a single operator.

SPS also offers processing equipment to convert baled film plastic to densified feedstock. Because higher levels of contamination can be tolerated in the finished product, this reduces the level of cleaning required and reduces the capital needed to process the recycled polymers. The process can produce parts from simple blends of mixed plastic with up to 50 per cent "non-melts", or can be used to produce complex composites with more demanding structural requirements, such as railway ties.

An automated line to produce railway ties can mold up to one tie per minute. Throughputs of 5,000 pounds per hour are attainable when producing large timber cross-sections. It is worth noting that thick cross-sections of molten polymer take very long times to cool and crystallize. Cooling cycles could be well over one hour for a 12" x 12" cross-section. A continuous extrusion process would require a water spray cooling line measured in kilometers to achieve the cooling necessary for dimensional stability. Once a plastic profile increases beyond two inches in thickness, this new flow mold system is most likely the process of choice.

Tie Tek (Houston, Texas) and U.S. Plastic Lumber (Ocala, Florida) have qualified railway ties made on the SPS system through extensive testing at the railway test center in Pueblo, Colorado. Plastic ties meet all the requirements for wood ties, but do not require the use of toxic preservatives and are expected to have at least double the lifespan. It is estimated that 18 million railway ties are replaced each year in North America.

Development of new plastic lumber products

film and HDPE being collected in Canadian curbside and other recycling programs has been finding its way to large U.S. manufacturers of plastic lumber, such as TREX Company Inc. (with plants in Winchester, Virginia, and Fernley, Nevada), U.S. Plastic Lumber (Boca Raton, Florida), and Advanced Environmental Recycling Technologies, Inc. (Springdale, Arkansas). High shipping costs make this situation less than optimum as a long-term diversion strategy. Another challenge to improving the economics of plastic recycling has been the problem of dealing with contaminants. Unless their feedstocks are exceptionally clean and free of contaminants, the plastic lumber companies currently extruding HDPE profiles or making WPCs have to sort, wash, clean and dry the incoming recycled plastic feed. This can be an expensive process. A modern, integrated recycled plastic-woodfibre composite plant — large enough to compete with the big U.S. producers — would be a very capital intensive proposition. The wash recycling plant needed to process curbside film to a state suitable for use in wood-plastic composites could cost \$10-15 million itself. The Canadian markets for recycled plastic lumber would have to exhibit explosive growth to support such an investment. High operating and capital costs, coupled with thin profit margins, would make establishing such a plant a risky business decision. However, an Ontario equipment manufacturer recently excited the recycled lumber business by updating an older extrusion flow molding technology. The company — SPS Inc. located in Tilsonburg, Ontario — has designed a low-cost, high-output system that should provide new options for using

recycled plastic, including sources that are heavily contaminated, to make large cross-section timbers, such as railway ties and marine pilings. This new system is profiled, in some detail, on page 4 of this special report. Other companies in Canada and the U.S. have also designed, developed, debugged and launched a number of innovative production systems to make recycled plastic lumber. While single polymer systems and woodfibre-plastic composites currently dominate the current plastic lumber market, there are also producers making fiberglass-reinforced recycled plastic lumber, PVC extrusion profiles, oriented woodfibre-polymer composites, and polymer-polymer products

Research activity pays off

With the markets for its products continuing to grow, the plastic lumber industry is actively researching new products, applications and production processes to take better advantage of the trend. This has led to the development of a number of new products offering improved properties. An on-going issue with some of the plastic lumber on the market has been its relatively lower stiffness and flexural strength, when compared with natural wood. These properties may have limited the use of plastic lumber or WPCs for structural applications, such as deck joists. (To date, most of the extruded plastic or WPC boards produced have been used for deck surfaces or similar applications where flex modulus is less critical.) However, the new oriented wood-polymer composites may be able to reverse that situation. These oriented WPCs offer stiffness that is up to 82 per cent of the flex modulus of conventional dried

While ASTM has begun the task of establishing test methods and engineering standards for recycled plastic lumber and wood-plastic composites, the various building codes in Canada and the U.S. have not begun to address the use of these materials. In Canada, the federal government sets and maintains the National Building Code, the National Farm Building Code and similar standards, while the provinces are responsible for enforcement of these standards through municipalities. It is clear that full acceptance of new plastic lumber building materials will require some co-ordinated action on the part of manufacturers and industry organizations to address building code amendments.

ASTM standards help fill the gaps in standards

Plastic railway ties meet stringent industry standards

Since 1996, plastic composite railway ties have undergone extensive testing at a railway test facility in Pueblo, Colorado. As a result, the proprietary compositions offered by two suppliers — U.S. Plastic Lumber and Tie Tek — have been approved as suitable replacements for standard treated hardwood ties. Plastic ties meet the load bearing and curve holding characteristics of wood ties. While plastic ties may currently cost more than wooden ties, it costs about \$150 (Cdn.) to replace a tie as it wears out. With an expected service life of about double that of conventional wood ties, plastic composites make good economic sense as well. The Union Pacific Railway has already approved plastic composite ties for use on its lines and is a major buyer.

pine, while more than doubling its flexural strength.

Filling gaps in standards

A key issue facing the plastic lumber industry in the early 1990s was the lack of engineering standards for the products it produced. This gap is being addressed by the Plastic Lumber Trade Association, which has worked to establish a set of ASTM standards that apply to plastic lumber made (primarily) from HDPE. The WPC industry is also working on ASTM standards that would address the properties of composites. The development of appropriate standards that address the properties of plastic lumber will support future growth in non-structural applications, such as deck boards, sid-

ing etc. However, building codes in Canada and the U.S. have not been revised to allow for the use of plastic lumber in any coded applications. Some suppliers are currently working to address this issue.

In addition, the Canadian Construction Materials Centre, a branch of the National Research Council in Ottawa, Ontario, is currently evaluating WPCs for some suppliers. The centre is developing a series of tests to determine whether the plastic products essentially comply with (or are equivalent to) building code requirements.

A Strategic Assessment

During the 1990s, a number of processing technologies emerged to utilize recycled plastics in products

Comparing the Costs of Recycled Plastic Lumber & WPC Processing

The manufacture of plastic lumber or plastic lumber composites can be very capital intensive. It is also clear that flow mold processing is a very cost-effective process to manufacture plastic composite products, such as railway ties. Much of the savings, in terms of capital and operating costs, is due to the fact that the process can tolerate higher levels of contamination without affecting product properties. There is, in effect, much less investment required in cleaning and recycling systems for preparing the feedstock to an acceptable state.

Process	Capacity (kg/hr)	Capital Cost (\$ Cdn.)	Operating Cost (\$/kg)
PE Film Wash Process	900	9,525,000	0.36
	3000	15,128,000	0.22
HDPE Wash Process	1000	1,104,000	0.18
	1540	19,925,000	0.83
Woodfibre-PE Composite	6000	56,728,000	0.76
	1000	3,204,000	0.75
Flow-Mold Railway Ties	2500	5,000,000	0.23

Notes: these estimates are approximate and are for comparison purposes only; the estimates could vary substantially based on equipment selection and site-specific requirements; integrated process estimates for operating costs include the raw material purchase price.

Observations on current state and future of industry

designed to replace dimensional wood lumber. Since that time, recycled plastic lumber and woodfibre-plastic composites have proven to be effective and cost competitive alternatives for many applications, offering good performance properties and high durability. The development and commercialization of new high-throughput, low-cost processing technologies may provide future markets for PE film and other difficult-to-recycle plastics collected in industrial, commercial and municipal programs. The following observations on the state and future health of the industry are taken from the technical report, "Recycled Plastic Lumber: A Strategic Assessment of its Production, Use and Future Prospects", jointly sponsored and released by EPIC and CSR in January of 2003.

1 The manufacture of recycled plastic lumber (RPL) and woodfibre-plastic composites (WPCs) grew rapidly through the 1990s and have captured nearly 12 per cent of the North American deck board market. Recycled plastic lumber has proven to be competitive with wood products, in terms of both price and utility, for many applications.

2 Strong growth of RPL and WPCs should continue and the market is expected to double by 2005, in part, driven by the phase-out of arsenic compounds from pressure treated lumber.

3 The development of ASTM standards for plastic lumber products will support their use by consumers. The industry is currently working to

amend building codes to permit the use of plastic lumber in coded projects.

4 Several WPC lumber operations have been launched in Canada over the past two years. While the focus of these new operations has been on use of virgin polymers (such as polypropylene, polystyrene and high density polyethylene), one product utilizes recycled HDPE. Several large U.S. producers of plastic lumber are currently the major consumers of PE film and other recycled feedstocks collected in Canada.

5 The high growth rate in plastic lumber sales has stimulated significant research in new production technologies and manufacturing techniques, new additives that support wider product applications, and new products.

6 An oriented polypropylene-woodfibre composite developed in Canada has demonstrated flex strength superior to wood with a comparable flex modulus. This new product may open up a number of new applications.

7 A new, Canadian-designed flow mold process for the production of large cross-section, plastic or plastic composite timbers can utilize PE films collected curbside, mixed plastics and carpet waste. The process (and the products produced) can tolerate higher levels of contamination than other plastic lumber applications and may provide a large and viable market for these materials.

Copies of the technical report, Recycled Plastic Lumber: A Strategic Assessment of its Production, Use and Future Prospects can be downloaded free of charge from the EPIC and CSR web sites.

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RECYCLED PLASTIC LUMBER & WOODFIBRE COMPOSITES

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