THE FAST GROWING
'WOOD PLASTIC COMPOSITES' - WPC

The term "wood plastic composite" (WPC) refers to any composite that contains wood and thermoset or thermoplastic. Thermosets include resins such as epoxies and phenolics. Thermoplastics include resins such as polyethylene, polypropylene and polyvinyl chloride. These new materials extend the current concept of "wood composites" from the traditional compressed materials such as particleboard and medium density fiber board (MDF) into new areas and more importantly, a new generation of high performance products.

The first generations of WPCs were a combination of recycled wood flour or chips and a binder. These were ideal for relatively undemanding applications. The new and rapidly developing generation of WPCs have good mechanical properties, high dimensional stability and can be used to produce complex shapes. They can be extruded to high dimensional tolerances, are tough and stable products. The new WPCs are high technology products for the most demanding applications. The most common type of the new WPCs are produced by mixing wood flour / fiber and plastics to produce a material that can be processed like a conventional plastic, but has the best features of wood and plastic.

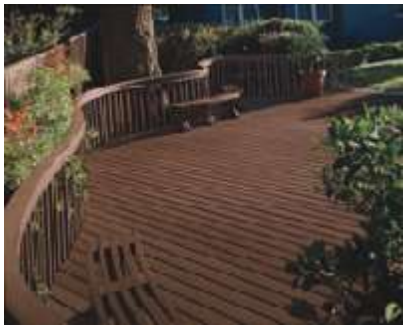
Thermoplastics Materials and Wood Filler

Because of the limited thermal stability of wood only thermoplastics that melt below 200 Deg C are commonly used in WPCs. Currently, most WPCs are made with PE, both virgin and recycled, for use in exterior building components. However, WPCs made with wood PP are typically used in automotive and consumer products and very recently, these materials have been investigated for use in building profiles. Wood filled PVC composites typically used in window manufacture are now being used in decking as well. Polystyrene and ABS are also being used. The plastic is often selected based on its inherent properties, product need, availability, cost and the manufacturer's familiarity with the polymer. The wood used in WPCs is most often in particulate

form (wood flour) or very short fibers, rather than longer individual fibers. Products typically contain 50% wood, although some composites contain very little wood. Others contain as high as 70%. The relatively high bulk density and free flowing nature of wood flour compared with wood fibers or other longer natural fibers, as well as low cost, and availability, is attractive to WPC manufacturers and users. Common species used include pine, maple and oak. Typical particle sizes are 10 to 80 mesh.

Processing

Wood and plastic are not the only components in WPCs. These composites also contain materials that are added in small amounts to affect processing and performance. Although formulations are highly proprietary, additives such as coupling agents, light stabilizers, pigments, lubricants, fungicides and foaming agents are all used to some extent. Some additive suppliers are specifically targeting the WPC industry. The manufacture of thermoplastic composites is often a two-stage process. The raw materials are first mixed together in a process called compounding and the compounded material is then formed into a product. Many options are available for compounding; using either batch or continuous mixers. The compounded material can be immediately pressed or shaped or formed into pellets for future processing. Some product manufacturing options for WPCs force material through a die (sheet or profile extrusion), into cold mould (injection molding) , between calendars (calendaring) or between mold halves (thermoforming and compression molding). Combining the compounding and product manufacturing steps is called In-Line Processing.



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The majority of WPCs are manufactured by profile extrusion in which molten composite material is forced through a die to make a continuous profile of the desired shape. Extrusion lends itself to processing the high viscosity of the molten WPC blends and to shaping the long continuous profiles common to building materials. These profiles can be a simple solid shape, or highly engineered and hollow. Outputs up to 3 mtrs / min are currently possible. Although extrusion is by far the most common processing method for WPCs, the processors use a variety of extruder types and processing strategies. Some processors run compounded pellets through single screw extruder to form the final shape. Others compound and extrude final shapes in one step-using twin-screw extruders.

STEER'S GENERATION NEXT
CO-ROTATING TWIN-SCREW EXTRUDERS

Some processors use two extruders in tandem, one for compounding and the other for profiling. Moisture can be removed from the wood component before processing, during a separate compounding step (or in the first extruder in a tandem process), or by using the first part of an extruder as a dryer in some in-line processes. Equipment has been developed for many aspects of WPC processing, including material handling, drying and feeding systems, extruder design, die design and downstream equipments such as cooling tanks, pullers and cut-off saws. Equipment manufacturers have set up partnerships to develop complete processing lines for WPCs. Some manufacturers are
licensing extrusion technologies that are very different from conventional extrusion processing.

Compounders specializing in wood and other natural fibers mixed with thermoplastics have fuelled growth in several markets. These compounders supply preblended, free flowing pellets that can be reheated and formed into products by a variety of processing methods. These pellets are a boon to manufacturers who do not wish to compound in- line.

Other processing technologies such as injection molding and compression molding are producing WPCs, but the tonnage is less. These alternative processing methods have advantages when processing of a continuous piece is not desired or a more complicated shape is needed. Composite formulations must be adjusted to meet processing requirements (e.g.; the low viscosity needed for injection molding can limit the wood content).

Applications for WPCs

The greatest growth potential for WPCs is in building products that have limited structural requirements. Products include fencing, industrial flooring and landscape timbers, railings and moldings. Figure is a list of some wood plastic composite products currently available in North America. The decking, window and door profile and automotive markets represent the majority of the WPCs manufactured in the USA.

Decking

Although WPC decking is more expensive than pressure-treated wood, manufacturers promote its lower maintenance, lack of cracking or splintering and high durability. The actual lifetime of WPC lumber is currently being debated; most manufacturers offer a 10-year warranty. Compared with unfilled plastic lumber, the advantages of WPC lumber include increased stiffness and reduced thermal expansion. However, mechanical properties such as creep resistance, stiffness and strength are lower than those of solid wood.

Hence these composites are not currently being used in applications that require considerable structural performance. For example, WPCs are used for deck boards but not the substructure. Solid, rectangular profiles are manufactured as well as more complex hollow and ribbed profiles. Wood fiber, wood flour and rice hulls are the most common organic fillers used in decking. About 50% wood is typically used in decking and some products contain as much as 70% wood. A polyethylene matrix is used most often, but manufacturers of decking made with PVC and PP have recently entered the market. At least 20 manufacturers produce decking from WPCs.

Window and Door Profiles

Window and door profile manufacturers form another large industrial segment that use WPCs. Fiber contents vary considerably and can range anywhere from 30 to 70%. PVC is most often used as the thermoplastic matrix in window applications, but other plastics and plastics blends are also used. Although more expensive than unfilled PVC, wood filled PVC is gaining favor because of its balance of thermal stability, moisture resistance and stiffness and strength. Patent activity is very high in this area. Several industry leaders are offering wood-plastic composites in their product line, but their approaches vary. One leading manufacturer co extrudes wood filled PVC with an unfilled PVC capstock for durability. Another manufacturer co extrudes a PVC core with a wood filled PVC surface that can be painted. A third manufacturer offers two different composites: 1. Highly wood filled PVC for stiffness and 2. A composite with a foamed interior for easy nailing and screwing.

Automotive Applications

Wood-filled PP sheets for interior substrate is still made in the USA by several manufacturers. However, manufacturers are beginning to investigate the use of other natural fibers such as kenaf, flax and hemp in air laid processes. Growth in the use of natural fiber filled thermoplastics, rather than unfilled plastics have been rather slower in the USA than in Europe, where environmental considerations are a stronger driving force.

One market analyst cites the lack of delivery channels and high transportation costs as major factors that slow growth in the USA. One major U.S. Company has used German technology to produce automotive door quarter panels from natural fiber composites with PP and polyester. A number of other automotive components are being made with similar technology. Nonwoven mat technology is being used to make rear shelf trim panels with flax reinforced PP. Other products being tested include instrument panels; package shelves, load floors and cab back panels.

Conclusion:

- Wood and natural fibers are one of the fastest growing fillers-reinforcements in the United States.
- For the next five years, a 50% growth rate has been projected for WPCs in the building products sector.
- In the automotive sector, growth for WPCs is estimated at around 15% over the next five years.
- WPCs are being investigated for more demanding applications with concurrent developments in processing and product design.

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