

SOY-BASED ADHESIVES



Soy delivers lower costs, lower VOCs and higher profits to the wood products industry.

THE PRODUCTS

Soy-protein-based wood adhesives have been used for centuries. Since World War II, they have been largely replaced by petroleum-based adhesives with superior performance and economics. Current research is focused on developing and commercializing two soy products.

1. A soy/phenol-resorcinol-formaldehyde (PRF) system for use in oriented strand board (OSB) and plywood.
2. A soy meal/flour formaldehyde-free adhesive to replace UF adhesives.

MARKET SIZE AND VALUE

Markets for these products include applications in wood composite panels, and new or emerging uses.

Long-Term Soybean Potential

Market Segment Million Bushels (4-5 years)

Wood Composite Panels:

| | |
|---------------------------------|-------------|
| Particleboard | 7.5 |
| Medium density fiberboard (MDF) | 5.4 |
| Plywood | 1.2 |
| Oriented strand board (OSB) | 4.5 |
| Total Soy Bushels | 18.6 |

WOOD PANEL PRODUCTS

North American mills produce approximately 30 billion square feet of combined particleboard, MDF, plywood and OSB annually.

Particleboard and MDF are composed of low-value wood byproducts, such as sawdust bound with UF resins. The replacement adhesive, a soy meal/flour-based product, is expected to result in a product with no formaldehyde emissions and equal performance to UF



resins. OSB is made of layered wood strands oriented at right angles to develop maximum strength and stability. OSB competes with plywood and has seen significant growth due to its lower price and competitive performance in many uses. Phenol formaldehyde (PF) and, to a lesser extent, diphenyl methane diisocyanate (MDI) are

primary adhesives for OSB applications requiring more demanding performance characteristics. Hydrolyzed soy proteins added to PF resins provide reduced costs without degrading performance. Ongoing research sponsored by the United Soybean Board (USB) involves the optimization of hybrid PF-soy adhesives in phenol products and the replacement of UF with soy-based alternatives to completely eliminate formaldehyde emissions from adhesive in interior applications.

Panel products are a large market for softwood plywood but have seen market share decline since the introduction of OSB. PF is the principal adhesive used to bind thin wood veneers together or over products such as MDF. A soy-based extender for PF resins is being currently pursued for use in softwood plywood.





SOY-BASED ADHESIVES

USB-sponsored research has resulted in the commercialization of soy protein to replace blood meal in making foamed glues for plywood production. Foamed glues expand adhesive volume to realize equal bond performance with a 20 percent to 30 percent reduction in adhesive use.

A soy-based formaldehyde-free resin was commercialized for use in manufacturing hardwood plywood for interior use. Under a licensing agreement from Oregon State University, Hercules began marketing the PureBond® plywood panels to Columbia Forest Products and eventually granted the company an agreement to sell the product in North America for decorative panel applications. In 2007, Hercules (now Ashland) and Heartland Resource Technologies developed a fully formulated resin based on this technology and is continuing to market their line of SOYAD® resins for plywood, MDF and particleboard applications. USB-sponsored research is extending this new formaldehyde-free technology to provide an exterior grade resin for use in OSB and softwood plywood.

EMERGING MARKETS

There appear to be emerging new markets for soy in heat-resistant adhesives, biobased composites and enzymatic processing for new soy hydrolyzates. Soy adhesives do perform very well in high-heat testing of structural engineered wood products like finger joints and I beams. These adhesives have been shown to have superior heat resistance, prolonging the structural integrity of the wood structure in a fire.

Soy proteins are being developed as a binder to provide a renewable, plant-fibers-composite particleboard and medium density fiberboard. These composites could be a cost-competitive, formaldehyde-free solution to traditional wood composite particleboard and medium density fiberboard.

Iowa State University has developed an enzymatic approach to making soy hydrolyzates that can be tailor-made to be used with phenol formaldehyde resins in OSB and softwood plywood. The new approach is more environmentally friendly and less expensive than the traditional use of caustic and high-temperature and high-pressure approaches.

New applications have been found in the construction adhesives and sealants markets. Bondaflex has introduced products that were developed by replacing petrochemical polyols with soy-based alternatives in urethane adhesives. The soy component has been shown to offer improved adhesion on a wide variety of substrates.

STATE OF THE ART

Most USB-sponsored research has concentrated on either reducing formaldehyde emissions in UF-produced wood composites or reducing the costs of using phenol in structural wood composites such as OSB and softwood plywood.

For more information, visit: soynewuses.org

RELATIVE ECONOMICS/SUPPLIES

The major adhesive resins used for wood-composite panels contain phenol or urea, plus formaldehyde. Formaldehyde is made from methanol, which is made from natural gas. Phenol is derived from benzene and cumene, which are made from petroleum and propylene, which is made from natural gas in most of the world. Urea is a product of ammonia, which is primarily made from natural gas and carbon dioxide.

Formaldehyde pricing is dependent on methanol, which has fluctuated greatly in the last few years based on shortages worldwide. Urea pricing rose due to increased costs of ammonia then dropped significantly during the economic situation early in 2009. The costs of phenol are attributed to the cost of the base stock petroleum, which has followed the same trends as urea.

Soy meal/flour costs have remained flat for many years, but they recently increased due to increased demand for soy meal/flour. In spite of these recent price increases, soy meal/flour remains an inexpensive raw material for wood adhesives.

ADVANTAGES AND THE PATH FORWARD

New soy adhesives promise both improved performance and economics to the wood products industry. They also have shown to be excellent alternatives to urea-based products for interior applications where legislation now restricts emissions of formaldehyde.

USB supports research and testing to commercialize these products and ensure they meet industry standards. Working with industry partners, USB helps develop standard industry practices, an infrastructure to supply the products and acceptance of the resulting end products at all levels.

ABOUT USB

USB is made up of 68 U.S. farmer-directors who oversee the investments of the soybean checkoff, a U.S. soybean research and promotion program, on behalf of all U.S. soybean farmers. Checkoff funds are invested in the areas of animal utilization, human utilization, industrial utilization, industry relations, market access and supply. As stipulated in the Soybean Promotion, Research and Consumer Information Act, USDA's Agricultural Marketing Service has oversight responsibilities for USB and the soybean checkoff.



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