WOOD MODIFICATION: AN UPDATE

Callum Aidan Stephen Hill FIAWS FIWSc

Wood modification is a generic term describing the application of chemical, physical, or biological methods to alter the properties of the material. The aim is to get better performance from the wood, resulting in improvements in dimensional stability, decay resistance, weathering resistance, etc. It is essential that the modified wood is non-toxic in service and that disposal at the end of life does not result in the generation of any toxic residues. Over the past five years there have been significant developments in wood modification technologies, especially in the commercial sector. This technology is here to stay.

Keywords: Wood modification; Acetylation; Impregnation modification; Thermal modification

Contact information: Forest Products Research Institute, Edinburgh Napier University, Colinton Road, Merchiston, Edinburgh, EH10 5DT, UK; mailto:c.hill@napier.ac.uk

The History of Wood Modification

An essential part of the definition of wood modification is that it involves the alteration of the properties of wood by intervening at the cell wall level. The three methods used commercially are chemical, thermal, and impregnation modification. Each of these has advantages and disadvantages when it comes to the properties of the modified wood and the complexity of the modification process. Although commercial developments in wood modification have taken place only in the last decade or so, most of the technologies currently in use have a long history. Research into thermal modification dates back to work at the Forest Products Research Laboratory (FPRL) in Madison WI, in the early part of the 20th century. Further developments in thermal modification, furfurylation, and acetylation took place prior to WW2 and into the 1970's at the FPRL latterly in collaboration with the Koppers company in the US. The leadership of FPRL in this area was kept alive through the prolific output of Roger Rowell into the 1990's. Although some of this work was developed into commercial processes, this only led to niche products and on the whole these were not successful. In the 1970's and 80's various attempts at commercialization were also made in Latvia, Japan, and Canada. However, towards the end of the 20th century the focus began to shift to Europe, with considerable R&D efforts being made, driven by impending legislation from the European Commission. The first significant commercial developments were in thermal modification in Finland, following on from research work at VTT, and Finland currently has the highest production of thermally modified wood globally.

Recent Commercial Developments

The science and technology of wood modification has been comprehensively described in a recent text book (Hill 2006) but most of the commercial developments have only take place since that book was published. Although Europe has become world

leader in the development of commercial wood modification technologies in the past decade, there has also been much interesting work undertaken at Scion in New Zealand and the University of New Brunswick in Canada. The commercial chemical modification (acetylation) of wood in Europe arose from the research and development work undertaken at Stichting Hout Research in the Netherlands with the building of a pilot plant at Arnhem. Although this venture was not successful, the infrastructure and intellectual property were subsequently taken over by Accsys Technologies PLC who formed a company called Titanwood PLC. Titanwood built the largest wood acetylation plant in history with a 30,000 m^3 capacity, which began production of acetylated wood in 2007. Acetylated wood displays high levels of dimensional stability and decay resistance, but the product has a residue of acetic acid, which can corrode ferrous fastenings. The original intention of the company was to build a demonstrator plant and then sell licenses for the technology, but market uptake has been slow. Other companies have expressed an interest in developing wood acetylation processes (e.g. Eastman of the USA).

As noted, thermal modification was the first process to be developed commercially in Europe, with Finland now producing in excess of 80,000 m^3 per annum. Although most ThermoWood production is located in Finland, there are modification plants already established or being built in Estonia (NFS Ltd), Russia (ESTW), Turkey (Novawood), and Canada (Superior ThermoWood, Ohlin Thermotech, SEESIn Wood Ltd.). Other thermal modification processes have been developed in France (Retiwood), Québec (La Bois Perdure), the USA (Westwood Heat Treated Lumber Corporation), and the Netherlands (Lambowood, Lignius). The Plato process (based in the Netherlands) is rather more complex than other thermal wood modification technologies, but it is claimed that the products has superior properties as a result.

Impregnation modification does not necessarily require a chemical reaction with the wood cell wall polymers, but it is essential that the reagent penetrates the cell wall and that it is non-leachable in service. The furfurylation process is the impregnation modification with the longest pedigree, but the problem with these earlier processes was the use of zinc chloride as a catalyst, which resulted in severe degradation of the wood. This was overcome almost simultaneously by researchers in Sweden and Canada, and this became the basis of the Kebony (formerly Visorwood) product originally manufactured by Wood Polymer Technologies ASA of Norway (now Kebony ASA), who recently opened a new 25,000 m^3 per annum production facility at Skien in Norway. A new furfurlyated wood product, called Keywood, has just been launched by Arch Timber Protection. Although a good product, furfurylated wood is dark in color and if that is an undesirable quality, then there are three main alternatives. One is a family of processes which owe their pedigree to work undertaken in New Zealand using oligosaccharides combined with melamine resins and other proprietary ingredients. Examples include Indurite, Kurawood, and Lignia. A process originally developed by SHR uses reaction of the wood with dimethyloldihydroxyethylene urea and has recently been commercialized under the process name Belmadur (BASF). Finally, there has been a recent development in the USA where wood is modified by impregnation with sodium silicate (water glass) which has been recently launched onto the US market.

This is an area that is growing rapidly – watch this space!