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COMMERCIALIZATION OF THERMAL MODIFICATION

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Summary

The market for thermally modified wood, or heat-treated wood, has developed considerably over the last decade. Initially, thermal modification was viewed as an alternative to chemical preservatives. Although this perspective continues to some degree, today many manufacturers have relaxed their claims that heat-treated wood is completely durable. Instead, the marketing focus has shifted to colour change and increased dimensional stability, highlighting an improvement in durability compared to other naturally durable species.

1. Introduction

Thermal modification of wood may be accomplished by various methods; steam, nitrogen or hot oil are some mediums used to displace the oxygen around the wood, thus preventing it from burning at the high temperatures. Within these different methods and other wood modification technologies, the Finnish ThermoWood treatment for thermal modification is the most successful commercially. Some reasons for this success are that the Finnish ThermoWood method is chemical free, using steam, and does not require a high-pressure vessel, however, they do require an airtight stainless steel kiln.

The Finnish ThermoWood Association has patented the following three-phase thermal modification process:

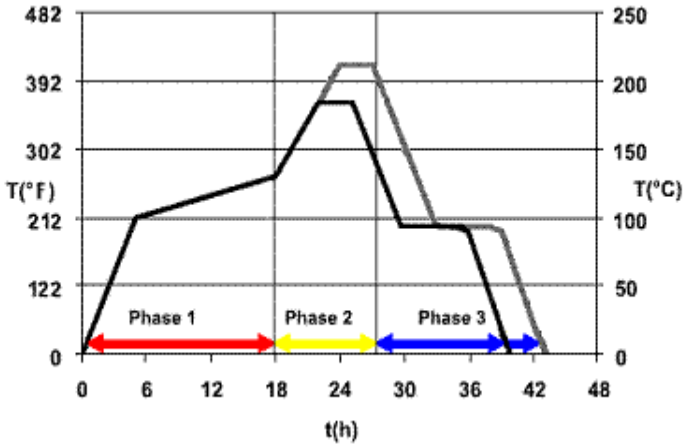

Figure 1. Thermal Modification Process, Courtesy of Jartek

Phase 1–High Temperature Drying

- Heat and steam raise temperature to 100°C
- Moisture content of wood reduced to approximately 0%

Phase 2–High Intensity Heat Treatment

- Temperature increased between 180°C to 210°C for 2-3 hours (temperature and time depend on end-use application)

Phase 3–Cooling and Moisture Conditioning

- Temperature decreased with water spray to increase moisture content to a usable 4–7%

The thermal modification process creates a permanent change in the chemical composition of the wood. At its simplest level, the change is lower moisture content and permeability. The cause of this change is the caramelizing of hemicellulose chains which reduces the amount of water absorbing hydroxyl groups. (Finnish ThermoWood Assoc., 2003) The effects of this change are increased stability, improved durability and darkened colour of the original wood.

2. Methodology

Commercial applications for thermal modification have focused on the improved properties heat treatment provides when compared to traditionally kiln-dried wood. For instance, the equilibrium moisture content being 40-50% lower than regular kiln-dried wood means a reduction in tangential and radial swelling (Finnish ThermoWood Assoc., 2003). Also the reduced moisture permeability lowers the finishing and adhesive requirements and improves their performance based on the increased stability and lack of extractives in the wood, which prevents sap stain. In the case of mountain pine beetle wood a benefit of darkening the colour by thermal modification is that the blue stain can be completely concealed (Value to Wood, 2003).

The most important result for softwoods is that standard tests have proven that thermally modified wood has very good biological durability. Originally, thermal modification was employed as an alternative to chemical preservatives, which required heating the wood above 230°C. While durability tests were positive, the workability of the wood was diminished; the high temperatures that reduced the amount of fungi susceptible material correspondingly increased the wood's brittleness (Finnish ThermoWood Assoc., 2003). However, tests also showed a moderate increase in durability with temperatures as low as 180°C that could be comparable to cedar. On softwoods, the colour at 180°C–200°C closely emulates cedar as well. This colour change, and increased dimensional stability, highlighted by an improvement in durability compared to cedar have now become the target market.

Thermally modified wood in Europe over the last decade has developed five main product markets. They are siding and cladding, decking, hardwood flooring, saunas and wall paneling, and specialties. Thermal modification's success has come from allowing lower-

cost species to compete with naturally durable and higher-cost species, such as cedar and exotic hardwoods in these markets.

Costs for thermally modifying wood vary greatly, from $50–$140/Mbf, depending on the technology used and the volume of the operations. Typical chamber volumes range from 2 to 10 million board feet (MMbf) per year. As a new technology it is hard to know exactly how successful thermal modification really is in terms of annual production. In 2001 production capacity was estimated at 70MMbf with an increase to 112MMbf projected by 2003 (Holger, 2002). Yet the figures for thermal modification production world wide in 2004 was estimated at 21-42MMbf per year (Homan, 2004). In 2006 the Finnish ThermoWood Association reported its members having an annual capacity of 42MMbf (Finnish ThermoWood Assoc. 2006). Also worth noting is that ThermoWood annual sales production increased 30% in 2006 (Finnish ThermoWood Assoc., 2006).

However, the three ThermoWood technology providers represent only a portion of the market. In fact, wood manufacturers currently have 12 different technology providers to choose from for thermal modification. These providers are listed below in Table 1.

Thermal Modification Technology Providers

Company Name	Country of Origin	Process Method	Estimated Capacity+	Number of Units Built
Jartek	Finland	Steam	30 MMbf	16 Commercial 5 R&D
Mahild	Germany	Steam	>10 MMbf	>2 Commercial 2 R&D
MEC	Canada	Steam	3MMbf	1 Commercial
Menz Holz	Germany	Hot Oil	? MMbf	? Commercial
Muhlbock	Austria	Steam	? MMbf	>1 Commercial
RETItech*	France	Nitrogen	2 MMbf	4 Commercial
Plato	Netherlands	High Pressure Steam	? MMbf	>1 Commercial
Perdure	Canada	Steam	9 MMbf	3 Commercial
Stellac	Finland	Steam	>20 MMbf	>10 Commercial
Superior Thermowood	Ontario, Canada	Steam	? MMbf	1 R&D
Valutec	Finland	Steam	>8 MMbf	>6 Commercial
WTT	Denmark	High Pressure Vacuum	? MMbf	>1 Commercial 1 R&D

*previously New Option Wood
+ in Million board Feet

Table 1. Thermal Modification Technology Providers

The market for heat-treated wood in Europe is the most well established in the world. It includes large corporate sawmills such as StoraEnso and Finnforest; flooring manufacturers such as Tulipuu, Volunta Parket, and Majur; service providers such as Ruskapuu and SWM; and midsized value-added manufacturers such as TreTimber and Isku. Start ups such as Novawood and LunaWood are also utilizing the technology, with LunaWood now having the biggest market share of decking in Finland and currently operating eight chambers, six at 25Mbf and two at 16Mbf.

3. Results and Discussion

The manufacturers of thermally modified wood in Europe have gained valuable understanding of heat treatment such as the affects of higher temperatures on the workability of the wood and the need to use high grade material. If North American manufacturers avoid the mistakes and build upon the successes the European manufacturers have experienced they could create a commercially viable market for thermal modification as well.

To be commercially viable, thermal modification needs a market with a substantial profit margin to compensate for the high capital costs of a system. Such a market exists due to the price gap between western red cedar (WRC) and SPF. According to Random Lengths, the price for 2x4 std.&Btr. WRC is $815/Mbf while at the same time the price for SPF is $230/Mbf (Random Lengths, 2007). This price gap comes from the many issues currently plaguing western red cedar producers including reliability of raw materials and quality of second growth wood. While on the other side, many issues are currently plaguing SPF producers including reliability of raw materials, quality of mountain pine beetle killed lodgepole pine and low housing starts.

Additional issues such as environmental concerns and increased competition from foreign imports are growing. Especially as foreign importers offer cheap substitutes for North American products. Using thermal modification Canadian and American wood manufacturers have the opportunity to offer less expensive substitutes of their own, with the environmentally friendly label. The WRC-SPF price difference of $585/Mbf minus the estimated cost of thermal modification at $140/Mbf leaves a gap of $435/Mbf for thermal modification producers to exploit.

Yet, barriers do exist for thermal modification in North America. The high capital cost is foremost, especially as the industry is impeded by low investment capital due to low returns. Maximizing capacity requires pre-drying which increases handling costs and sticker consumption. Additionally, the wood itself is still a consideration as heat treatment does not remove knots, wane, and checks already present. Tear out is not uncommon and UV protection is required to keep it from fading. Although rot and insect problems are significantly reduced by thermal modification, they are not eliminated.

4. Conclusion

Commercialization of thermal modification is increasing, based on strong European market experience and a substantial number of technology providers. Thermal modification offers cheaper products to the same markets, using high-quality, low-cost local species. Nevertheless, the high capital cost will be prohibitive to many investors.

In many ways North American wood markets will be able to follow the European model to integrate thermal modification into their production. Flooring manufacturers will find that heat treatment helps them keep their raw material costs down and allows them to use wider planks. The flooring industry already has the drying experience and needs the colour change to compete with imports. For siding, cladding and decking, thermal modification provides an inexpensive substitute for western red cedar that is a better option than regular SPF due to the durability and stability improvements and the elimination of resin bleed.

The development of thermal modification in North America is unlikely to begin with large corporate sawmills until the market is creating big demand or partnerships/subsidiaries take interest. Midsized value-added manufacturers and start up companies are well situated to capitalize on the market potential of thermally modified wood. Many of these mid-sized companies will be siding and decking manufacturers. Other value-added manufacturers will invest to compete with imports and create less expensive substitutes. Even cedar manufacturers can diversify with thermal modification to offer their distributors lower cost goods, and not rely exclusively on variable cedar availability. Entrepreneurs who are looking for new opportunities will see a chance to provide specialty products to an industry always needing a new colour or a new line. Start up companies like this will fuel an industry that is trying to rediscover its competitive advantage.

The opportunity exists, and the path to follow has been laid out, if North American wood manufacturers will seize it. Thermal modification can aid them to regain the competitive advantage over foreign imports.

5. Literature

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