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IMPACT OF BIOTHERMAL TREATMENT OF BALSAM FIR WOOD ON DURABILITY

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Summary

Commercial bioesters were used as a heat vector to thermally treat balsam fir wood samples. Treatment temperature and time ranged from 150 °C to 200 °C and from 20 to 30 minutes, respectively. Treatment effects on wood durability, dimensional stability and bending strength were evaluated according to ASTM standard procedures. Results indicate that the treatment improved dimensional stability and mould resistance but had no significant impact on decay resistance. Bending properties decreased with increased treatment temperature and time.

1. Introduction

Wood is thermally or chemically treated to improve its durability in terms of resistance to biological attacks by fungi and insects, dimensional stability, weathering and degradation (Kamdem et al., 2002; Hakkou, et al. 2006; Esteves and Pereira, 2009). Thermal treatments for wood preservation are gaining popularity, mainly due to the development of new legislations against the use of classical preservation methods based on toxicity mechanisms (Esteves and Pereira 2009). These preservatives are perceived negatively by the general public because of their toxicity, potential harm to human beings and the toxic emissions during production and use and after use. This environmental pressure has led to the development of new thermal processes for wood protection. Most heat treatment processes are carried out at temperatures ranging from 180 °C to 260 °C under low oxygen conditions (Podgorski et al. 2007). Heating vectors for wood thermal treatments include air, oil and liquid solutions (Rapp 2001). Table 1 presents the main commercial heat treatment processes for wood and their operating parameters.

In the last decade, there has been growing interest in oil-based processes for heat treating wood (Rapp and Sailer 2001, Treu *et al.* 2003). For example, the German company Menz Holz has developed an oil-based treatment performed in a closed process vessel in which hot oil circulates around the wood at a constant high temperature (Rapp 2001, Homan and Jorissen 2004). Another oil-based treatment called the "Royal Process," was developed and patented by Häger for drying treated timber (Powell 2003). Other studies (e.g., Sailer *et al.* 2000) have reported that treating spruce and pine wood in a linseed oil bath at temperatures ranging from 180 °C to 220 °C improved resistance to *Coniophora puteana*.

The use of oil for heat treating wood has several advantages, including a relatively low treatment time, generally simple processes and the fact that the oil can be recycled. However, oils have a complex structure and variable chemical composition, which leads to high fluctuation in the treated products. The use of bioesters instead of oil as a vector for wood heat treatment can overcome these drawbacks and result in more efficient heat treatment of wood.

Bioesters are obtained from fatty acids contained in virgin and used vegetal oils and animal fats. Compared to vegetable oils (Table 2), they have low viscosity and high thermal stability and oxidation resistance, and they are more commercially available. Table 1 presents comparative data on the physical and thermal properties of vegetable oils and bioesters prepared from vegetable oils.

The general objective of this study was to develop a new process to thermally treat wood using bio-residues. More specifically, the aim was to use bioesters from used oils and animal fat to thermally treat wood and to study the effects of the treatment on the physical and mechanical properties and durability of wood.

Table 1. Heat treatment processes for wood and their operating parameters (Rapp 2001)

Process	Heating energy	Heat treatment	Thermal Vector	Pressure	Treatment Time
ThermoWood	Electricity / Thermal oil	230 °C	Air + Steam	No	≈ 33 days
Perdure	Gas	230 °C	Air	No	7–16 h
Retification	Electricity /Gas	245 °C	Air	No	8–10 h
Plato	-	180 °C	Air + Steam	Yes	16-21 h + drying time
OHT	Electricity / Thermal oil	220 °C	Oil	Yes	≈ 8 h
Thermoholz	Thermal oil	220 °C	Air	No	25–27 h
Intemporis	Gaz	200 °C	Air	Yes	20–25 h

Table 2. Physical and thermal properties of vegetable oils and bioesters prepared from vegetable oils (Srivastava and Prasad 2000; Agarwal, 2007)

Oil / Bioester	Viscosity cSt at 40 °C	Heating value (MJ/kg)	Flash point (ºC)	Density (g/cm^3)
	Vegetable oil			
Linseed	22.2	39.3	241	0.924
Peanut	39.6	49.8	271	0.903
Soyabean	32.6	39.6	254	0.914
Sunflower	33.9	39.6	274	0.916
	Bioesters derived from vegetable oil			
Linseed	3.6	35.3	176	0.874
Peanut	4.9	33.6	176	0.883
Soyabean	4.5	33.5	178	0.885
Sunflower	4.6	33.5	183	0.860