ISSN impresa 0717-3644
ISSN online 0718-221X
maderas CIENCIA Y TECNOLOGIA, 12(1):53-55 2010

FIRE RESISTANCE OF TWO PANEL PRODUCTS MADE FROM CHEMICALLY MODIFIED RAW MATERIAL

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ABSTRACT

The objective of this paper was to examine the effect that chemical modification of raw material had on fire resistance of two panel products, namely Oriented Strand Board (OSB) and particleboard and to investigate the influence of the anhydride type. The results have shown that chemical modification affected the ignition and glowing time of two wood panel products.

Keywords: acetylation, propionylation, OSB, particleboard, fire resistance, anhydrides

INTRODUCTION

Chemical modification has been extensively used to improve dimensional stability and decay resistance of both wood and wood based panels (Rowell *et al*. 1997; Youngquist *et al*. 1986; Rowell *et al*. 1986a,b; Rowell *et al*. 1989; Papadopoulos 2007). Lignocellulosic materials are potentially very reactive due to the abundance of hydroxyl groups on the polymeric units. The natural reactivity of lignocellulosics can be utilized to enhance their properties with the resulting material being superior in terms of performance and versatility. The basic types of chemical modification use simple monofunctional modifying agents while others use difunctional, or even polyfunctional modifying agents. One of the most practical of these is the reaction of a hydroxyl group with acetic anhydride, known as acetylation (Rowell 1983, Hon 1996). Although there many papers concerning the effect of chemical modification on dimensional stabilisation and decay resistance, there is limited information about the influence that chemical modification may has on fire resistance of wood panel products. The objective of this paper therefore was to examine the effect that chemical modification of raw material may has on fire resistance of two panel products, namely Oriented Strand Board (OSB) and particleboard.

MATERIALS AND METHODS

Chemical modification of wood raw material and manufacture of panel products

The acetylation of strands (weight gain of 11.2% after 30 minutes at 120^0C) and the laboratory manufacture of OSB was described in detail in a previous paper (Papadopoulos and Traboulay 2002). The propionylation of wood chips (weight gain of 12.2% after 60 minutes at 120^0C) and the laboratory manufacture of boards was fully described in a previous publication (Papadopoulos and Gkaraveli 2003).

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Received: 03.12.2009 .Accepted: 12.04.2010

Fire tests
Both OSB and particlebords were cut into sizes of 200×100 mm and sanded to make smooth and clean surface without any dust. Four samples from each type of board (modified and non modified) were selected and fixed on sample holder of fire test apparatus. The samples were placed 3 cm lower than the holder from their bottom. Based on ISO 11925-3, burner was angled at 45° and propane gas with flow rate of 10 ml/min was used during the experiments. The burner was moved closer and placed at a distance of 25 mm from bottom edge of the panel. The samples were exposed to the burner's flame for 60 seconds and then the burner was moved back. Immediately, the ignition time was measured until the flame on the sample was extinguished and changed to a glow. Afterwards, the glowing time was determined when the glow disappeared.

RESULTS AND DISCUSSION

Table 1, shows that the ignition time of both modified panels is higher than the ignition time of the non modified panels. This is an expected result since it is known that wood combustion is an oxidative reaction and the length of the ignition depends upon the combustive mass (Browne 1958). The modified wood panel a contains higher amount of the combustive mass in comparison with the non modified wood panel and therefore it burnes longer than the non modified one. During ignition the combustible gases are oxidized in presence of oxygen producing flame. Obviously, the modified panels produced more volatiles which in turn caused longer ignition. The results of the present work are in line with those reported by Mohebby (Mohebby *et al*. 2007), who studied the effect of acetylation on the fire resistance of beech plywood.

Table 1. Ignition and glowing time of modified and non modified panels.

Panel	WPG (%)	Ignition time (sec)	Glowing time (sec)
OSB	0	103 (4.2)	263 (7.4)
OSB	11.2	228 (5.1)	92 (4.7)
Particleboard	0	93 (3.6)	255 (11.2)
Particleboard	12.2	245 (5.2)	72 (3.9)

a: Each value represents the mean of twelve replicates

On the other hand, the glowing time of both modified panels was lower than the glowing time of the non modified panels, as Table 1 reveals. Glowing is attributed to the oxidation of soot by oxygen. Glowing is combustion without flaming and it depends upon access to atmospheric oxygen. That occurs when combustion is not completed due to formation of CO, because CO is a combustible gas and still has a tendency to react with oxygen; whilst CO_2 is an incombustible gas and does not react with oxygen. During this phase, soot and tar are formed. In modified panels, more tar and less soot is formed compared with the unmodified panels. Since tar does not produce glowing, it is reasonable tp expect lower glowing time in modified panels.
Mohebby *et al*. (2007) showed that the combustion is completed due to the chemical modification and sequenced with less CO formation. According to Mohebby *et al*. (2007) chemical modification reduced formation of the combustible CO and resulted in a shorter glowing time with modified panels compared with the non-modified ones.

CONCLUSIONS

The present study showed that chemical modification of raw material with linear chain carboxylic acid anhydrides affected the ignition and glowing time of two wood panel products. It can be stated that chemical modification plays the role of fire retardant, since the ignition time was increased whereas the glowing time was decreased. The type of anhydride employed has little influence on fire resistance, since two panels which were modified with two different carboxylic acid anhydrides at equivalent levels of modification showed the same behaviour against fire resistance

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