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Influence of press temperature on the properties of binderless particleboard made from oil palm trunk

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ABSTRACT

The objective of this investigation was to evaluate the properties of binderless particleboard manufactured from oil palm trunk as a function of press temperature. Particleboard samples were manufactured with a target density of 0.80 g/cm^3 using press temperatures of 160 °C, 180 °C and 200 °C. The modulus of rupture, internal bond strength, water absorption and thickness swelling of the boards were determined based on Japanese Industrial Standards (JIS). Thermal gravimetric analysis, Fourier transform infrared spectroscopy and field-emission scanning electron microscopy coupled with energy dispersive X-ray analysis were employed to characterize the properties of the raw materials and the manufactured panels. The moduli of rupture of the samples were observed to increase with increasing press temperature, but they did not meet the standard values. However, the internal bond strength of the samples attained satisfactory values according to the JIS standard for all three temperature levels. Water absorption and thickness swelling of the boards decreased with increasing pressing temperature. Based on the findings in this study, increasing the pressing temperature may be considered a potential way of improving the properties of binderless particleboard.

1. Introduction

It is well known that the worldwide demand for particleboard has been growing over the last 20 years [1]. Currently, most of the commercially produced particleboard is bonded with formaldehyde-based adhesives, which may result in environmental and health concerns due to formaldehyde emission. The global trend indicates that the marketplace is moving towards using particleboard with little or no formaldehyde [2]. The decreasing supply of raw materials and the need for formaldehyde-free particleboard have led to studies on the manufacture of particleboard without using synthetic adhesives and towards using raw materials other than wood [3].

One of the most important manufacturing parameters influencing board properties is the pressing temperature. Binding in binderless particleboard without synthetic resin is mainly accomplished using naturally occurring materials. A previous study carried out by Okuda et al. [4] has shown that hemicelluloses and lignin were decomposed during the pressing process. The condensation reactions of lignin contributed to a self-bonding mechanism, and the sugar content of the boards decreased with increasing pressing temperature. According to Bouajila et al. [5], the bonding strength of binderless boards may be due to lignin-lignin and lignin-polysaccharide cross-linking reactions that occur at high temperature and deformation of the system under pressure. Other studies have also shown that binderless boards developed from sugar-containing lignocellulosic materials such as sorghum need to be pressed at a temperature of 180 °C or higher to achieve satisfactory bonding [6]. Salvadò et al. [7] tried to maximize the properties of binderless boards using steam-exploded *Miscanthus sinensis* by pressing them at temperatures ranging from 195 to 245 °C and have obtained satisfactory results. The generation of simple sugars from the degradation of hemicelluloses at 170 °C and the partial degradation of cellulose around 220 °C to produce simple sugars have been reported to contribute to bonding in binderless boards made from steam-exploded materials [8].

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