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ABSTRACTS (PH D THESIS)

Curing and degradation processes of cement-bonded particleboard by supercritical CO_2 treatment

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Cement-bonded particleboard (CBP) and its application in the building industry have been rapidly accepted in many countries because of its excellent exterior properties. In the development of CBP, many studies have focused on understanding the utilization of carbon dioxide (CO_2) in the manufacturing process [1-6]. This study aimed to evaluate and clarify the curing and degradation processes of CBP under supercritical CO_2 treatment. In order to improve understanding of curing process, the amount of water as a key factor in the production of CBP with CO_2 in the form of supercritical CO_2 was adjusted to determine the optimum condition of moisture content (MC) equaling to certain water-cement (w/c) ratio of boards. Then, CBPs were treated with supercritical CO_2 to provide further evidence and improved understanding of curing and degradation processes.

Considering the properties of CBPs are different when treated by CO_2 in both low and high concentrations compared to the conventional board, the effect of CO_2 at either the gaseous or supercritical phase on the degradation of CBP based on treatment to conventional cured board and estimate long term degradation of these boards affect by gaseous and supercritical CO_2 were also investigated.

Significant correlations were found between the supercritical CO_2 treatment and mechanical properties and dimensional stabilities of CBP during both the curing and degradation processes. Internal bond (IB) strength and modulus of rupture (MOR) values as shown in Figure 1, and modulus of elasticity (MOE) values of CBP achieved their maximums, also thickness swelling (TS) and water absorption (WA) improved significantly by supercritical CO_2 treatment in 30 min. These conditions indicated that supercritical CO_2 treatment accelerates the curing process rapidly and enhances the mechanical properties and dimensional stabilities of CBP.

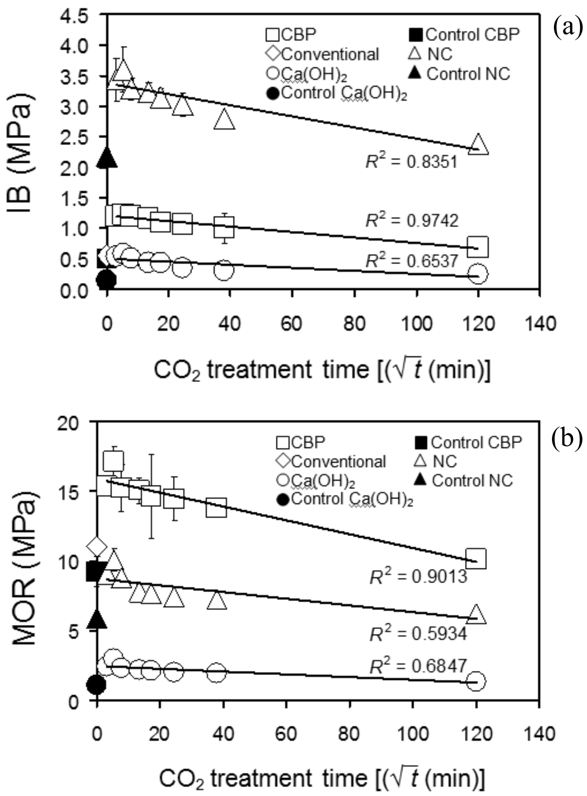

Figure 1. Effect of supercritical CO_2 treatment on the CBP, neat *cement boards (NC) and Ca(OH)₂ boards performa*nce at various curing time; **a.** IB, **b**.MOR

During the curing process of manufacturing these boards, a MC of about 30%, which is nearly equal to the water-cement (w/c) ratio of about 0.34, is an ordinary condition of the cement required in curing of CBP, and could promote the reaction of carbon dioxide to form calcium carbonate ($CaCO_3$) which leads to increase in final strength of these boards. However, the mechanical properties and dimensional stabilities of CBP decreased in the treatments from 60 min to 10 days and had a negative effect on the board performance, indicating that supercritical CO_2 treatment over a longer time span leads to the degradation of the CBP. This finding suggests that higher CO_2 consumption, equaling longer treatment time by supercritical CO_2, causes decreased of density, which suggests the changes of morphological structure of $CaCO_3$ formed in CBP, could account for higher porosity and lead to degradation of CBP (degraded mechanical properties and increased water absorption). Furthermore, X-ray diffractometry (XRD) as shown in Figure 2, also thermal gravimetry (TG-DTG) and scanning electron microscopy (SEM) observation clarified that the mechanisms of the degradation are directly affected by the mineralogical composition of the system, in particular by the calcium carbonate content as caused by carbonation of cement. Moreover, the properties of CBP are improved by CO_2 treatment in both gaseous and supercritical phase even after the conventional curing process. These properties, however, over the longer treatment time degraded in rapid rate against CO_2 treatment in both gaseous and supercritical phase. The times required for degradation of such properties of CBP treated at 10.0 MPa of CO_2 pressure or under supercritical phase was markedly short compared to the times at 1.0 MPa of CO_2 pressure or under gaseous phase. High coefficient determination values between the degradation rates of IB strength, MOR, MOE, TS and WA of CBP, and the treatment time and CO_2 concentration were observed and the simple linear model was found among the properties and affecting factors.

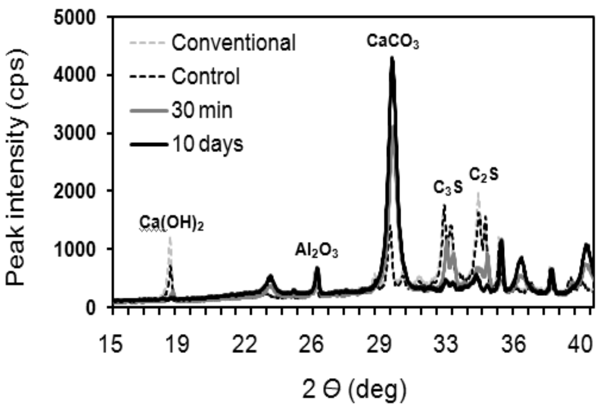

Figure 2. XRD patterns of various curing treatment of CBP

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