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Properties and hygroscopic isotherm of cement-bonded particleboards and fiberboards made by carbon dioxide injection method and conventional methods

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Material and Methods Poplar cement-bonded particleboards (CBPB) using the carbon dioxide injection method were made according to Simatupang et al (1991). Cement-bonded fiberbords (CBFB) were made from recycled newspaper fibers. The properties of these fibers have been published elsewhere (Takats and Simatupang 1993). The inorganic binder was a mixture of PZ 45F (70 %) and metakaoline (30 %) with 1,5 % $Al_2(SO_4)_3$ based on total binder. Metakaoline was obtained by heating kaolinite (Riedel de Haen, Germany) at 750 °C for 6 h in a muffle oven. The calcined material was cooled in a desiccator and stored in air tight containers before use. The furnish for the CBFB was blended with a modified rotating concrete mixer with a volume of 50 l. A propeller type mixer, driven by an electrical motor, was fixed an inserted near the wall into the mixing cylinder. During blending this motor rotated countercurrently to the direction of the mixing cylinder. The mixer was also provided with a device to reverse the rotation direction of the mixing cylinder. Fibers and inorganic binder were dry mixed before make water was sprayed with an airless sprayer. The aluminum sulfate powder was dosed shortly before discharging the blended furnish in order to postpone the accelerating effect. To avoid dust formation, the inlet of the mixing cylinder was covered with a stationarey rubber plate. In the semi-dry process to manufacture CBFB, mixing fibers with the inorganic binder was very critical. Formation of lumps have to be avoided, as such furnish can not be formed into a homogenous mat. Also the amount of make water was very critical, as too much moisture will enhance formation of unwanted lumps. In these experiments the effective water binder ratio was 0,30 (Simatupang 1979). After mixing, the furnish was discharged by reversing the rotation direction of the mixing cylinder. The fluffy furnish was manually filled into a wooden frame (40 × 40 cm). The mat was slightly prepressed before it was densified to target thickness using steel distance bars. The pressing temperature was 40 °C for 8 h. The initial specific pressure was 1,5 N/mm^2. The ratio of oven dry fiber material to inorganic binder was 0,1. Target board density and thickness were 1,4 and 1,2 cm, respectively

Both the poplar CBCB and recycled newspaper DBFB were stored for 1 ½ year in a conditioned room having a constant temperature of 20 °C and 65 % RH before being cut into specimens for the testings. Five boards, measuring 40 × 40 cm, of each type were used for the determinations.

Testings were accomplished to DIN 52 362 and 52 364. Specimens of 20 × 20 mm were used for the hygroscopic isotherm determination. For each board type 48 specimens, divided into three groups, were used. They were conditioned at various relative humidities until constant weight. The adsorption as well as the desorption isotherm were determined. It was found that the isotherms of both CBPB and CBFB were identical, and the results were grouped together. Each point in this graph represents the results of 32 determinations.

Results and Conclusion The properties and hygroscopic isotherm of both kinds of boards are tabulated in Table 1 and shown in Figure 1.

Table 1. Properties of poplar cement-bonded particleboards (CBPB) made by carbon dioxide injection and recycled newspaper cement-bonded fiberboards (CBFB) made by conventional methods

Properties	Number of specimens (N)	CBPB	CBFB
Density	32,40	1,25	1,50
Variation coefficient		(2 %)	(3 %)
Bending strength N/mm^2	32,40	5,6 ... 10,7 ... 15,2	6,6 ... 9,9 ... 11,4
Variation coefficient		(19 %)	(12 %)
Modulus of elasticity N/mm^2	32,40	1900 ... 2700 ... 4000	2100 ... 3000 ... 3700
Variation coefficient		(12 %)	(12 %)
Thickness swelling (2 h) %[1]	32,40	2,2	0,20
Variation coefficient		(18 %)	(70 %)
Thickness swelling (24 h) %[1]	32,40	2,7	0,37
Variation coefficient		(23 %)	(44 %)
Thickness swelling (2 h) %[2]	32,40	1,9	0,23
Variation coefficient		(35 %)	(64 %)
Thickness swelling (24 h) %[2]	32,40	2,5	0,35
Variation coefficient		(31 %)	(52 %)

[1]Specimens 25 × 25 mm
[2]Specimens 50 × 50 mm

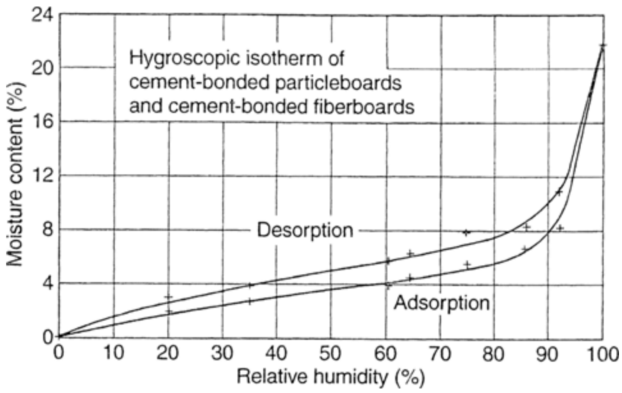

Fig. 1

1. According to ISO 8335 CBPB should have at least a bending strength of 9 N/mm^2; a modulus of elasticity of 3.000 N/mm^2; and a swelling of not more than 2 %. Both kinds of boards do not comply wholly with this standard.
2. The hygroscopic isotherm resembles that of a light weight cement-bonded composite (Bröker and Simatupang 1981), which have only a density of 0,45 and a cement/wood ratio of 11,2. The examined CBPB and CBFB have a ratio of 2,4 and 10, and a density of 1,25 and 1,50, respectievely.Within the range of the mentioned densities and ratios, the hybroscopic isotherm is mainly influenced by the hydrated portland and cement matrix.

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