Formaldehyde emission of hydrothermally recycled particleboards

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ABSTRACT

Recycling today constitutes one of the environmentally most respectable methods of managing waste particleboards. Hydrothermally recycled particleboards in which no fresh particles are added illustrate downgraded hygroscopic and mechanical properties due to thermal degradation. In the current research formaldehyde emission of hydrothermally recycled particleboards was determined. Four different hydrothermal treatments were applied in order to recover wood particles from laboratory particleboards and use them in the production of new (recycled) ones.

For the purposes of this research, one-layer laboratory particleboards with nominal density of 0.65g/cm^3 were manufactured. A liquid E2 Urea - Formaldehyde (UF) resin with 50% solids content was applied to the particles in a proportion of 7% (dry resin weight per dry weight of particles). The ammonium chloride (NH_4Cl) hardener was incorporated at 2% per dry weight of adhesive. Hot pressing duration was 240s and the temperature was 185°C.

To carry out particle recovery, the laboratory boards were treated with four different hydrothermal (steam) treatments in various pressure-temperature-duration conditions. The combinations of conditions applied were: 2bar/ 119°C/ 480min, 4bar/ 140°C/ 120min, 6bar/ 156°C/ 45min, 8bar/ 167°C/ 20min. Under the effects of saturated steam, the UF adhesive bonds were hydrolytically degraded, thus resulting in the detachment of wood particles which could then be re-used for the production of new (recycled) particleboards. The treatment durations varied due to the fact that lower temperatures require relatively larger time intervals for the adhesive bonds to be hydrolytically degraded compared to higher temperatures. Moreover, for the evaluation of effects caused only by hydrothermal treatments (without recycling) on the board properties, boards were manufactured using wood particles which had previously been hydrothermally treated at 6bar/ 156°C/ 45min. Utilizing the particles recovered from each of the four different hydrothermal treatments, new laboratory particleboards were produced under the same conditions as the original ones.

Formaldehyde content evaluation was conducted by the perforator (EN120) method for both the original (control) and the recycled boards. Furthermore, the impact of a second recycling process on the formaldehyde content of recycled particleboards was studied. The results indicated that the 1st and 2nd particleboard recycling processes had a beneficial effect on the formaldehyde content of the recycled boards.

In detail, the recycled boards showed considerably lower values (the degree of reduction varied from 39 to 159%) compared to the control boards, a fact which indicates that they could release lower quantities of formaldehyde if used as construction material for interior fittings. The reduction of formaldehyde content of the recycled particleboards, compared to the original ones, in combination with the fact that the boards produced from hydro-thermally treated wood particles showed almost the same formaldehyde content as the original ones, leads to the probable conclusion that the residual resin (mostly urea, due to volatility of formaldehyde) which remains on the recovered particles acts as a formaldehyde scavenger. The second recycling process did not cause substantial reduction to formaldehyde emission of the recycled boards compared to the first process.