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Fast pressing of thick biodegradable lightweight boards

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Introduction Biodegradable lightweight construction materials based on tannin/hexamine-bound hemp shaves were pressed employing a novel fabrication concept, which works via gas/steam injections and evacuations during pressing. The aim of this outline is to display the technique and to show that samples manufactured on the laboratory level and industrial produced boards can be fabricated with an exceptional thickness at very fast pressing times.

Materials and methods Aqueous adhesive/hardener solutions consisting of either 38 wt.% mimosa tannin (Weibull type extract, formerly Tanac, Brazil) or Argentinean quebracho wood tannin extract powder (Indunor ATO, formerly Silva, Italy) and 5.3 wt.% of a 33% wt.% aqueous NaOH solution as well as 2.5 wt.% hexamethylenetetramine powder (as a 40 wt.% aqueous solution) were premixed. To the mimosa solution 16.9 wt.% of aqueous boric acid (13.9 wt.% of solids) in NaOH (33% wt.% solution) was added, which works as an additional hardener (Pizzi et al. 1995). Field retted hemp crop was further processed by cutting and milling (hammer mill) the straw followed by a separating (drum separator) the desired hemp shaves from residuals like fibers and dust (MBR Agrar Service, Montabaur, Germany). Finally, the respective solution was mixed with the hemp shaves (average length ~30 mm) to obtain a weight-ratio of adhesive/hexamine solids to dry hemp fiber of 1:5.3. Using the hemp/quebracho mixtures, samples of dimensions of 200×200×70 mm and 200×200×100 mm were pressed in an Erlenbach (Lautert, Germany) laboratory steam/gas injection press (LIP) at temperatures of ~100ºC, applying H_2O steam. The pressing times were 2 min. and, consequently, 1.7 s/mm and 1.2 s/mm sample thickness, respectively. The processing of the hemp/mimosa mixtures occurred in an industrial Erlenbach press system (IIP) for boards with dimensions of 1250×625×10–60 mm. For fabrication the hemp shave boards, a controlled flow of hot air (heated by the press form) through the boards was adjusted at 70ºC and the wood/adhesive mixture pressed for 2.5 min (6 s/mm board thickness). Both the LIP and the IIP consist of a Teflon coated mould and a pressure plate containing numerousness small steam/gas injection-evacuation holes. In addition, both set-ups have no further heating system other than the hot steam/gas injection. Detailed drawings of the industrial mould-plate-system are given in Fig. 1.

Results and discussion Whereas the LIP was developed to investigate the concept of the press system regarding pressing times, gas or steam injection, different sample materials and sample dimensions, the IIP is a further development, which accelerates the turnout of processed material. The results obtained employing the IIP for pressing hemp/mimosa mixtures are encouraging, because boards (1250×625×~25 mm) with dry internal bond strengths of up to 0.34 MPa with average densities of 0.26 g/cm^3 can be pressed very fast (Theis, Grohe 2002). Presently, a press system is near completion allowing for pressing boards with dimensions of 2000×1000×10–80 mm and equipped with more automatically running operations. So, a further increase of the board-output (m^3/unit of time) will be provided. It has to be pointed out that the mechanical characteristics obtained at similar pressing times are nearly the same for all samples, and therefore independent from the thickness. This means that the Erlenbach-technology is independent of the pressing time, at

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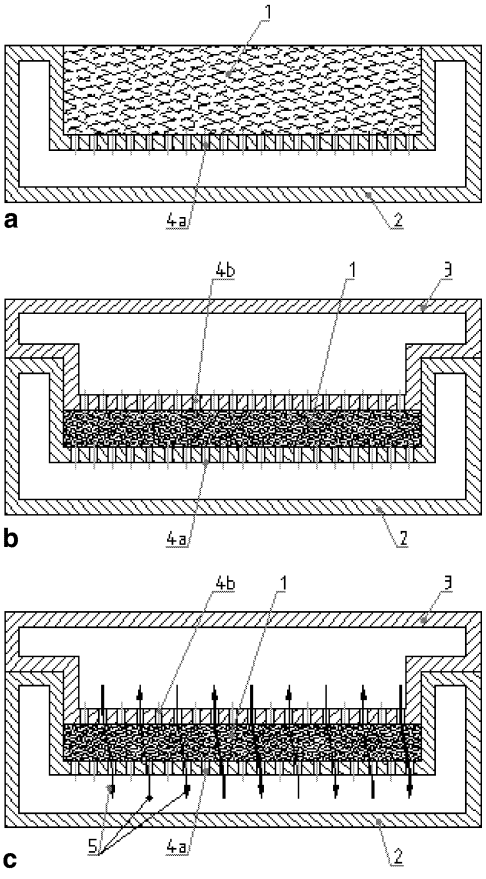

Fig. 1 Engineering drawings of the industrial press-mould-plate-system (Teflon coated) for the production of boards of dimensions of 1250×625×10–60 mm. The figure shows (*1*) the wood/adhesive mixture inserted in (*2*) the mould, (*3*) the pressure plate, (*4a*) and (*4b*) the respective mould and pressure plate perforation and (*5*) the gas/steam injection or evacuation

Abb. 1 Technische Zeichnungen des industriellen Pressform-Platten-Systems (Teflon beschichtet) zur Produktion von Brettern mit Dimensionen von 1250×625×10–60 mm. Die Abbildung zeigt (*1*) die Holz/Binder Mischung, eingebracht in (*2*) die Form, (*3*) die Druckplatte, (*4a*) und (*4b*) die jeweilige Form- und Druckplatten-perforierung und (*5*) die Gas/Dampf Injektion oder Evakuierung

least for very low-density boards respective for boards characterized by highly porous internal structures. The most important factors for high internal bond strengths are rather reaction temperatures between 70–100ºC accompanied by high evacuation rates of the gas/water mixture as well as fast drying processes at ~100ºC after the pressing (Theis, Grohe 2002). The aim of this procedure is to completely release the water content of the boards and to have finally a high rate of condensed and cross-linked phenolic polyflavonoids (Heinrich et al. 1996). It is important to note that the same technology will work equally well and possibly at even faster pressing times when synthetic adhesives would be used. Furthermore, a variety of substrates like wood ships, flax shaves and even cut tetrapack-materials can be pressed to obtain this kind of boards, as several preliminary experiments have shown. Also coco waste provided with a high amount of lignin could be bound at the activation temperature of the lignin. Finally, a wide range of different gases, e.g. CO_2, could be employed.

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