The Press Process
in the wood-based panel industry

Wood-based panel products combine the advantages of the natural material wood with developments and innovations from science and technology. The usability of wood-based panels in many areas of application is only possible when adding additional surface treatments. This paper wants to give an overview of one of the possible technologies for surface enhancement, the press process.

1) Reasons for the surface treatment of wood-based panels

   There are two main reasons why the surface of wood-based panels are treated:

   a) To protect the surface by enhancing the resistance to mechanical and chemical stresses, by improving the durability against long-term effects such as humidity, temperature or light, or by improving the functionality that allow to use the components in a broad range.

   b) To design the surface by changing the decorative effect of a wood-based panel in order to adapt it to regional needs or trends and fashions such as e.g. glossy versus matt, light versus dark, colour versus monochrome. In times of increasingly desired product individualization the decorative surface treatment is of growing importance.

2) Materials to enhance the surface of wood-based panels

   For the surface treatment of wood-based panels there are a variety of options in terms of the material that is used or the application method that is applied. Figure 1 summarizes the most important material groups. These are solid surface coverings, liquid coatings as well as other coatings. For each group some examples of individual materials are listed.

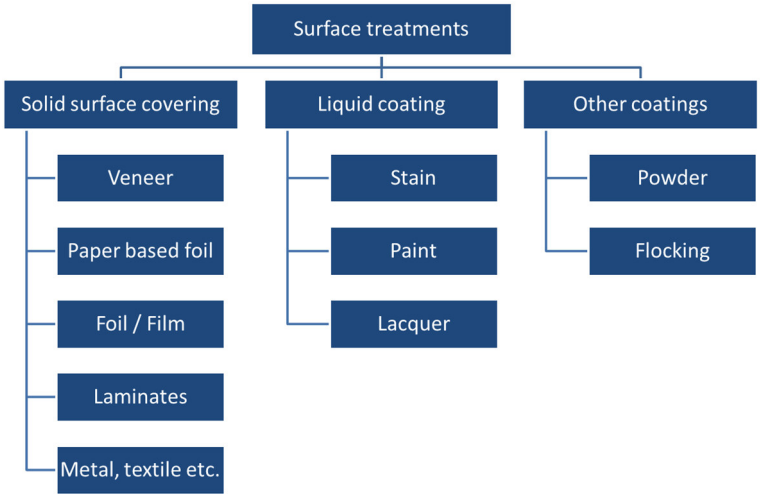

Figure 1: Material types for enhancing wood-based panel surfaces

   For some of the solid surface coverings the final workpiece surface is achieved by the solid coating material itself, as these have a finished surface already when being used in the manufacturing process. For other materials, such as resin-impregnated papers, the final workpiece surface is actually formed during a press process. And there are other solid surface coverings (e.g. veneers) where it is necessary to apply further liquid coatings in order to receive a usable workpiece surface.

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3) Technologies to apply solid surface coverings

The relevant process parameters to apply any solid surface covering material (Figure 1) onto the surface of a wood-based panel are *pressure*, *temperature* and *process time*. These technical requirements are generally provided by a press. All press technologies can be classified in two clearly distinct categories: the ones working in a continuous process and the ones working in a discontinuous process.

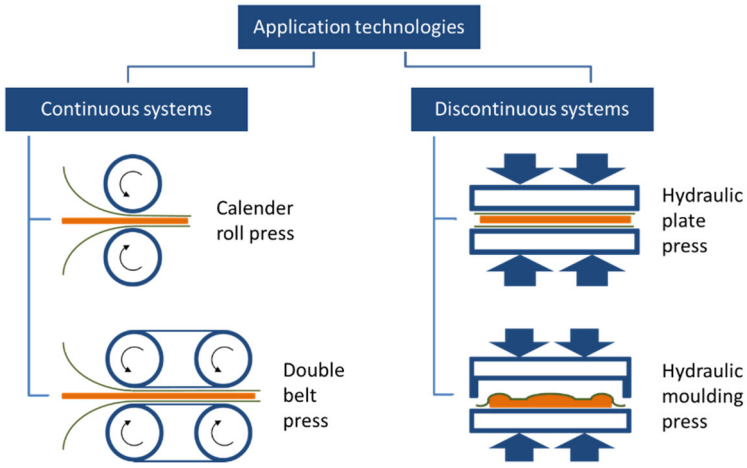

Figure 2: Technologies for the application of solid surface coverings

Depending on the coating material, the individual manufacturing process are referred to as:

a) Veneering: Thin sheets of wood are applied to a wood-based panel using suitable adhesives. The veneer technique was already used by the Egyptians more than 3,000 years ago. Since precious woods were popular in Egypt but the country itself was sparsely wooded an economical processing method was important. Typical for veneering is that the surface covering material is mostly used in sheet form. Veneer presses normally work in a discontinuous process.

b) Laminating or foiling: This describes a process in which the surface of a wood-based panel is covered with a glued-on foil. Depending on the coating material itself both, continuous and discontinuous working presses are used. For the discontinuous process the surface covering material is used in sheet form and for the continuous process the material is supplied as a roll.

c) Pressing: This means the direct compression of a paper sheet impregnated with phenolic and/or melamine synthetic resins onto a wood-based panel without adding any additional adhesive. During the pressing process the resin impregnation melts because of the pressure and the temperature inside the press and the paper adheres to the base panel. At the same time the resin forms the final surface finish of the wood-based panel. The final workpiece surface can be distinct by the degree of gloss and a possible structure of the press plate.

d) Covering defines the gluing of laminated sheets onto a wood-based panel. This is mostly done in hydraulic plate presses and requires the use of an additional adhesive. The finished surface of the laminated board needs after pressing not be upgraded because they had been trained already completed before the coating process.

4) Discontinuously working hydraulic plate presses

In a hydraulic plate press the pressing pressure is applied to the workpiece with an upper and a lower press-plate. The surfaces to be bonded are held together during setting. Depending on whether the press plates are heated or not hydraulic plate presses are referred to as hot-presses or cold-presses.

Figure 3: Single-day-light hydraulic plate press

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Figure 4: Multi-day-light hydraulic plate press

Another categorization of hydraulic plate presses is possible by the number of existing daylights. A daylight is the space between two press plates. A press with two pressplates has one opening where workpieces can be placed and is called a single-daylight press (Figure 3). If a press is equipped with a multiple number of pressplates it allows multiple workpieces to be processed during one press-cycle. These presses are called multi-daylight presses (Figure 4). Today presses with more than 40 daylights are common in the industry.

Due to a large number of different requirements in the wood-working industry presses are built in many different versions. They can be further differentiated by the following characteristics:

- Press-plate dimension and pressing-force. Since there are no values generally accepted the following numbers only give a rough overview:
  A press is considered a light press when its press plates roughly range in the dimension of 1.2 x 0.8 m up to 3 x 1.3 m and the pressing force is about 400 – 1400 kN. These presses are mostly used in small woodworking shops to manufacture furniture parts or interior fittings.
  Medium duty presses have a dimension of about 2.6 x 1.4 m up to 4 x 2.3 m and a pressing force of about 1800 to 6000 kN. In furniture factories, these presses are used as short-cycle presses for veneer and laminate surfaces.
  Heavy duty presses can generate pressing forces of 4000 to 30.000 kN and more and typically have press plates with 2.5 x 1.3 m up to 3 x 2.2 m. These presses are often used to produce plywood or melamine faced surfaces.
- Position of the hydraulic cylinder: Normally one of the press-plates is fixed to the press-frames and the other plate is moved up and down by the hydraulic cylinders. The position of the hydraulic cylinders defines weather the press is categorized as a down-stroke-press (in this case the upper press plate moves) or as an upstroke-press (when the lower press plate moves upwards to close the press).
- Feeding direction: For loading and unloading of the press an area is needed where no press-frame components may interfere with the work-pieces.
  A press feed from the broadside has particular advantages for a manual loading and unloading. In case of an automatic feeding faster loading and unloading are possible due to the shorter conveying distances. The disadvantage of this design is that, due to the large spans, additional construction and material efforts are required not to exceed the required deflection values of the press components.
  For structural and commercial reasons presses with high pressing forces can only be feed from the narrow side. Due to the large conveying distance manual loading on these presses is not feasible. Typically they are equipped with mechanical systems for loading and unloading of workpieces.

Figure 6: Small hydraulic veneer press (Joos)

Figure 5: Single-Daylight through feed press (Wemhöner)

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For all hydraulic plate presses the following basic requirements apply:

Figure 7: Machine frame of a hydraulic press (Hymmen)

- The machine frame must be designed structurally very stable and rigid to absorb high compressive forces. Each press consists of minimum two press-frames into which the press plates are mounted. Depending on the size of the press plates (length x width) the number of necessary press-frames can vary.
- The press plates must be rigid and have a good resistance to bending. The plates have to be produced with a high manufacturing tolerance to guarantee a uniform thickness. As well they have to have a flat and smooth surface. In case of a hot-press the press plates are produced with integrated channels, allowing a heating media to flow through the entire press plate.
- The hydraulic pressure must be distributed uniformly over the whole pressing surface.
- Fast closing and opening of the press is especially important when fast-setting adhesives are used.
- All process parameters (pressure, temperature and time) must be controlled automatically.

5) Discontinuously working hydraulic moulding presses

There are two fundamentally different design types of hydraulic moulding presses, the ones with a fixed three dimensional mould and the ones with a flexible membrane. Moulding presses with a fixed mould are mainly used for the industrial production of moulded wood components, e.g. chairs and lounge furniture and not so much for upgrading the surface of wood-based panels. Therefore they are not further considered in this paper.

When the surface of shaped wood-based panel product are covered with a solid surface covering material, then the three dimensionally shaped workpiece itself forms the solid mould (die) to which the coating material is pressed by an elastic membrane. When processing an air impermeable coating materials such as PVC films another type of press has established which works without using an additional membrane. In these cases, the air impermeable film itself is pressed to the workpiece surface by means of compressed air. The functioning of a membrane and a membrane-less moulding press are the same and the main processing steps are illustrated in Figure 8. The second picture shows how the foil is pressed against the upper heating plate using compressed air. This heats up the foil to the required processing temperature. In a second step the heated foil is pressed onto the workpiece by a vacuum underneath the foil and compressed air from the top.

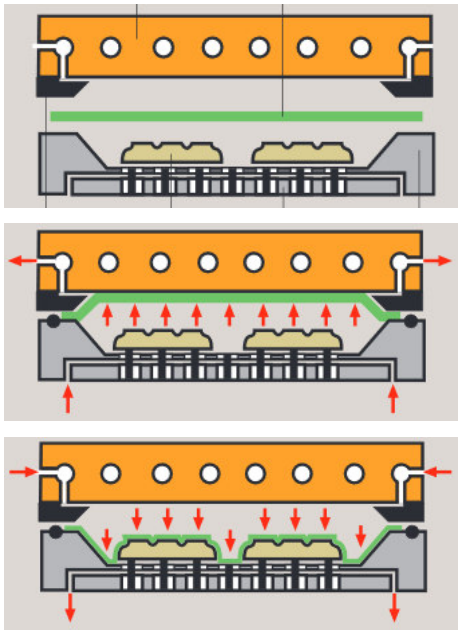
Figure 8: Operating principle of a moulding press working without a membrane (Bürkle)

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6) Continuously working calender roll presses

Looking at continuously working press systems the term laminating refers to a process in which a solid surface covering material is unwound directly from a coil in a continuous operation and is glued to the surface of a wood-based panel either on one side or simultaneously on both sides. Initially mainly PVC films where applied with dispersion adhesives or solvent-based adhesives using unheated pressure rollers. This technique is referred to as (cold) laminating. However, this technique has its limitations. Solvent adhesives require extensive and expensive measures to fulfill modern legal requirements. With water-containing dispersion adhesives very thin films (below 40 g/m²) can only be processed with limited surface quality since only the wood-based panel can absorb the water from the adhesive and this caries the risk of swelling of the panel surface.

Much higher surface qualities can be achieved with the so called hot-laminating process (or thermo-laminating process). Characteristic of this technology are heated calender rollers. The calender rollers can either chromium plated or covered with silicone rubber and are heated to about 150° - 220° C. Hot laminating lines have been developed for the processing of decorative printed, impregnated and pre-painted paper films (finish foil). Mostly nowadays PVAc adhesive as well as urea-formaldehyde containing glues.

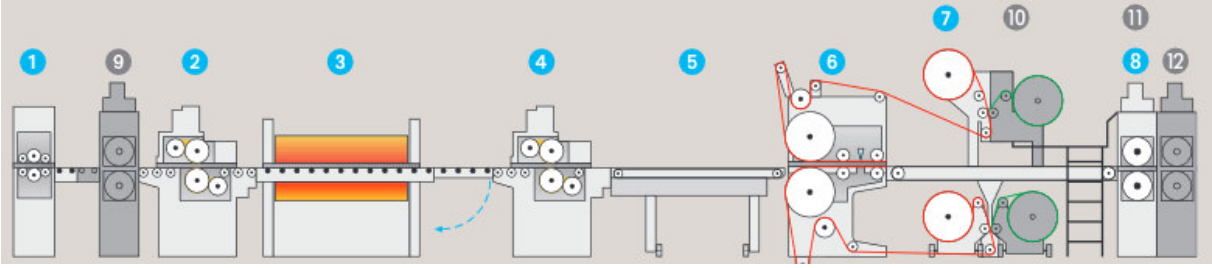

Figure 9: Double sided working thermo-laminating line (Bürkle)
1) Brushing machine; 2)Hardener applying roller coating machine; 3) IR heating unit; 4) Glue applying roller coating machine; 5) Transport; 6) Calender roll press; 7) Unwinding station for surface covering material; 8) Smoothing calender.
Optional: 9) Smoothing calender; 10) Automatic foil-splicing unit; 12) Second smoothing calender

7) Continuously working double belt presses

As an alternative to hot laminating lines so-called double-belt presses were developed. In this type of a continuously working press two endless steel belts are mounted on top of each other (see Figure 10). Main advantage of a double belt press compared to a calender roll press are the generated surface pressure instead of the line pressure as well as the longer pressing time between the two belts instead of two rollers. Compared to a short-cycle press the advantage of a double belt press is the much higher production volume since there is no production time lost for loading and unloading of workpieces into the press. The main application area for these presses today is the production of decorative laminates, the laminating of wood-based panels with decorative laminates or melamine films, but also the production of particleboard, fiberboard (MDF) or composite panels.

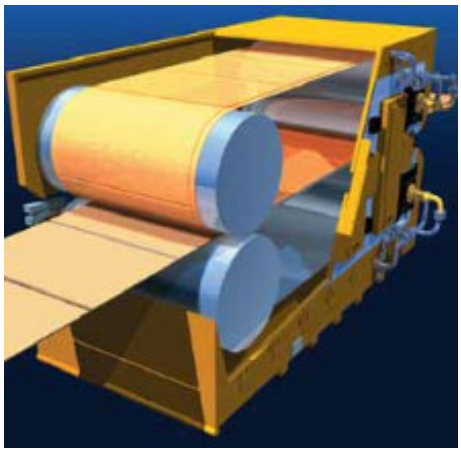

Figure 10: Schematic illustration of a double-belt press (Hymmen)

There are two main construction types of double belt presses today, the isobaric and the isochoric pressure system. The isobaric pressure system (from Greek = equal pressure) is based on a pressure cushion filled with compressed air or oil (Figure 11). This pressure cushion generates an absolutely equal pressure to the steel bands and further on to the workpiece. The isochoric system (from Greek

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= equal volume) is based on a roller carped between the heating plates and the steel belt (Figure 12). Because of the non-linear pressure application of the rollers the isochoric press is not suitable for applying decorative laminates. Therefore this type of press is not used for the melamine board production or for decorative laminates.

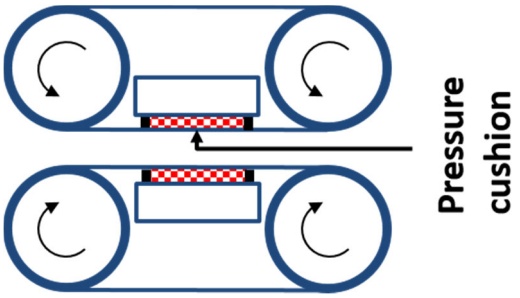

Figure 11: Schematic illustration of an isobaric pressure system

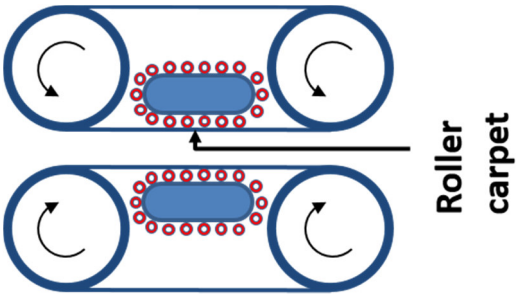

Figure 12: Schematic illustration of an isochoric pressure system

A typical configuration of a production line to manufacture HPL/CPL laminates is described in

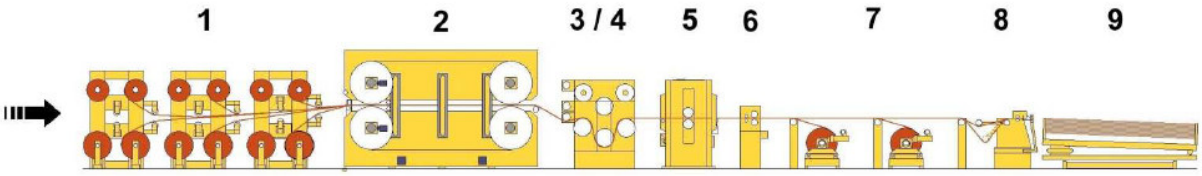

Figure 13: Production line for HPL/CPL laminates (Hymmen)
1) Film unwinding station; 2) Double belt press; 3) Cooling station; 5) Sanding unit for the backside; 6) Edge trimming station; 7) Winding station for thin laminates; 8) Cutting unit for thick sheet laminates; 9) Stacking unit

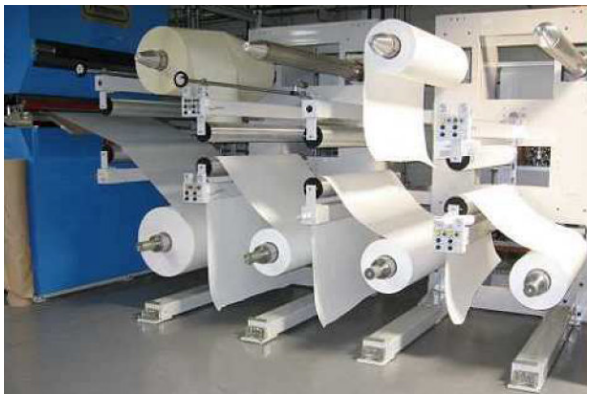

Figure 14: Pictures of a production line for HPL/CPL (Hymmen)
1) Film unwinding station; 2) Double belt press

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