Fibre to board

Today’s processes of separating fibre and making paperboard take place in facilities characterised by capital intensity, high production volumes and the application of the latest techniques of materials handling, continuous production and process control.

In many cases, including the mills of Iggesund Paperboard, the production of pulp and the manufacture of paperboard are carried out on the same site in a continuous integrated process, giving benefits in quality, efficiency and economy.

Managed forests provide the primary source of cellulose fibre from wood varieties such as spruce, pine and birch. The fibre is separated by mechanical or chemical pulp- ing and the whiteness and purity may subsequently be improved by bleaching.

Processing on the paperboard machine starts with the formation of a layer of entangled fibres on a moving wire or plastic mesh from which water is removed by drainage. Further layers of pulp are usually combined in the wet state. More water is subsequently removed by pressing and drying. Paperboard is coated on-line or off the machine to improve the printing surface. Large diameter, full machine-width reels are produced by the machine. These reels are subsequently cut into smaller reels or sheeted, labelled, and wrapped prior to dispatch to the customer.

The forestry cycle
The virgin fibre for paperboard is derived from naturally occurring species such as spruce, pine and birch, which provide fibres with suitable characteristics. These species are supplied by managed forestry operations in Sweden and other parts of Europe.

To maintain sustainable development, including the requirements for biological diversity, modern forest management makes use of several combined methods. Detailed planning is done at both a county and local level. Natural regeneration, planting and sowing are used. Biologically sensitive areas and old growth forests are protected according to the local conditions.

Another important characteristic is that managed forestry is an integrated operation whereby wood for pulp- ing is harvested with wood for the timber industry. Thinnings, the smaller diameter trees taken from the forest at various stages to allow other trees room to mature, are used to produce pulp. When mature trees are harvested, the thicker part of the trunk is used as sawn timber, and the tapered top goes to the pulp mill. This ensures maximum use of the harvested timber.

Making the best use of raw materials is a key principle within Iggesund Paperboard. The trees supplied to the mills are transformed into paperboard – but also into the energy that drives the production process, heats nearby homes and dries sawn timber. Other end products are soil compost and road-building material. Using the entire tree is an important part of our ambition to carry out sustainable production.

From timber to fibre – the pulping process
The timber logs which are delivered to the pulp mill are first debarked, since bark does not contain fibre suitable for pulp manufacture. Bark is removed by friction, as logs are tumbled together in a rotating drum. The bark is then used as a fuel within the mill or composted to create garden soil.

The next process depends on the type of separation or defibration process used.

Pulp manufacture
Basically the choice is between long fibres (spruce and pine) and short fibres (birch). The boardmaker optimises sheet forming, appearance and performance properties with an appropriate choice and blend of fibres to meet the needs of particular products.
Mechanical pulp characteristics
This process gives a very high yield from the timber. The presence of lignin has a number of implications – the fibre is hard and rigid and this gives the sheet a limited degree of consolidation, high bulk (low density), resilience, dimensional stability, and stiffness.

The presence of lignin and the limited degree of consolidation would make a sheet made solely from mechanical pulp relatively weak. The pulp retains the colour of the wood used and is of known natural composition and purity. Refiner mechanical pulp (RMP) is a two-stage process in which the debarked logs are first converted into small flat chips. These chips, with a moisture content of 25–30 %, are forced between the rotating metal discs of a refining machine. The heat and water vapour generated soften the lignin so the fibres can be separated. The pulp is screened and cleaned and fibre clumps are reprocessed.

Mechanical pulping results in a very high yield. About 95 % of the wood is converted to fibre. Mechanical fibre separation requires high levels of electric power, and some of the energy is usually recovered and used as heat in the process.
Chemical pulp characteristics
This process preserves fibre length and the pure cellulose develops a high degree of consolidation, both features that give a very strong sheet.

The fibre is flexible and soft, giving good creasing, embossing, and cutting properties and with low dust generation. Bleached cellulose pulp has high whiteness, brightness, and light stability. This material has the highest purity and provides products with the best odour and taint neutrality. In the chemical process timber is first converted into wood chips. These are then cooked in chemical solutions to dissolve 80–90% of the lignin, allowing the fibres to separate easily.

The sulphate process, which is used within Iggesund, also permits efficient chemical recovery and energy utilisation. The fibre yield of unbleached chemical pulp relative to wood is in the range of 50–65%. The dissolved lignin and resins from the wood are used in internal energy generation.
Chips + liquor

Caustic soda/sodium sulphide solution (white liquor)

High pressure steam

Pulp

Impregnated chips (incl. liquor)

Wash liquor

Chips

Caustic soda/sodium sulphide solution (white liquor)

IMPREGNATOR

DIGESTER

Forward flow cooking

Reverse flow cooking

Black liquor in recycle loop

Fibre to board
Bleaching
All the varieties of pulp used in the manufacture of paperboard can be bleached to influence colour and purity.

Chemical pulp is brown in colour, the colour density depending on the cooking process and degree of lignin removal. While unbleached pulp may be used for some purposes, such as corrugated board boxes, it is necessary to whiten the pulp for many graphical and packaging applications.

The whitening of pulp is called bleaching, though the process can take many forms depending on a number of factors. These include the degree of colour change required, choice of chemicals, method of treatment and whether coloured compounds are removed (delignification) or merely changed in colour.

All these factors have technical and economic implications, not least of which is their environmental significance. Whitening methods fall into three categories:
- Bleaching by delignification using chlorine gas. This approach has largely been replaced by processes with better environmental safeguards. The use of oxygen is being progressively introduced instead.
- Bleaching by oxidation using materials such as chlorine dioxide, hydrogen peroxide or sodium hypochlorite.
- Bleaching by reduction using materials such as sodium bisulphite.

If the pulp mill is integrated with paperboard manufacture, the pulp is pumped to intermediate storage facilities. If the pulp is sold to the open market it is dried in sheets or by fluffing and drying in hot air. Market pulp is baled for shipment.
Fibre to board

Pulp (stock) preparation
If the pulp is bought in bales it is first mixed by agitation in water in a large vessel known as a hydra pulper. All pulp, including the pulp which comes straight from the pulp mill without drying, is then treated in various ways to prepare it for use on the paperboard machine. The processed pulp is referred to as “stock”. The consolidation properties of fibre can be improved by mechanical processing – refining – which modifies the surface structure of the fibre. Swelling in water expands the fibres’ surface area, thereby increasing their strength and ability to consolidate.

Additives such as internal sizing can be used to increase the water repellency of fibres, and retention aids to increase dry strength. Fluorescent whitening agents (FWAs), also known as optical brightening agents (OBAs), can be added as required to increase the whiteness.

Discards and trimmings from the board making process – called “broke” – are broken up and mixed into the stock in varying amounts depending on which paperboard layer the stock is intended for.

Finally, the “consistency” (fibre/water ratio) is finely adjusted prior to pumping the stock to the paperboard machine.

Forming
The fibre suspension in water, at a consistency of around 99% water, is “formed” in several even layers on a moving wire or plastic mesh. Each layer has a specific stock composition suited to the layer’s function in the board construction. The composition and properties of the stock depend on the amount of long vs. short fibres, the kind of pulp, its degree of refinement, retention properties, and the proportion of broke that has been added. The water is drained with vacuum assistance from the layer of entangled fibres. The layers are brought together in the wet state.

Pressing
At the end of the wire section and moving at a speed of between 100–500 m/min the combined sheet or web is sufficiently consolidated to briefly support its own weight as it is transferred to the press section on an absorbent textile blanket. Here the board is pressed together with blankets between hard rollers and, with vacuum assistance, more water is removed, reducing the moisture content to around 60–65%.

Drying
The moisture content is further reduced to 5–10% (depending on the product) by passing the sheet over steam-heated steel cylinders. Some machines include in their drying section a very large heated cylinder with a polished steel surface. A wet paperboard web will adhere to the cylinder surface and be progressively dried while at the same time achieving a very smooth board surface. This cylinder is known as an MG (machine glazing) or Yankee cylinder.

Surface sizing
A starch solution can be applied to the paperboard surface to improve strength and anchor surface fibres firmly in the sheet. Within Iggesund Paperboard the baseboard is surface sized prior to being coated. When board is surface sized a starch-based solution is applied to both sides of the product; this improves surface strength and anchors the fibres to the sheet.

Calendering
Passing the sheet through a series of nips between steel rollers or a soft nip calender can improve its smoothness and adjust its thickness.
Fibre to board
Coating
Paperboard products are coated to improve the appearance of the product and also to improve performance during printing.

The process
After surface sizing the board is coated using blade coaters, air knife or curtain coating. In a blade coater the coating is applied to the baseboard using an applicator roll or a jet applicator. The sheet continues up to a blade that removes the excess coating. The excess coating is recirculated and reused. Once the excess coating has been removed the paperboard is dried prior to the application of the next layer of coating.

The coating
White pigmented coatings are applied to the print side of the board and sometimes also to the reverse side. These consist of selected mineral pigments and synthetic binders, dispersed in water. Selection depends on product requirements and processing conditions. The application and smoothing technique ensures a specified coat weight and smoothness. Smoothing may be by roll bar, air knife or blade. There may be one, two or even three coating layers applied to achieve the required appearance, colour, smoothness and printing properties. The largest component of a coating in terms of mass is the pigment. The pigment used is usually a calcium carbonate (ground marble), clay or a mixture of the two. The nature of the particles that make up the pigment has profound effects on the properties of the paperboard. Calcium carbonate has a very high whiteness but a relatively low opacity. Clay has a lower whiteness and its use results in a smooth surface with a higher gloss level and higher opacity. The second largest constituent of a coating is the binder, which is often a latex supplied as a water-borne emulsion. At this stage the latex is a large number of very small particles. When the latex is heated during the papermaking process the latex melts and forms a film that binds the pigment particles to one another and also to the baseboard. Many other chemicals are also routinely added to coatings to improve the performance of the coating in the production process and the performance of the finished paperboard.

Brushing and glazing
Some paperboard machines incorporate equipment for further surface enhancement by brushing and glazing.

Reeling
The final process on the paperboard machine is to reel up the paperboard in the full machine width to specified reel diameters.