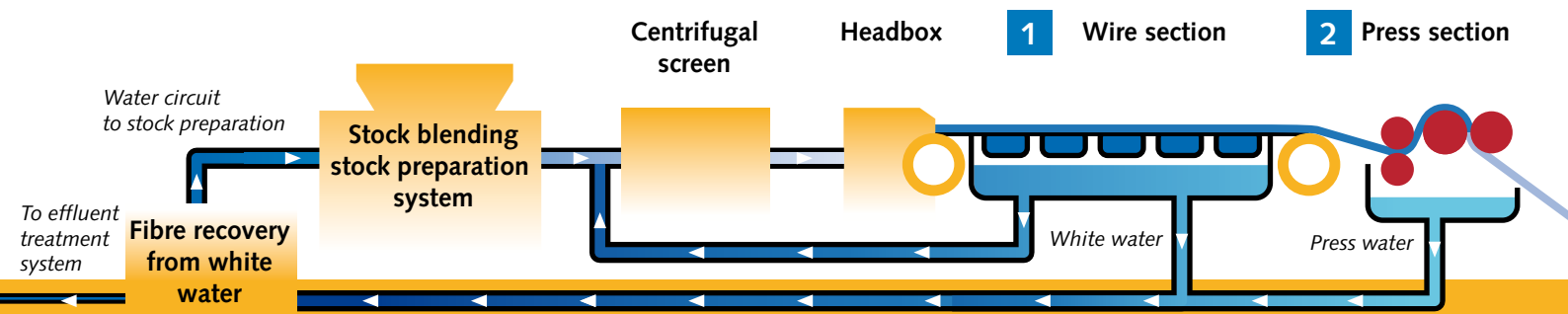
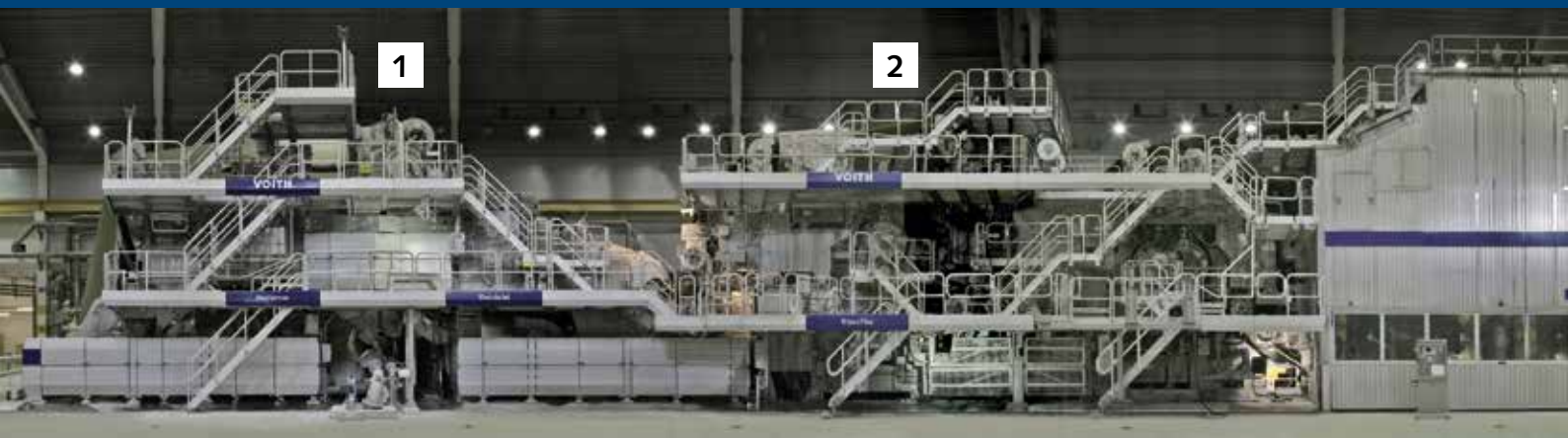


Paper making



Industrial paper production

High art of engineering for ultra-high aspirations



Paper-making is based on a principle which still applies today, some 2,000 years after its invention: plant fibres dissolved in water, when drained through a screen or „wire“, combine to form a continuous fibre web – paper.

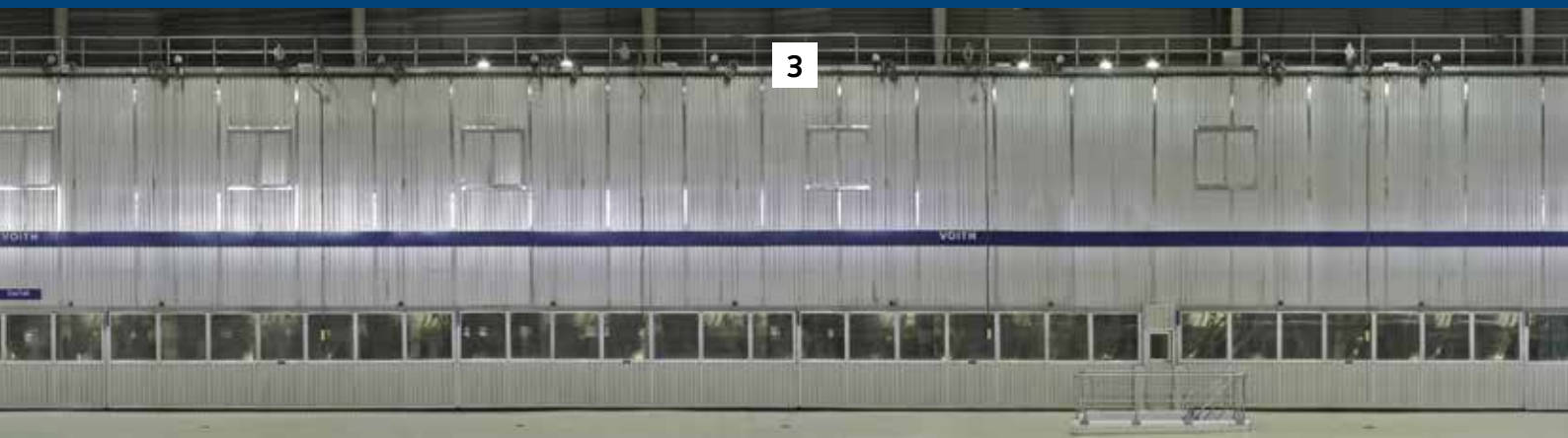
The paper machines used in today's paper mills are extremely sophisticated production plants in their technology. They can measure more than ten metres across and up to 120 metres in length. Their design and various elements are determined by the nature of the paper and board grades to be produced, and by the raw-material input.

Every minute, the machines produce up to 1,400 metres of paper. It takes only a few seconds from the first arrival of the fibre-water suspension on the screen or wire until the paper is finished. Diluted in a ratio of 1:99, the fibres, together with additives, are laid down on the paper ma-

chine. The fibres settle on the wire next to and on top of one another. The water runs off or is sucked off. In this way, an even fibre composite emerges which is further drained by applying mechanical pressure and steam heat. At the end, the paper web is rolled up onto a steel shaft (reel).

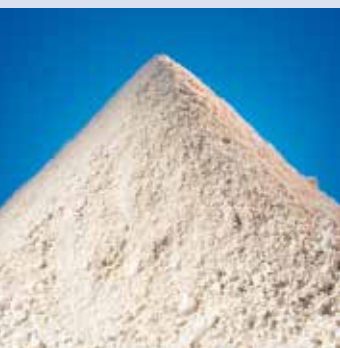
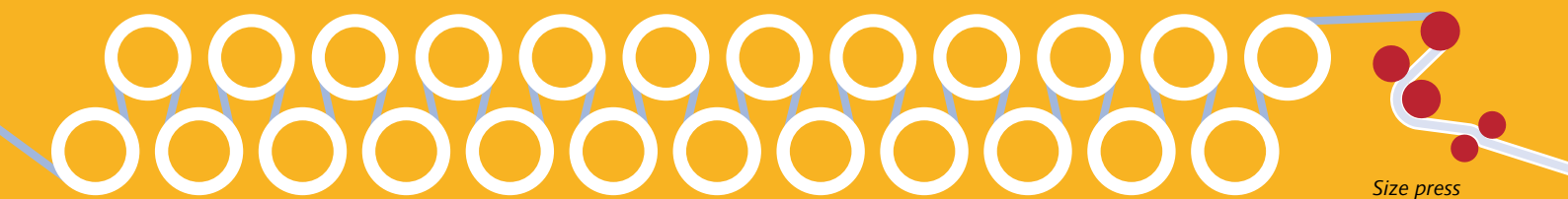
Here, the overall process sequence can be divided roughly into stock preparation, paper machine, upgrading and finishing.

Industrial paper-making



3

Dryer section



Fillers

The chief fillers are the natural minerals kaolin (china clay) and chalk. A liquid mixture of kaolin and chalk is applied wafer-thin to the paper. This coating gives the paper even more smoothness and strength and a surface that ensures good printability.

► Stock preparation

Paper for recycling and, usually, chemical pulp as well reach a paper mill in a dry state, whereas mechanical pulp is normally produced in the same factory and pumped into the stock-preparation system as a fibre-water mixture. Paper for recycling and chemical pulp are likewise dissolved by adding water. In the refining unit, the various raw materials are mixed according to the desired paper grade.

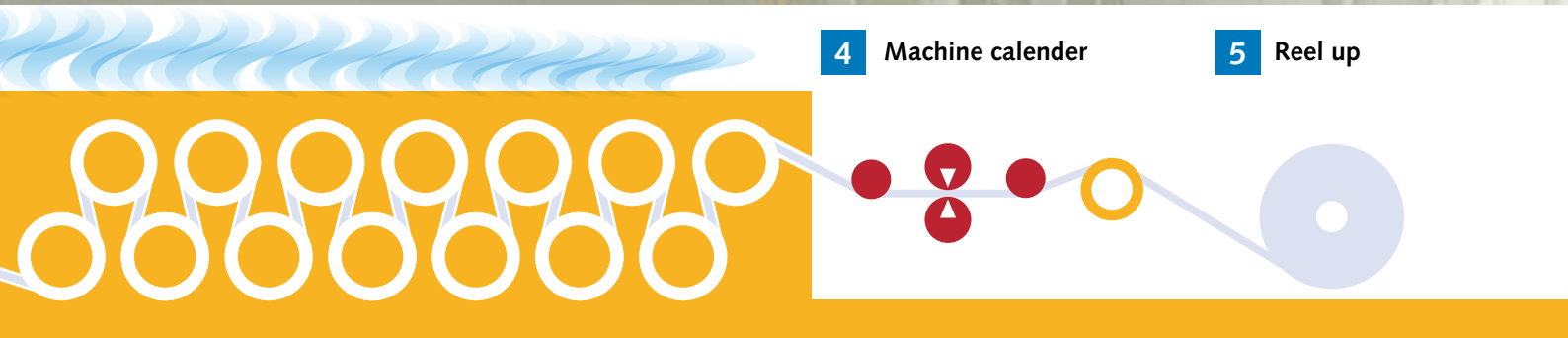
In addition to fibrous raw material, paper-making also uses additives, fillers and dyes. These are mainly mineral substances, but also include certain chemicals that serve to improve the paper's quality and enhance productivity. Use of these substances also determines specific properties in the paper, eg, its whiteness or colouration, but also certain functional properties, like grease resistance or wet strength.

► 1 Headbox and wire section

The headbox of a paper machine distributes the fibre-water suspension across the entire width of the wire. In this way, a best-possible fibre orientation is achieved. On the wire, the fibres settle next to and on top of one another. At the same time, the water runs off or is sucked away. This forms the sheet. Each litre of fibre-water suspension merely contains approx. five grams of fibrous and solid material. At the end of the wire section, the paper web still contains about 80 percent water.

► 2 Press section

The further draining process is by mechanical pressure in the press section. Here, using an absorbent continuous felt cloth the paper web runs through rollers of steel, granite or hard rubber, thus draining it. Such pressing compacts the paper structure, its strength is increased and the surface quality significantly improved.



4 Machine calender

5 Reel up



Paper storage

► 3 Dryer section

The residual water is vaporized from the paper in the dryer section. Slalom-style, the paper web runs through several steam-heated drying cylinders. The raw paper is able to dry evenly. In the end, the paper has a residual moisture content of a few percent. The emerging water vapour is sucked out of the closed drying hood and conducted into a heat-recovery system.

► 4 Machine calender

To follow the dryer section, some paper-making machines have a machine calender consisting of several rollers stacked on top of one another which give the paper web a smooth surface and an even sheet thickness. This is also where the most important paper-quality values are captured online using highly sensitive measurement detectors and fed into the automatic control of the interlocking or signalling centres.

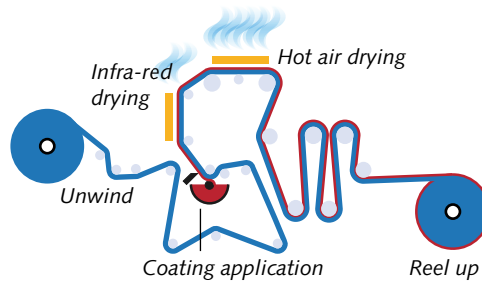
► 5 Reel

The finished paper web is wound up on to a steel shaft (reel). The paper now contains only five to eight percent residual moisture. Depending on the type of paper, such a shaft can hold up to 25 tonnes – a sheet of paper about 60 kilometres in length.

Upgrading and cutting



Coater



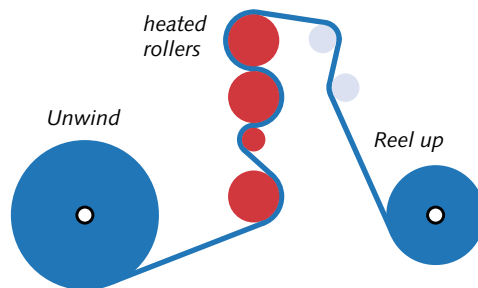
Coater

► Paper coating

An important process for upgrading is coating. Here, the raw paper is treated with a substance consisting of pigments and binders, giving the paper a sealed and readily printable surface.



Supercalender



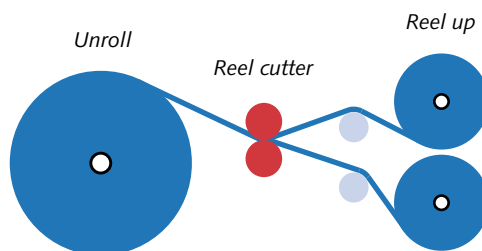
Supercalender

► Paper smoothing

A subsequent smoothing of the paper surface can be achieved by calendering the paper web. In a calender, the paper – under pressure – runs through several heated rollers. This gives the paper smoothness and gloss and makes it even more printable.



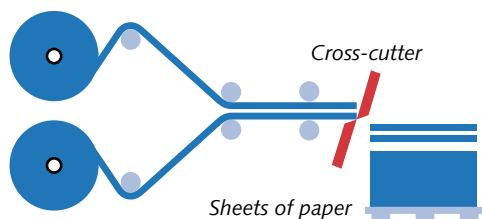
Reel cutter (above)
Cross-cutter (below)



Reel cutter (above)
Cross-cutter (below)

► Paper cutting

Normally, paper is not processed in the length and width in which it is rolled up at the end of a paper machine. The mechanical cutting of the paper web to size to meet buyers' various requirements is the finishing stage. In this process, the jumbo reels are cut into smaller reels by a reel cutter for further processing. Paper needed for format printing is cut by a cross-cutter into format-cut sheets.



Raw materials and their processing

Mechanical pulp production



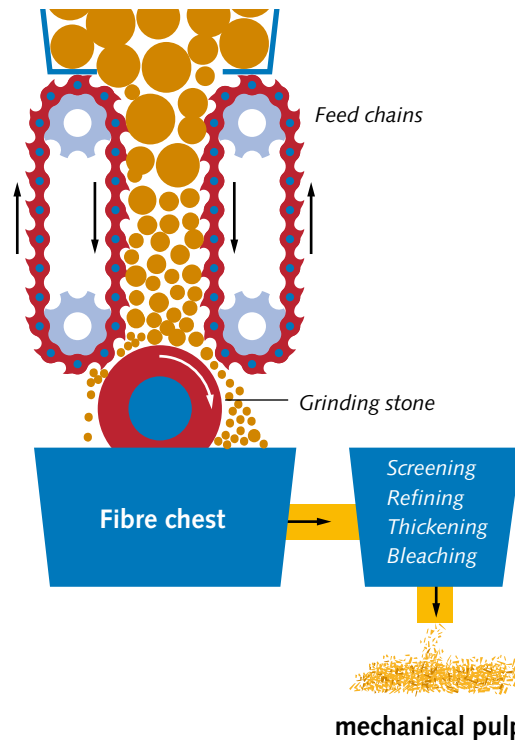
Mechanical pulp



Wood chips

Fibrous material

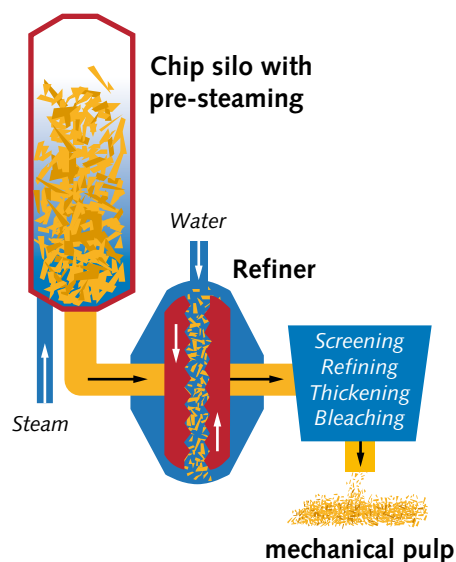
The main raw material for paper and board production is fibrous material. This is created by breaking wood down into its fibres. If wood is defibred mechanically, the result is mechanical pulp. If a chemical method is used, the result is chemical pulp. Mechanical pulp and chemical pulp are also referred to as fresh fibres or primary fibres, while paper for recycling is secondary fibrous material.



Mechanical pulp is produced by two different methods: the traditional process of grinding the wood on a grinding stone, and the more modern process of refining.

Mechanical pulp production

In the wood grinding process, debarked logs are pressed against the surface of a rotating grinding stone while hot water is added. The rough stone surface breaks the wood down into intact fibres, fibre fragments and fine fibre particles. The balanced ratio between short and long fibres determines the quality of the groundwood pulp. After the grinding process, the pulp is screened, refined and thickened.



Thermo-mechanical pulp production

The base raw material for the refining process is wood chips. The wood is cooked in the refiner at a high temperature with water being added and then defibred between two counter-rotating refiner discs. Most of the lignin, which turns paper yellow, survives in the fibres using this method.

Both methods enable a very high raw-material yield to be obtained depending on the grinding process: 100 kg of dry wood substance gives between 95 and 98 kg of mechanical pulp.

Chemical pulp production and processing paper for recycling



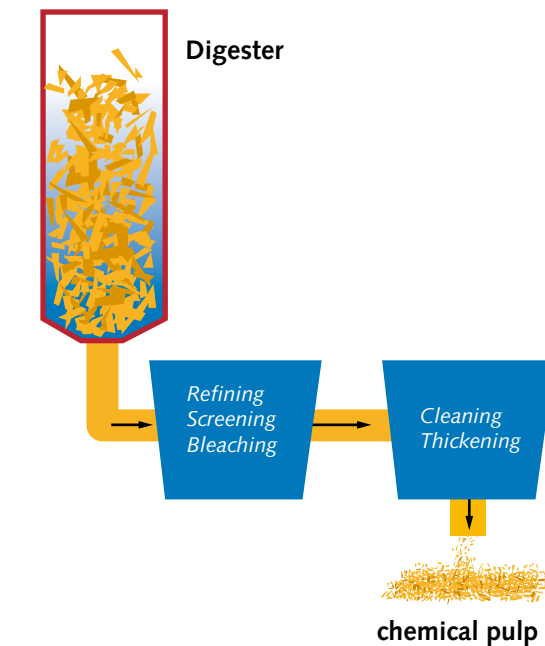
Chemical Pulp unbleached



Chemical Pulp bleached

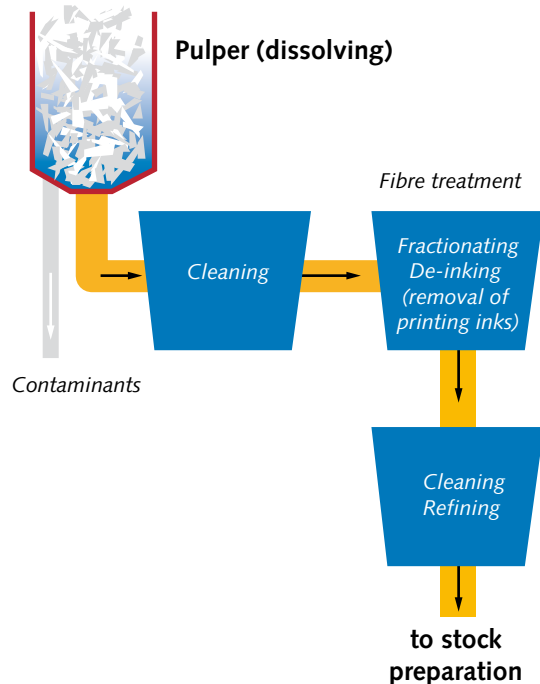


Paper for recycling



Chemical pulp production

Chemical pulp is marked by long, firm fibres. They ensure that paper is stable and tear-proof. To make chemical pulp, wood – usually wood chips – is chemically broken down in a digester. Pressure and heat are used to detach substances like resins and lignins from the wood fibres. Depending on the method used and the manufacturing conditions, around 50 kg of chemical pulp is produced from 100 kg of dry wood material. Depending on the proposed use of the paper, bleaching may also be necessary. Bleaching used to be done with elemental chlorine, but today with oxygen, hydrogen peroxide or chlorine compounds. While predominantly sprucewood is used for the production of mechanical pulp, both coniferous (softwood) and deciduous (hardwood) woods are suitable for the production of chemical pulp. In addition, chemical pulp is also made from annual plants (e.g. from straw, sugar cane and alfagrass). Chemical pulp is mainly imported from Scandinavia and Canada.



Processing paper for recycling

Paper for recycling is collected in numerous quality categories and used for many paper grades. The modern techniques available for recycling paper enable the paper industry to largely eliminate contaminants and, after sorting in the disposal company, any still remaining, though undesired, substances from the paper. However, these processes require high additional time and cost outlays. Due to the processing and deinking procedure, the fibres do lose quality. Over time, the ability to form into a sheet is weakened, so that fresh fibres have to keep being added to the cycle to make new paper.

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