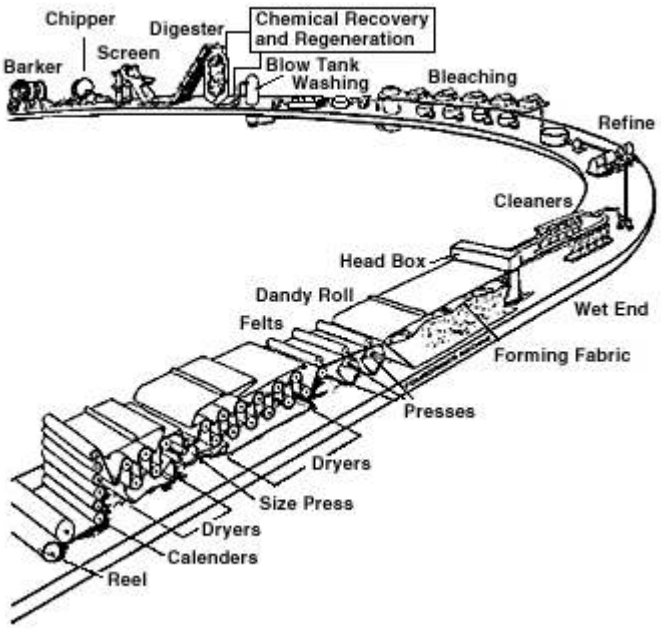
How paper is made

Below is a diagram of the papermaking process, followed by a detailed description.



The basic raw material for the papermaking process is wood. To begin the process, pulpwood logs must be reduced to chip form. Prior to chipping, logs are passed through a debarking drum (large, open-ended cylinder). Within the drum, logs collide with one another and rub together removing the bark. The bark falls through slots in the cylinder walls and is collected and burned as fuel in the power boilers. The debarked logs are conveyed to a chipper, which reduces them to small 1.5- to 2-inch squares with a 0.25-inch thickness.

Softwood and hardwood chips are kept separate until the pulp is blended at the paper machine since each has its own physical properties. Wood is made up of small cellulose fibers, bound together by a glue-like substance called lignin. In the pulping process, cooking the wood with chemicals to dissolve the lignin separates these fibers.

To accomplish this, the chips are loaded into large vessels called digesters on either a batch or continuous basis. Digesters are designed on the same principle as a kitchen pressure cooker. The chips and chemicals are steamed under pressure for 1.5 to 4 hours until the mixture is reduced to a wet, oatmeal-like mass. The cooking frees the fibers so they can be suspended in water.

The pulp is blown from the digesters under pressure to separate the fibers. It is then washed to remove the cooking chemicals and dissolved lignin and then bleached to the proper shade of whiteness. From there, the pulp is passed through refiners. These refiners roughen the surface of the individual pulp fibers by loosening the thread like elements from the fiber wall so they cling together when formed into a

sheet. Added after refining are dyes and other additives to give the finished paper the desired properties.

Water is then added to the pulp in a ratio of 200 parts water to one part fiber. This furnish, as it is called, is then run onto the forming fabric or wire of the paper machine. The forming fabric is an endless mesh screen that circulates at the wet end of the paper machine. There the fibers become interlaced, forming a mat of paper, and much of the water is extracted.

Traveling at speeds of more than 3,000 feet per minute, the paper is pressed between water-absorbing fabrics and wound through a series of steam-heated cylinders called dryers, where the last of the water in the sheet is removed. At this point, the paper passes through a size press that applies a starch solution to both sides of the sheet. Sizing seals the surface so ink cannot soak into the paper during printing. Since sizing wets the paper, the paper must again be dried by travelling through another series of steam-heated drums.

After drying, the paper goes through a calendaring process that provides a smooth finish by ironing the sheet between heavy, polished rollers. At the dry end, the paper is wound onto spools to form a machine reel and then rewound and slit into smaller rolls on a winder. Some of these rolls are sent for sheeting and packing into cartons. Others are rewound to smaller-sized rolls and wrapped for shipment.

How paper is made Glossary :

Barker
Debarking drums tumble and rub logs against each other to remove bark.

Bleaching
Pulp to be used for printing paper undergoes a series of bleaching steps.

Blow Tank
The fibers are separated, becoming pulp, in the blow tank.

Calendars
The paper is then run through polished steel rolls that make it even smoother and more compact. While most calendars add gloss, some calendars are used to create a dull or matte finish.

Chemical Recovery and Regeneration
The process in which the inorganic chemicals used in pulping are recovered and regenerated for use.

Chipper
The chipper reduces the logs to approximately one-inch square chips.

Cleaners
Clean stock is removed from the top and stock containing dense contaminates is removed from the bottom. Centrifugal force causes the dense materials to lose their momentum on the inside walls of the cleaners. This allows the dense material to settle much more quickly than the fibers.

Dandy Roll

Levels the fibers to make the sheet more uniform.

Digester
Chips in a chemical solution are cooked under pressure, dissolving and separating the wood fibers from the lignin, a natural "glue" that holds the wood fibers together.

Dryers
The longest part of the paper machine. Steam-heated cylinders contact both sides of the paper, evaporating the water to a 5% content level.

Felts
Fabrics that support the mat or sheet of paper as it travels through the press and dryer sections. Press felts absorb water from the sheet as the press cylinders squeeze water out. Dryer felts hold the paper tightly to the dryer cylinders.

Forming Fabric
Endless plastic or wire mesh screen that supports the fibers as water is removed. The fibers interlace and bond, forming a mat.

Head Box
"Furnish" is spread out the width of the forming fabric. Furnish consists of 0.5% refined pulp, 99.5% water and trace chemicals to help bond, brighten and if needed colour the paper.

Presses
The paper still consists of 50% water when it leaves the forming section of the machine and enters the press section. There, a series of heavy rotating cylinders press the water from the paper, further compacting it and reducing its water content to 30%.

Reel
The paper is wound onto a parent reel and taken off the machine.

Refine
The fibers of the bleached pulp are cut and brushed. This improves their bonding properties and strength.

Screen
A screen is used to separate larger chips.

Size Press
The paper passes through a sizing liquid to make it less porous and to help printing inks remain on the surface instead of penetrating the paper. Then the paper goes through additional dryers that evaporate the liquid in the sizing and coating.

Washing
Used to filter out any remaining lignin, chemicals and impurities. At this stage, the pulp is naturally brown and can be used to make grocery bags and boxes.

Wet End
First section of the paper machine where the majority of water is removed from the paper. The final section of paper machine where the paper is dried is called the dry end.