

Paper

From Wikipedia, the free encyclopedia

Paper is a thin, flat material produced by the amalgamation of plant fibres, which are subsequently held together without extra binder, largely by hydrogen bonds and to a small degree by fiber entanglement. The fibres used are usually natural and composed of cellulose. The most common source of these kinds of fibres is wood pulp from pulpwood trees, largely softwoods such as spruce. However, other vegetable fibre materials including cotton, hemp, linen, and rice may be used.

Contents

- 1 Manufacturing
 - 1.1 Preparation of the fibres
 - 1.2 Sheet formation
 - 1.3 Drying
- 2 Applications
- 3 Types
- 4 History
- 5 The future of paper
- 6 See also
- 7 External links

Manufacturing



International Paper Company: Kraft paper mill, located in Georgetown, South Carolina

Whether done by hand or with a paper machine, the paper making process has three simple steps:

Preparation of the fibres

Wood or plant cell walls are composed of fibers bound together. During pulping, these fibers are separated from each other and carbohydrate surfaces (cellulose or hemicellulose) are exposed. It is hydrogen bonding between these carbohydrate surfaces that provides paper strength. Fibers can be separated either chemically or mechanically.

Most chemical pulp is made using the Kraft process. The purpose of a chemical pulping process is to break down the chemical structure of lignin and render it soluble in the cooking liquor, so it may be washed from the cellulose fibers. Because lignin holds the plant cells together, chemical pulping frees the fibers and makes pulp. After Kraft pulping the pulp can be used directly for bags and boxes or further delignified, during bleaching, to produce white pulp for printing and writing. Chemical pulps tend to cost more than mechanical pulps, largely due to the low yield, 40-50% of the original wood. Since the process preserves fiber length, however, chemical pulps tend to make stronger paper. Another advantage of chemical pulping is that the majority of the heat and electricity needed to run the process is produced by burning the lignin removed during pulping.

There are two major mechanical pulps, thermomechanical pulp (TMP) and groundwood. In the TMP process wood is chipped and then fed into large steam-heated refiners where the chips are squeezed and fiberized between two steel discs. In the groundwood process debarked logs are fed in into grinders where they are pressed against a rotating stones and fiberized. Mechanical pulping does not remove the lignin, so the yield is very high, > 95%, but also causes paper made from this pulp to yellow and become brittle over time. Mechanical pulps have rather short fiber lengths and produce weak paper. Although large amounts of electrical energy are required to produce mechanical pulp, it costs less than chemical pulp.

Paper made from either chemical or mechanical pulp can also be recycled. By mixing with water and applying mechanical action the hydrogen bonds in the paper can be broken and fibers separated again.

Sheet formation

The pulp mixture is further diluted with water resulting in a very thin slurry. This dilute slurry is drained through a fine-mesh moving screen to form a fibrous web, a long continuous sheet. Water from the slurry is drained through the screen and the resulting paper is pressed, dried and at the end of the process, is fed into a roll.

While it is still wet, a watermark woven into the continuous screen may be impressed into the paper. Visible when the finished paper is held to the light, a watermark is used on paper currency and on finer quality paper to identify the manufacturer and establish authenticity.

In the traditional mould process, a quantity of pulp is placed into a form, with a wire-mesh base, so that the fibres form a sheet on the mesh and excess water can drain away. Pressure may be applied to help remove additional water. The paper may then be removed from the mould, wet or dry, and go on to further processing.

Most mass-produced paper is made using the continuous Fourdrinier process to form a reel or web of fibres in a thin sheet. When dried, this continuous web may be cut into rectangular sheets by slicing the web vertically and horizontally to the desired size. Standard sheet sizes are prescribed by governing bodies such as the International Organization for Standardization (ISO).

Drying

After the paper web is produced, the water must be removed from it in order to create a usable product. This is accomplished through pressing and drying. The methods of doing so vary between the different processes used to make paper, but the concepts remain the same.

Pressing the sheet removes the water by force. Once the water is forced from the sheet, another absorbant material must be used to collect this water. On a paper machine this is called a felt (not to be confused with the traditional felt). When making paper by hand, a blotter sheet is used.

Drying involves using air and or heat to remove water from the paper sheet. In the earliest days of papermaking this was done by hanging the paper sheets like laundry. In more modern times, various forms of heated drying mechanisms are used. On the paper machine, the most common is the steam-heated can dryer. These dryer cans heat to temperatures above 200°F and are used in long sequences of more than 40 cans. The heat produced by these can easily dry the paper to less than 6% moisture.

Applications

- To write or print on: the piece of paper becomes a document; this may be for keeping a record (or in the case of printing from a computer or copying from another paper: an additional record) and for communication; see also reading.
- To represent a value:
 - paper money
 - bank note
 - check
 - security
 - voucher
 - ticket
- For entertainment:
 - book
 - magazine
 - newspaper
 - art
 - zine
- For packaging:
 - corrugated box
 - paper bag
 - envelope
 - wrapping tissue
 - wallpaper
- For cleaning (see also tissue, Kleenex):
 - toilet paper
 - handkerchiefs
 - paper towels
 - cat litter
- For construction
 - papier-mâché
 - origami
 - origamic architecture (OA)
 - quilling
 - Paper honeycomb, used as a core material in composite materials

- paper engineering, see also construction paper
- Other uses
 - emery paper
 - sandpaper
 - blotting paper
 - litmus paper
 - universal indicator paper

Types

- Construction paper/sugar paper
- Cotton paper
- Electronic paper
- Inkjet paper
- Leather paper
- pH Indicator paper
 - Litmus paper
 - Universal indicator paper
- Photographic paper
- Plain paper
- Recycled paper
- Rice paper
- Sandpaper
- Tracing paper
- Tyvek paper
- Wallpaper
- Washi
- Coated paper: glossy and matt surface
- Uncoated paper, also named wood free paper

History

Main article: [Papermaking](#)

The word *paper* comes from the ancient [Egyptian](#) writing material called [papyrus](#), which was woven from [papyrus plants](#). Papyrus was produced as early as 3000 BC in Egypt, and in ancient [Greece](#) and [Rome](#). Further north, [parchment](#) or [vellum](#), made of processed [sheepskin](#) or [calfskin](#), replaced papyrus, as the papyrus plant requires subtropical conditions to grow. In China, documents were ordinarily written on [bamboo](#), making them very heavy and awkward to transport. [Silk](#) was sometimes used, but was normally too expensive to consider. Indeed, most of the above materials were rare and costly.

While the [Chinese](#) court official [Cai Lun](#) is widely regarded to have first described the modern method of papermaking (inspired from wasps and bees) from [wood pulp](#) in AD [105](#), the [2006](#) discovery of specimens bearing written characters in north-west China's Gansu province suggest that paper was in use by the ancient Chinese military more than [100](#) years before Cai in [8 BCE](#) [\[1\]](#). Archaeologically however, true paper without writing has been excavated in China dating from the [2nd-century BCE](#). Paper is considered to be one of the [Four Great Inventions of Ancient China](#). It spread slowly outside of China; other East Asian cultures, even after seeing paper, could not figure out how to make it themselves. Instruction in the manufacturing process was required, and the Chinese were reluctant to share their secrets. The technology was first transferred to Korea in [604](#) and then imported to Japan by a Buddhist priest, [Dam Jing](#) (??) from [Goguryeo](#), around [610](#), where fibres (called *bast*) from the [mulberry](#) tree were used. After further commercial trading and the defeat of the Chinese in the [Battle of Talas](#), the invention spread to the [Middle East](#), where it was adopted in [India](#) and subsequently in [Italy](#) in about the [13th century](#). They used [hemp](#) and [linen](#) rags as a source of fibre. The oldest known paper document in the West is the [Missel of Silos](#) from the [11th century](#).

Some historians speculate that paper was the key element in global cultural advancement. According to this theory, Chinese culture was less developed than the West in ancient times prior to the [Han Dynasty](#) because bamboo, while abundant, was a clumsier writing material than papyrus; Chinese culture advanced during the Han Dynasty and preceding centuries due to the invention of paper; and Europe advanced during the [Renaissance](#) due to the introduction of paper and the [printing press](#).

Paper remained a luxury item through the centuries, until the advent of steam-driven paper making machines in the 19th century, which could make paper with fibres from wood pulp. Although older machines predated it, the Fourdrinier paper making machine became the basis for most modern papermaking. Together with the invention of the practical fountain pen and the mass produced pencil of the same period, and in conjunction with the advent of the steam driven rotary printing press, wood based paper caused a major transformation of the 19th century economy and society in industrialized countries. Before this era a book or a newspaper was a rare luxury object and illiteracy was normal. With the gradual introduction of cheap paper, schoolbooks, fiction, non-fiction, and newspapers became slowly available to nearly all the members of an industrial society. Cheap wood based paper also meant that keeping personal diaries or writing letters ceased to be reserved to a privileged few. The office worker or the white-collar worker was slowly born of this transformation, which can be considered as a part of the industrial revolution.

Unfortunately, the original wood-based paper was more acidic and more prone to disintegrate over time, through processes known as slow fires. Documents written on more expensive rag paper were more stable. The majority of modern book publishers now use acid-free paper.

The future of paper

Paper made in the west since the industrial revolution has been almost exclusively wood based, except for a few specialized papers like those used in banknotes. However, at least one company (Cloudy Bay Cotton) has recently tried to introduce cotton based tissue papers to westernised countries as an alternative to wood based ones. Their reasons for doing this are that the cotton based tissue papers are less abrasive, less likely to cause allergic reactions, and far more environmentally friendly than wood papers, as they are made from renewable materials. The type of cotton fibres used for making paper are discarded as unusable waste from the textile industry, and can be manufactured using fewer chemicals and less energy.

Some manufacturers, notably AMD, have started using a new, slightly more environmentally friendly alternative to expanded plastic packaging made out of paper, known commercially as paperfoam. The packaging has very similar mechanical properties to some expanded plastic packaging, but is biodegradable and can also be recycled with ordinary paper.

With increasing environmental concerns about synthetic coatings (such as PFOA) and the currently higher prices of hydrocarbon based petrochemicals, there is a recent focus on zein (corn protein) as a coating for paper in high grease applications such as popcorn bags.

Synthetics such as Tyvek and Teslin have been introduced as printing media as more durable material than paper.