Pulp facts

Paper is arguably one of the most useful commodities every invented, one that most of us make use of every day, and yet few people know exactly how paper is manufactured

Since its invention paper has played an essential role in spreading literacy and knowledge, and despite our modern communications technology it is still irreplaceable. Making paper is a multi-billion dollar industry and part of a major economic sector: the global forest industry employs 13 million people in nearly 200 nations. The major players are in Asia, responsible for 36 percent of world paper and board production, North America for 28 percent and CEPI member countries (in Europe and Scandinavia) providing 27 percent.

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The basic principle of making paper is simple, but achieving the quality that is expected today is a very complex business. It involves two distinct processes, making the pulp and making the paper, which may be carried out at the same site or separately. The paper may then go through a third process - finishing.

You can make pulp in many ways and from many substances, but for virgin wood pulp there are just two basic types: mechanical and chemical (traditionally known as woodfree). Mechanical pulp, put very simply, is made from chipping and then grinding up trees, and is predominantly used for making newsprint and magazine papers. This type of pulp still contains its natural lignin, the glue that binds the cellulose fibres of a tree together and makes paper yellow with age. Variations on the process include the use of steam to soften the wood particles or pre-treating them with chemicals.

The type of pulp most commonly used for graphic arts paper is chemical pulp, particularly sulphate, or kraft, pulp, which accounts for around 80 percent of chemical pulp globally, and so this is what we'll concentrate on for the purposes of this article.

The paper-making process

So how is pulp made, and why is kraft the most common chemical pulp? If you speak German, the name gives a clue – it means 'strength', and this type produces much stronger paper than mechanical pulp or sulphite, the other chemical contender.

The raw materials - wood needs to be de-barked and chipped before being fed into the paper mill.

Pulping is the first stage of taking wood and making a slurry to be turned into paper. Pulp manufacturers may blend several different woods to achieve the desired paper. Softwood pulp, using pine or spruce, for example, gives strength whereas hardwood pulp such as birch or eucalyptus adds opacity and smoothness. Each tree has its own characteristics.

The wood can arrive at the mill in many forms – usually the off-cuts from sawmills, the parts of a tree not usable for building or furniture, or forest thinnings. If whole, it is debarked and chipped. Chips are cooked under high pressure with chemicals, generally caustic soda and sodium sulphate, to remove the lignin: about half the total volume is lost at this stage, as 'black liquor' – a mixture of lignin and chemicals. After chemical recovery, the lignin, along with any bark, provides a valuable carbon-neutral fuel source for the mill.

The resulting pulp is dark, and, in addition to washing, if it is to be used for graphic papers it needs to be bleached

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to brighten it and to remove any residual lignin. If it is to be transported to a paper mill it will also be dried.

Once at the mill, water is added to give about 1-to-10 parts fibre to 1000 parts water and further ingredients mixed in, including additives such as clay, chalk or titanium dioxide to give the paper its desired look and feel. The resulting slurry is spread across a moving wire mesh belt on the papermaking machine. Modern machines are massive pieces of precision engineering; the largest in Europe, newly started up in Portugal, makes jumbo reels weighing 116 tons.

The pulp is passed over a moving wire mesh, which helps to knit the fibres together and drain off the water.

As the mesh moves, the fibres knit together and suction and gravity force the water out, leaving a 'felt' that's about 50 percent water and just about recognisable as paper. This then travels through a series of heated rollers to continue drying until the moisture content comes down to around 5 – 8 percent. The final stage is winding it onto a jumbo reel, ready for slitting the paper into smaller reels or sheets.

There are a number of ways that the paper can be treated to change its surface either on the paper machine or afterwards – sizing, then polishing it with a series of spinning metal rollers (calendering), coating or both.

Forests and logging

Most paper nowadays is made from wood pulp – forests are inextricably linked with paper. Recycling does maximise the use of fibres, but cannot replace the need for virgin pulp. Although recovery rates are steadily increasing, with over 50 percent of paper and paperboard being recovered in much of the world, we still need to add virgin fibres to replace those weakened and lost in the recycling process. We also have to meet a growing demand for paper.

Simply replanting trees is not protecting forests. Everything that lives there must be looked after, protecting the ecosystem, whose natural balances allow co-existence – which may mean leaving areas untouched. Soil, water and air need protection from pollution and the types of damage that can be caused by anything from how and what is planted to making roads for loggers, and of course, people have to be considered too. Forest certification is a way of managing this, with chain of custody certification, providing assurance to purchasers of paper products.

This certification also plays a part in work the paper industry globally is doing with environmental groups and governments to address the challenge of illegal logging. Your choice of paper - recycled or paper from certified forests – can make a valuable environmental contribution, as does reducing waste.

Chemicals & bleaching

The process of making paper requires the use of chemicals. These include those for the look and feel of the paper – sizing agents, wet strength agents, dyes, coatings etc – as well as those chemicals that are part of the process, such as anti-foaming agents, cleaning agents, retention agents and slimicides.

Bleaching is used not just to achieve the whiteness that paper buyers demand, but also to remove the residual lignin. Commonly used bleaching agents include chlorine dioxide (ECF bleaching being the main form), hydrogen peroxide and oxygen. Recycled paper does not require the same degree of processing, as the recovered graphic papers have already been treated, although bleaches are often used for brightening.

Water and air

Effluent from the mill needs to be treated before re-entering the water supply to remove pollutants, both from

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processing and those naturally occurring in the wood. New technologies and different methods of bleaching have achieved major improvements in water quality over the past three decades. Process water recycling is also increasingly used, reducing water consumption and effluent.

Paper stacked up on pallets at a printing plant ready to be used.

The industry has also been steadily reducing atmospheric emissions. The types will vary from mill to mill – if it's generating its own electricity there will be combustion by-products, which, if uncontrolled, not only contribute to climate change but also to acid rain, local air pollution and respiratory disease. The kraft process also has potential for an interesting (to put it politely) aroma, although less so nowadays as a result of process changes.

Wide-ranging legislation at federal, state, European or national level in many areas, with further local regulations, plays a part in pollution prevention and control. Many companies have invested heavily in pollution reduction – but not all, and there are still areas of serious concern among local populations and environmental groups. Leading mills in the field have environmental management systems and publish performance data, often backed up by third-party certification or verification; looking for this can help with making a good environmental choice. Eco-labels are also good, but because of costs mills already reporting will not necessarily choose both.

Energy and carbon emissions

The paper industry is in a good position with carbon dioxide emissions, despite being energy-intensive. It is a major user of biomass, considered carbon neutral, as a fuel source. This accounts for over half of the industry's primary energy use in Europe and the picture is repeated elsewhere – 58 per cent in Canada, for example, according to the Forest Products Association of Canada.

Pulp mills will often generate surplus heat, used for district heating, and power, exported to the grid, if there is no integrated paper mill. Paper mills require a lot of heat for drying. Combined heat and power (CHP), or co-generation, plays an important part in this. Conventional coal- or gas-fired power stations typically achieve around 38 percent and 48 percent efficiency respectively, as the heat produced during the process is discarded – the white plumes are steam from the cooling towers. Mills with CHP, on the other hand, use the heat and therefore efficiencies of 70 per cent or more can be reached.

As energy can account for as much as 30 percent of cost, there are good incentives for reduction and the trade associations regularly publish performance figures.

Recycling paper, even once transport is taken into account, generally uses less energy than making virgin paper, as much of the work has already been done. However this does not always mean it has a lower carbon footprint. For processors and paper mills buying electricity off the national grid it will reflect the local energy mix.

In conclusion

Paper is amazing. It has endless uses and is easily portable. Its main raw material is renewable, with responsibly managed sources available, and it's also recyclable. Its environmental performance has improved

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substantially, but there is still work to be done, and this is something that we can all help with as our choices make a difference.

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