Frequently Asked Questions on Kraft Pulp Mills

As at 4 March 2005

Q1: **Has CSIRO research found that kraft pulp can be bleached to a high level of brightness using ozone instead of chlorine gas or chlorine dioxide?**

A1: No – CSIRO research, like all of the other research conducted in pulp and paper laboratories around the world found that ozone bleaching of kraft pulps gives pulp brightnesses one or two points below the levels achievable with chlorine dioxide, which is equivalent to, or better than chlorine.

Q2: **If so, when was the research conducted and how detailed was it?**

A2: The last research that CSIRO undertook on bleaching of eucalypt kraft pulps using ozone in a totally chlorine free (TCF) process was very detailed and it was conducted in the early to mid 1990's as part of the research aimed at preparing the "Environmental Guidelines for New Bleached Eucalypt Kraft Pulp Mills, published by the Commonwealth Government in 1995. Since that time CSIRO has been actively monitoring developments in TCF processes worldwide. A very large amount of research has been undertaken in laboratories internationally, comparing TCF bleaching using ozone with elemental chlorine free (ECF) bleaching using chlorine dioxide. These studies have shown that ECF bleaching produces much lower levels of organochlorine by-products than older bleaching methods that use elemental chlorine. When ecotoxicological studies are done on effluents from ECF and TCF bleaching following proper biological treatment (including microanalysis for the "dioxins", PCDF and PCDD), both types of effluent show very low levels of toxicity that is removed by adequate dilution in the sea. These findings have been reviewed by the United Nations Environment Program (UNEP) who, in 2003, published the statement:

> *"The United Nations Environment Program (UNEP) considers the ECF and TCF bleaching methods to be equivalent with respect to their potential formation of PCDD and PCDF."*

Both ECF bleaching and TCF bleaching of kraft pulps are considered to be Accepted Modern Technology in the European Union and in North America.

Q3: **Is TCF bleaching with ozone economically viable?**

A3: CSIRO did not commercialise its ozone bleaching results because they did not offer any advantages over results from other laboratories. A number of companies and pulp mills overseas have put TCF bleaching into practice on a commercial scale. TCF bleaching is more expensive than ECF bleaching and almost all mills making TCF pulp also make ECF pulp, because the market for TCF pulp (that is intrinsically less bright than ECF pulp) is limited.

Q4: **Is TCF bleaching technology used anywhere?**

A4: Yes, TCF bleaching technology developed by European and American companies is used in Sweden, Finland and the US. Only 5 – 6% of the kraft pulp produced in the world is produced by TCF processes and the majority of that pulp is sold and used in Germany. By contrast, around 75% of the bleached kraft pulp produced worldwide is produced by ECF processes and is used to make the highest quality white printing and writing papers. The remaining 19 - 20% of bleached kraft pulp is made by older bleaching processes that use elemental chlorine.

Q5: Could TCF technology be applied to Tasmania's pulp mill proposal?

A5: The answer to this question lies outside the scope of CSIRO's expertise, as it depends on entirely economic and market factors, such as the predicted demand for ECF and TCF pulps. The Tasmanian Government in its recent publication, "Development of new environmental emission limit guidelines for any new bleached eucalypt kraft mill in Tasmania", has classified both ECF and TCF processes as Accepted Modern Technology, in line with other economically developed jurisdictions. It is therefore up to the proponent of any new pulp mill to decide for themselves which of the two acceptable bleaching processes they will use and to prepare a very detailed Environmental Impact Statement (EIS) that specifies what the chosen process will achieve in terms of environmental and other impacts. This EIS will then be reviewed by the process legislated by the Tasmanian State Parliament.

Q6: **Why don't more kraft pulp mills use TCF bleaching?**

A6: In scaling up the results of ozone bleaching on the small scale in the laboratory to a commercial scales in the range of hundreds of tonnes of pulp per day, it has been found universally that bleaching with ozone is harder to control and gives pulps of inferior strength and brightness to those produced with ECF processes that use chlorine dioxide, hydrogen peroxide and oxygen. The greater difficulty in controlling ozone bleaching on a tonne scale has to do with the low solubility of ozone in water (compared to chlorine dioxide) and in the non-specific way that it oxidizes the chemical components of the pulp. For this reason only 5 – 6% of the kraft pulp produced in the world is produced by TCF processes and the majority of that pulp is sold and used in Germany. By contrast, around 75% of the bleached kraft pulp produced worldwide is produced by ECF processes and is used to make high quality white printing and writing papers. The remaining 19 - 20% of bleached kraft pulp is made by older bleaching processes that use elemental chlorine.

Q7: **What about the organochlorines produced in ECF and chlorine based bleaching, don't they persist in the environment and eventually build up to unacceptable levels?**

A7: The reason that the older chlorine-based bleaching technology is being phased out is largely due to environmental concerns over the levels of organochlorine by-products (measured using a term "AOX" that stands for

absorbable organohalides – halogens are elements in the chlorine chemical group that also includes fluorine, bromine and iodine). In order to remove the organohalides from effluents from older mills, very extensive waste water treatment systems were required and those were very expensive. It was found that when chlorine was replaced by chlorine dioxide in the bleaching sequence, most of the bleaching was done by the "dioxide" part of the molecule and the levels of AOX dropped by factors of between 10 and 50. The organochlorines produced by the ECF process have been extensively studied and found to be degraded biologically and by sunlight to carbon dioxide and sodium chloride, so they do not accumulate in the biosphere in the way that certain obsolete chlorine-containing pesticides, such as DDT and chlordane, accumulate.

Q8: **Why does the pulp mill propose to use woodchips as its raw material – couldn't waste paper or an annual crop, like hemp be used instead as a source of papermaking fibre?**

A8: About 55% of the world's paper is made from recycling waste paper. In Australia the figure is closer to 60%. In the process of recycling the fibres from which the paper is made become weaker and some are broken beyond repair, so the world needs about 300 million tonnes of new, or "virgin" papermaking fibre every year to supply the demand for paper. Of this 300 million tonnes of fibre, around 90% of it is made from woodchips and about 10% from the residues of annual crops, like wheat straw, rice straw and sugar cane bagasse. Unfortunately crop residues have many disadvantages as a raw material when compared to woodchips. Firstly they have to be stored for up to 9 months of the year, because the harvest takes place over a 2-3 month period and the pulp mill has to operate for 12 months of the year. During this period of storage the crop residue has to be protected from the weather, otherwise it will degrade and become unsuitable for making paper of uniform quality. Typically a modern pulp mill might produce 500,000 – 1,000,000 tonnes of pulp each year, which would mean storage of between 750,000 – 1,500,000 tonnes of straw, or other crop residue. Compared to woodchips, that can be harvested on demand all year round as needed by the mill, this storage cost would add a huge cost to the mill and it could not compete on international markets. A second disadvantage of annual crops is that they produce pulps that retain water much more tightly than pulps from woodchips, so most paper mills will either refuse to use them, or will offer much lower prices for the pulps. Thirdly, many annual crops contain 1-2% of natural silica that dissolves in the chemicals used to separate the fibres and then interferes with the very efficient recycling of chemicals that is practiced in a modern kraft mill.

Q9: **But what about the 10% of papermaking pulp that is made from annual crops – why can some companies do it successfully but we can't in Australia.**

A9: The pulp that is made from annual crops is always made in countries that don't have sufficient forest resources to supply their paper mills and where economic necessity makes it necessary to limit the amount of imported wood-derived pulp that they use. Usually, these regions are very poor economically speaking with a lot of unemployment and very low wage rates. Under these circumstances, it makes good social and economic sense to employ many

hundreds of people on low wages and to seek funding from the World Bank to build the additional storage and processing facilities to make pulp and paper from annual crop residues. This is how a recent kraft mill in Tamil Nadu in India was built, based on sugar cane bagasse. In Australia, the economics just don't stack up.

Q10: **Could annual crops be blended with woodchips and be used as a supplementary source of fibre in Australia?**

A10: The answer to that question is open. Generally speaking the handling and pulping of thousands of tonnes of crop residues requires different equipment to the equipment used to handle and pulp the woodchips. So, you are looking at least doubling the cost of that part of the processing equipment. There was a feasibility study conducted between 2000 and 2001 near Bundaberg in Queensland that looked at mixing annual crops and woodchips that did not proceed, so one is forced to the conclusion that the investors did not like the look of the economics. If you are an investor considering investing around a billion dollars in a pulp mill and facing all of the uncertainties in fluctuating prices for pulp, the prudent choice is to "keep it simple" and to process woodchips alone. Again it is up to the individual proponent to look at the processes that are Accepted Modern Technology, the costs involved and the potential returns and to make a balanced decision.

Q11: What exactly is kraft pulp and why has it been chosen for this mill?

A11: Kraft pulp is a pulp that is made from woodchips (or annual crop residues) using the kraft process. The process itself was invented by a German engineer called Carl Dahl in 1882 and he coined the name, using the German word for strength, "kraft", because the process makes pulp that is physically stronger than any other process. Today 70% of the world's virgin papermaking fibre is made by the kraft process, because the process has been refined in the intervening 123 years to be the most cost-effective way of making market pulps with the highest value. Many alternatives to the kraft process have been researched and commercialised, however none match kraft if you are in the business of selling pulps on international markets, because kraft pulp is the benchmark.

Q12: What is bleached kraft pulp then?

A12: When woodchips are pulped using the kraft process, the pulp that is produced is light brown in colour. This material is called unbleached kraft pulp and it is used to make stronger grades of corrugated cardboard and strong paper bags and wrapping paper. If you want to make paper that is white enough to be easily read when printed then the pulp must be bleached white in a second series of process steps that come after pulping. A series of process steps are used because no-one has yet been able to find a single process step that will take unbleached kraft pulp to bright white bleached pulp in a single step. This series of steps often involves the use of caustic soda and oxygen in the first step, then either chlorine dioxide or ozone in the second step, more caustic soda and oxygen and some hydrogen peroxide in the third step and finally either more chlorine dioxide in the fourth step, or caustic soda and hydrogen peroxide. There are dozens of variations on the types of chemicals used and

the sequence in which they are used, but the ultimate aim is to produce a white pulp that reflects between 88 and 90% of the light falling on it at the blue end of the spectrum. This is known as 88 or 90 brightness bleached kraft pulp and again this is the international benchmark for people buying pulps to make office papers and high quality printing papers.

Q13: What about newsprint, it's a printing paper, is it made from kraft pulp too?

A13: Generally speaking no. Depending on where it is made, newsprint will be made largely from the second major type of pulp that is manufactured (accounting for most of the 30% of the world's pulp that is not kraft pulp), mechanical pulp. Mechanical pulp differs from kraft pulp by virtue of the fact that mechanical energy, rather than chemical energy is used to separate the fibres from the woodchips. Because mechanical energy is used, none of the natural polymer, called lignin, that binds the fibres together in wood is removed during the mechanical pulping process. This retention of the lignin causes the fibres to bond less firmly when formed into a paper sheet and causes the paper to yellow with age. That said, some newsprint does contain small percentages of bleached kraft fibre, either because it is put in to add strength to the mechanical pulp, or because the newsprint is made partly from mechanical pulp and partly from recycled fibre (from waste paper) that has a proportion of bleached kraft pulp in it.

Q14: What about odour from kraft pulp mills – I've heard that kraft mills always smell bad?

A14: Many older kraft mills do smell bad. This is because the process of pulping uses a compound of sulphur, called sodium sulphide. In the process of removing the lignin polymer and retaining the strength of the fibres a small amount of the sulphur is converted into malodorous gases, including hydrogen sulphide (rotten egg gas), methyl mercaptan (smells of rotten cabbage) and dimethyl sulphide (smells of burning rubber). Collectively these gases are called Total Reduced Sulphur, or TRS. In modern kraft mills, these by-products of pulping are collected in sophisticated pollution control systems and burnt to remove the odour. The only time that these gases escape to the atmosphere are during periods of process upset. In a mill using Accepted Modern Technology odour should only be detected beyond the mill boundary for 2 – 3 days per year at most, during the time the mill is being started up or being shut down for its annual maintenance program. The emission limit guidelines for odour established by the Tasmanian Government are the most stringent in the world.

Q15: What about bleached chemithermomechanical pulp that has been proposed for a future mill near Heywood in Victoria?

A15: BCTMP is a pulp that is closer in quality to mechanical pulp than to kraft pulp, so it isn't as strong, it isn't as bright and it isn't as valuable. It should be up to the proponents of the mill to decide which process they propose to use, so long as it complies with State legislation.

Q16: What advantages will there be to Tasmania if the mill is built to offset some of these disadvantages?

A16: If it is built, the mill will take woodchips that are currently exported with a value around $100 per tonne into 500 kilograms of bleached kraft pulp valued at around $450. This addition of value to the fibre will enable the mill owners to create many new jobs and to reduce the current trade deficit from imported pulp and paper products of around $2 billion per annum. The 500 kg of each tonne of woodchips that does not end up as pulp (mainly lignin) will be burnt to release the solar energy stored by the tree in order to run the mill and to recycle the chemicals used to pulp the wood. Kraft mills are usually self sufficient in energy and often have a small excess of electricity to contribute to the State power grid. In summary the kraft process effectively runs on solar energy stored in the wood and turns carbon dioxide that a tree has converted into cellulose fibre into a useful and natural polymer, papermaking pulp. That is why there are so many kraft mills in environmentally conscious countries like Sweden, Finland, Norway and Canada.

Q17: Are there other bleached kraft pulp mills in Australia?

A17: There is currently only one bleached kraft pulp mill in Australia, near Traralgon in Victoria, that is part of the Australian Paper Maryvale pulp and paper making facility. There are also two kraft pulp mills in Australia that make unbleached pulp; one is also part of the Maryvale facility and the second mill is at Tumut in NSW, owned by Visy Pulp and Paper.