



This Fact Sheet summarises the environmental impact of the two main methods used for bleaching chemical woodpulp. These methods are Elemental Chlorine Free (ECF) and Total Chlorine Free (TCF).

Background

Until the early '90s, chlorine gas was used as the main component of the bleaching process for chemical woodpulp. At that time, it was discovered that significant amounts of the dioxin and furan chemical families were being discharged to watercourses by pulp mills and a world-wide movement was begun to implement alternative processes. Initially, the main alternative pursued was the TCF process where oxygen is used to remove the lignin from the pulp and ozone or hydrogen peroxide used to complete the bleaching. Then, gradually, ECF began to emerge as a viable alternative where chlorine dioxide is substituted for the element chlorine in the bleaching cycle. As the ECF process was refined, it eventually became the main method and currently accounts for over 80% of the world production of bleached pulp. Virtually all new pulp mills use this process and some TCF mills have even converted to it.



Environmental Impacts

It is generally recognised that discharges to atmosphere and energy use are not significant environmental issues for either process. There are, however, discernable differences in liquid effluent discharges and the quality of the pulp itself. These differences are summarised on Page 2.

Overall, it is accepted that TCF and ECF discharges cannot be separated on environmental grounds. Regarding the pulp itself, the ECF process has the advantage of a significantly higher ratio of finished fibre to wood.

When chlorine bleaching was being phased out, the replacement technologies were largely untried and some of the processes were unstable. Effluent data generated at that time reflected those problems and opinions were formed about the merits of the new situation which have proved incorrect in hindsight. Whilst the processes themselves have become better understood, the biggest progress has been made in effluent plant technology and it is now possible to demonstrate that the discharges to watercourses, from both ECF and TCF, are of no environmental concern.

Best Available Technology (BAT)

BAT has legal status in both the USA and Europe when determining consents for the discharge of effluent. In the USA, the ECF process is regarded as being Best Available Technology and in Europe, the Commission has decided that there is no significant difference between TCF and ECF and, therefore, both are regarded as BAT.

A landmark report on the subject of the best technology was produced for the Tasmanian Resource Planning and Development Commission by a number of leading environmental consultancies in 2006. This analysed a report from WWF in which the

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relative merits of TCF and ECF were discussed in relation to the Arauco Valdivia ECF pulp mill in Chile. The former report clearly concluded that TCF and ECF effluents could not be separated on environmental grounds.

Sources of Data

A number of documents were used when compiling this paper and the details of some of them are given on Page 3. They should be consulted if more detailed data is required.

Table 1

EFFLUENT QUALITY AND CONSIDERATIONS

	TCF	ECF
AOX (adsorbable organic halides)	none	Some AOX content from bleaching process but substances are different to those produced by chlorine gas and are non persistent. Modern effluent plants reduce this content to a level which is insignificant.
Molecular weight of compounds in effluent	Low molecular weight compounds such as glyoxal and vanillin	Generally high molecular weight (and therefore less toxic) compounds detected.
Short-term single species toxicity	TCF and ECF equal	TCF and ECF equal
Chronic single species toxicity	Slightly higher but below toxicity level of natural peat bog water and municipal effluent	Slightly lower and below toxicity level of natural peat bog water and municipal effluent
Overall environmental watercourse impact	TCF and ECF equal and both below toxicity level of natural peat bog water and municipal effluent	TCF and ECF equal and below toxicity level of natural peat bog water and municipal effluent
Results of biological tests on effluent of mills having both TCF and ECF plants	TCF and ECF equal	TCF and ECF equal
Endocrine disruption	There is some evidence of endocrine disrupting substances in the effluent of both processes but these are believed to originate from wood or naturally-occurring chemicals and the impact from the two processes is indistinguishable.	

Table 2

PULP CONSIDERATIONS

Brightness	Bleaching reduces pulp strength. At the same level of reduction, ECF produces pulp having approximately 2 ISO points brighter than TCF.
Yield (i.e.) how much pulp can be made from the trees	For hardwoods, ECF has an approx. 2% higher yield than TCF and for softwood, this advantage rises to around 4%.

Sources of Data

- ÅF-CTS Oy (February 2006), 'ECF-TCF Comparison'
- Beca AMEC, 'Review of ECF and TCF bleaching processes and specific issues raised in the WWF report on Arauco Valdivia'
- ensis (2005) 'Frequently Asked Questions on Kraft Pulp Mills'
- European Integrated Pollution Prevention and Control Bureau (2006), 'Kick-off meeting of the Technical Working Group for the review of the BREF on Pulp and Paper Industry - meeting notes'
- National Council for Air and Steam Improvement (December 2006), 'A review of the contemporary topics on dioxin and pulp and paper industry effluents and waste water residuals – special report no. 06-08'
- Paper Task Force (December 1995), 'White paper no.5: environmental comparison of bleached kraft pulp manufacturing technologies'
- Pulp and Paper International (August 2003), 'ECF is on a roll!'
- Pulp and Paper International (August 2003), 'It's a mature technology'
- Nordisk Papper & Massa (June 2007), 'From ECF to TCF Bleaching – a market driven switch at Botnia Rauma'
- Scientific Advisory Panel on AOX Effluent Standards in British Columbia (May 2002), 'Review of Scientific Basis for AOX Effluent Standard in British Columbia'
- Stora Enso (January 2005), 'Sustainability Facts - Pulp bleaching at Stora Enso'