

ENVIRONMENTAL FOOTPRINT COMPARISON TOOL

A tool for understanding environmental decisions related to the pulp and paper industry



WOOD USE

EFFECTS OF DECREASED RELEASE OF CHLORINATED COMPOUNDS ON LAND AND WOOD USE

Pulp Yield for ECF and TCF Pulps

While the loss of some amount of fiber in cooking and bleaching is unavoidable, overall yield can be maximized by limiting the degree of cooking, maximizing the use of bleaching chemicals that selectively react with residual lignin, and by limiting the number of bleaching stages. In general, modern elemental chlorine free (ECF) mills tend to use wood more efficiently than totally chlorine free (TCF) mills due mostly to the strong preference of chlorine dioxide to react with residual lignin relative to fibers. TCF mills generally cook pulp to a greater extent before the bleach plant (i.e., lower kappa number), rely on less selective oxidants such as oxygen, ozone and peroxide, and require more bleaching stages than ECF mills. Technologies have been developed to mitigate yield differences between ECF and TCF processes, though these add cost and complexity to mill operations.

Cooking is designed to intentionally dissolve the non-fibrous components, primarily lignin, which are subsequently removed by washing the pulp. During the cook some fibers are also dissolved and a certain amount of such loss is unavoidable. Parthasarathy (1997) points out that a linear relationship exists between yield and the kappa number domain between 20 and 85, but that below 20, reductions in pulp yield can be precipitous.

In a conventional bleached kraft mill, cooking is terminated at a level that maximizes lignin removal, fiber strength, and overall yield. Residual lignin is then removed and the pulp is brightened in a series of bleaching stages in which chemicals are reacted with the pulp followed by washing. Lower kappa number pulps are necessary for TCF bleaching, especially if peroxide is used early in the bleaching sequence. TCF bleach plants are believed to require incoming kappa numbers below fifteen, and preferably below twelve.

Current TCF sequences are likely to have lower yields than ECF sequences when the bleach sequences have the same incoming bleach plant kappa and final brightness target. Very few literature data are available, however, to enable direct comparison of yields between ECF and TCF bleaching sequences.

In 1994, Fleming and Stone advanced a number of observations on the effects of TCF bleaching on pulp quality, including yield:

- Evidence is beginning to suggest that low kappa number pulping and TCF bleaching produce lower yields of bleached pulp compared with ECF bleaching of pulps with kappa numbers of more than 20.
- Besides the yield losses caused by low kappa pulping, the literature indicates that TCF bleaching produces more yield loss than ECF bleaching.
- Pulp strength also deteriorates as kappa number is decreased in cooking. Strength loss begins below 22 kappa number in the conventional cooking of softwood....and 18 to 20 kappa number is considered the optimum operating region.
- If environmental considerations force digester kappa numbers and bleaching technology into regions where strength loss occurs, then a higher percentage of the low-yield TCF pulp must be added to the paper furnish to maintain the strength of the sheet. It decreases the amount of mineral filler, high-yield pulp, or secondary fiber that can be included and consequently further increases the amount of fresh wood that must be used to produce one ton of paper.

Effects of Decreased Release of Chlorinated Compounds on Wood Use *Pulp Yield for ECF and TCF Pulps*

Over a decade later (2006), AMEC carried out a comprehensive review of ECF and TCF bleaching processes. Among their findings were observations related to pulp yield:

- The level of delignification in cooking, the cooking process [type], and oxygen delignification determine the final pulp yield.
- The yield loss in bleaching is in the range 1-3% (on wood) and is most likely independent of whether an ECF or TCF sequence is employed.
- There is a tendency for increased yield loss if either alkaline peroxide or ozone bleaching are carried out, particularly in the bleaching of hardwood pulps.
- Because TCF bleached pulps tend to have lower oxygen-delignified pulp kappa number, they have a lower overall bleached yield than ECF bleached pulps.

References

- AMEC Ltd. 2006. *Study report for review of ECF and TCF bleaching processes and specific issues raised in the WWF report on Arauco Valdivia*. Melbourne: Beca AMEC Ltd.
http://s3.amazonaws.com/zanran_storage/www.aet.org/ContentPages/2827017.pdf
- Fleming, B. and Sloan, T. 1994. Low Kappa cooking, TCF bleaching affect pulp yield, fiber strength. *Pulp & Paper* December. http://www.risiinfo.com/db_area/archive/p_p_mag/1994/9412/94120111.htm
- Parthasarathy, V.R. 1997. Shift in pulping, bleaching strategy yields better resource utilization. *Pulp & Paper* March. http://www.risiinfo.com/db_area/archive/p_p_mag/1997/9703/focus3.htm