EFFECTS OF DECREASED RELEASE OF CHLORINATED COMPOUNDS ON ENERGY USE

Importance of Unbleached Pulp Lignin Content

Kappa number is a measure of the amount of lignin remaining in pulp. The higher the kappa number value, the higher the use of bleaching chemicals required to brighten the pulp.

The kappa numbers of pulps leaving the digester are typically about 30 for softwoods and 20 for hardwoods in bleached kraft mills that employ conventional cooking methods. Several modifications to conventional cooking, known collectively as extended cooking (EC), have enabled kappa numbers to be further reduced in the digester in ways that minimize yield and strength losses. Kappa numbers associated with EC are about 20 for softwoods and about 14 for hardwoods.

Oxygen delignification (OD) is another technology that is used extensively to lower the residual lignin content prior to the bleach plant. The technology is more selective than most extended cooking processes. Lignin reductions of approximately 50% are achievable with OD, resulting in softwood kappa number in the 14-18 range.

Some mills use both extended cooking and oxygen delignification to achieve very low kappa number pulps prior to bleaching, producing pulps with kappa number values in the range of 10-12, perhaps even lower. Deterioration of pulp strength properties is the limiting obstacle for kappa number reduction prior to the bleach plant.

More recent strategies have been focused away from obtaining the most delignification possible in the digester and toward optimizing the fiberline as a whole based on economic, quality, and environmental factors. In these strategies, oxygen delignification plays a larger role because it can provide more selective lignin removal with less yield loss than extended cooking (Stratton, Gleadow, and Johnson 2005).

An EU appraisal of the kappa number reduction capabilities of the various pulping related technologies is summarized in Table C4.

Table C4. Kappa Numbers Currently Achieved after Different Technologies Used (Source: IPPC 2001)

Delignification Technology	Hardwood	Softwood
Conventional Cooking	14 - 22	30 - 35
Conventional Cooking and Oxygen Delignification	13 - 15	18 - 22
Extended Cooking	14 - 16	18 - 22
Extended Cooking and Oxygen Delignification	8 -10	8 - 12

TCF bleaching requires a low incoming kappa number (10-12) for the pulp to attain full brightness and good strength properties because of the power of the bleaching chemicals and fiber degradation during bleaching. A final pulp brightness of 89% ISO is achievable with TCF bleaching without yield loss. A larger amount of residual lignin remains in TCF bleached pulp than in ECF bleached pulp and this residue has to be stabilized to minimize yellowing after production. ECF bleaching can be done on a pulp with a higher kappa number (IPPC 2001).)

Data tabulated by Axegård et al. illustrates the significance of unbleached pulp kappa number to the electrical energy embodied in the production of bleaching agents.

Table C5. Approximate Costs and Use of Electrical Energy for Bleaching Chemicals Consumed in Different Bleaching Sequences (Source: Axegård et al. 2003)

Post Oxygen Kappa Number	Bleaching Sequence	Bleaching Chemical Cost (USD/ptp)	Electrical Energy Requirements to Produce Bleaching Chemicals (ptp)[a]	
			kWh	kWh/Kappa
18	(C85+D15)(E_O)DED	22	160	9
18	D(E_{PO})DD	31	260	14
8	D(E_{PO})DD	22	150	19
8	QPZP	25	96	12

Based on laboratory bleaching of oxygen-delignified softwood kraft pulp bleached to ISO-brightness 90%.
[a] Hydrogen peroxide is assumed to be generated from hydrogen produced by electrolysis of water.

The tabulation shows a 42% dividend in chemical energy accompanying the 55% kappa number reduction for a D(EPO)DD bleach sequence. The 36% energy reduction for the TCF sequence relative to the ECF sequence on the low kappa number pulp is also noteworthy.

References

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