

A scenic photograph of a river flowing through a forest. The river is turbulent, with white water rapids cascading over large, moss-covered rocks. A fallen log lies across the rocks in the foreground. The background is a dense forest of tall evergreen trees. A semi-transparent green rectangular box is overlaid on the upper portion of the image, containing white text.

An Introduction – Overview Environmental Aspects Bleaching Kraft Pulps

Bleaching Effluent Parameters

- BOD Biochemical Oxygen Demand
- COD Chemical Oxygen Demand
- Color Equivalent to Chloroplatinate
- AOX Adsorbable Organic Halogen
- Toxicity Acute and Chronic

Biochemical Oxygen Demand - BOD

- Indicates propensity to deplete the oxygen supply in the receiving water
- Represents that part of the dissolved organic material that is biodegradable
- Can be decreased by decreasing yield loss, by decreasing unbleached kappa no.
- Can be nearly eliminated by adequate secondary biological treatment

Oxygen-Consuming Substances

- Can deplete oxygen in receiving waters, with adverse effects on aquatic life forms that require oxygen
- Oxygen-consuming substances in effluents are mainly organic, and are present as complex mixtures of a large number of different substances
- Consequently, they are measured as “sum parameters” including BOD and COD

Chemical Oxygen Demand - COD

- A measure of total dissolved organic material
- Not all biodegradable, so $COD > BOD$
- Measured by dichromate oxidation
- Roughly proportional to kappa number

Color

- Measured as equivalent CoPtCl_6
- Generated mainly in the extraction stage
- Unaffected by conventional secondary treatment
- Roughly proportional to kappa #

Colored Substances

- Mainly lignin and lignin degradation products originating in the pulp mill and bleach plant
- Besides being esthetically undesirable, effluent color may affect natural processes such as photosynthesis and fish movements

Adsorbable Organic Halide - AOX

- Measures chlorine that is chemically bonded to carbon, regardless of the nature of the compound containing it
- Some chlorine-containing compounds are toxic, notably dioxins and highly chlorinated phenols others are not toxic,
- Does not correlate with toxicity

AOX Components of Concern

- Polychlorinated phenolic compounds containing 3 or more chlorine atoms are toxic but can be controlled by limiting molecular chlorine use
- Dioxins (polychlorinated dibenzodioxins and dibenzofurans) are toxic in minute amounts but the formation of detectable amounts can easily be prevented

Toxicity

- Can be acute, resulting in death of the test organism within a short time, or chronic, with more subtle but nevertheless serious effects
- Generally measured in bioassays with specific test organisms, e.g., fish, daphnia, sea urchins, etc.

Factors Affecting Bleaching Effluent Parameters

- BOD, COD, Color and AOX are all roughly proportional to the kappa no. of the pulp entering the bleach plant
- BOD and COD are roughly proportional to yield loss during bleaching
- Color decreases with substitution
- AOX is roughly proportional to the number of chlorine atoms applied

Controlling AOX

- Most of the AOX is generated in the ClO_2 delignification and caustic extraction stage
- A rough rule of thumb is that 10% of the chlorine atoms applied in the first stage end up as AOX
- The corresponding figure for ClO_2 brightening stages is 2% of the Cl atoms applied

Excerpts from Cluster Rules - Treated Effluent

Parameter	Daily Maximum	Monthly Average
AOX	0.951 kg/t	0.623 kg/t
COD	Deferred	Deferred
BOD ^a	15.45 kg/t	8.05 kg/t
TSS ^a	30.4 kg/t	16.4 kg/t

^aMarket pulp, exclusive of barking, etc.

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Summary and Conclusions

- Models are available for predicting bleach plant AOX generation rate, abiotic in-mill destruction of AOX, and removal of AOX in the biological treatment system
- The models can be used to determine the relative magnitudes of effects of process changes and the approximate level of AOX discharge to be expected

Environmental Regulations

Water

- The Clean Water Act of 1977, as amended by the Water Quality Act of 1987, regulates discharges and enforces water quality standards for receiving waters
- Both the federal government and the states administer the Act, which allows states to enforce more stringent rules if they wish
- Nonpoint sources indirectly regulated
- The Act establishes effluent limitations

Effluent Limitations: BCT and BAT

- Defined in terms of technology but do not require that technology
- Dischargers of conventional pollutants (TSS, BOD and pH) must use “best conventional pollutant control technology” (BCT)
- Dischargers of other pollutants (AOX, etc.) must use “best available technology economically achievable” (BAT)

Cluster Rules

- Integrates water and air regulations into a single “cluster”
- Regulations proposed 1993, promulgated April 15, 1998
- Compliance necessary by April 15, 2001
- BAT limits on AOX, dioxins, chlorophenols, chloroform

Excerpts from Cluster Rules - Bleach Plant Effluent

Parameter	Daily Maximum	Monthly Average
2378-TCDD	ND(<10pg/L)	
2378-TCDF	31.9 pg/L	
CHCl ₃	6.92 g/t	4.14 g/t
246 TCP	ND(<2.5 µg/L)	
245 TCP	ND(<2.5 µg/L)	
11 Other CP's ^a	ND (<2.5 or 5 µg/L)	

^aall tri-, tetra- or pentachlorinated