Pulp and Paper Processing

Process Description

Pulping is the process of dissolving wood chips into individual fibers by chemical, semi-chemical, or mechanical methods, each having its own set of process inputs, outputs, and resultant environmental concerns. The particular pulping process used affects the strength, appearance, and intended use characteristics of the resultant paper product. Kraft (or sulfate) pulping processes comprise 83% of all pulping processes used in the United States. The kraft process uses a sodium-based alkaline pulping solution (liquor) consisting of sodium sulfide (Na_2S) and sodium hydroxide (NaOH).

First, a stock pulp mixture is produced by digesting a material into its fibrous constituents via chemical, mechanical, or a combination of the two. In the case of wood, the most common pulping material, chemical pulping actions release cellulose fibers by selectively destroying the chemical bonds in the glue-like substance (lignin) that binds the fibers together. The liquid byproduct from the pulping process contains the dissolved lignin solids in a solution of reacted and unreacted pulping chemicals (black liquor). The black liquor undergoes a chemical recovery process to regenerate white liquor to be reused. After the fibers are separated and impurities have been removed, the pulp may be bleached to improve brightness and processed to a form suitable for the paper making equipment. Due to environmental and health concerns with elemental chlorine (Cl_2), most U.S. pulp mills use elemental chlorine free (ECF) and, to a lesser extent, total chlorine free (TCF) bleaching technologies. Chlorine dioxide is a common bleaching agent

At the paper making stage, the pulp can be combined with dyes, strength building resins, or filler materials to add texture, depending on the intended end product. The pulp is then spread out as a wet mixture, or slurry, onto a screen. Water is removed by gravity and vacuums, and the resulting layer of fibers is passed through a series of rollers that compress the material into sheets. Paper and paperboard are created through nearly identical processes. The final paper product is usually spooled onto large rolls for storage.

Waste Streams

General water pollution concerns for pulp and paper mills are effluent solids, biochemical oxygen demand, and color. The move towards elemental chlorine free bleaching processes has dramatically decreased the toxic effluent loads of chlorinated compounds (dioxins, furans, and adsorbable organic halides (AOX)). Many mills have primary and secondary wastewater treatment systems installed to remove particulate and biochemical oxygen demand (BOD). These systems also provide significant removal of other parameters such as AOX and chemical oxygen demand (COD).

Common air emissions from pulp and paper mills include: volatile organic compounds from chip digesters and chemical recovery evaporators, fine particulate and sulfur oxides from chemical recovery, and total reduced sulfur from chip digestion, black liquor evaporation, and chemical recovery. Other wastes commonly generated in the pulp and paper industry include wastewater

treatment sludges, lime mud, lime slaker grits, green liquor dregs, boiler and furnace ash, scrubber sludges, and wood processing residuals.

Pollution Prevention Opportunities

Recent pollution prevention efforts in the pulp and paper industry have focused on reducing the release of chlorinated compounds. Many of these efforts have required substantial production process changes. Another opportunity for pollution prevention in this industry is material substitution. The current trend is to find substitutes for pulping and bleaching chemicals that are less toxic and have less impact on the environment. The pulp and paper industry is also implementing pollution prevention techniques such as dry debarking, recycling of log flume water, bleach filtrate recycle, closed screen rooms, and improved storm water management to reduce water usage and water pollutant discharges.

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Pollution Prevention Checklist

- Implement a delignification process. Delignification processes include: extended delignification, oxygen delignification, ozone delignification, enzyme treatment of pulp, or using an anthraquinone catalyst.
- Improved brownstock and bleaching stage washing to reduce the amount of bleaching chemicals required. Modern washing methods include:
    - Atmospheric or pressure diffusion washers.
    - Belt washers.
    - Pulp presses.
    - Using acid filtrates from hypochlorite or chlorine dioxide stages can be used as dilution and wash water for the first bleaching stage (counter-current washing).
    - Using second extraction stage filtrates can be used as dilution and wash water in the first extraction stage (counter-current washing).
- A spill control system for black liquor including the following:
    - Physical isolation of equipment containing black liquor.
    - Floor drainage systems that allow black liquor spills to be collected and controlled.
    - Back up black liquor storage capacity.
    - Spill sensors.
    - Enclosing washing and screening equipment.
- Improved chipping and screening to attain the appropriate chip thickness.
- Utilize oxygen-reinforced and peroxide-reinforced extraction processes to reduce the amount of chlorine and / or chlorine dioxide needed while increasing the pulp brightness.
- Using chemical application control and monitoring systems to avoid excess concentrations of chlorine based chemicals within reactor vessels.
- Investigate reuse and recycling options for the paper sludge waste.
- Seek beneficial disposal methods for secondary treatment biosolids removed during the wastewater treatment process.

- Use process chemicals that do **not** contain Nonylphenol / Nonylphenol ethoxylates (NP/NPE).
- Switch to a total chlorine free bleaching process.
- When possible cover tanks and keep all lids closed to prevent air releases
- Perform an energy use audit to identify ways to reduce energy consumption.