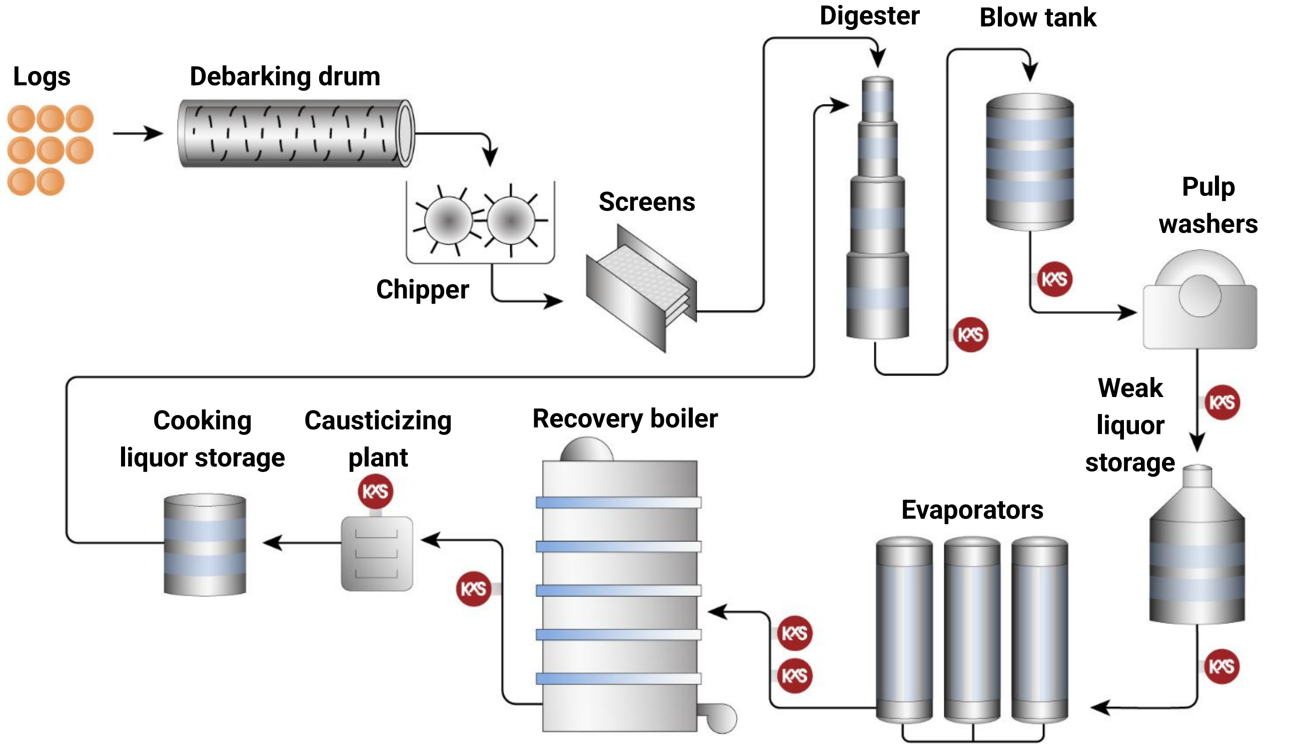
PULP AND PAPER

Overview of Kraft pulping process applications

Kraft black liquor, green liquor, brown stock



Benefits of R.I. measurement

- Reliable real-time measurements help to optimize energy-intensive operations, increase evaporator capacity, and improve white liquor quality by continuously controlling the TTA of the green liquor in the causticizing process.
- TDS changes in feed and outlet stock lines, as well as in filtrate lines, can be detected immediately. Optimizing the brown stock washing process and increasing black liquor solids content results in immediate profits, cleaner and better quality pulp for bleaching, and optimized use of water, chemicals, and energy.

Overview

The Kraft pulping process is the dominant method for producing chemical wood pulp. It involves the removal of the lignin from wood fibers using a strong alkaline solution known as white liquor (a mixture of sodium hydroxide and sodium sulfide).

The process results in black liquor, which contains dissolved organic materials and spent pulping chemicals. Efficient recovery and reuse of these chemicals is critical for energy efficiency, high-quality pulp production, and cost-effective operations.

Wood chips are fed into high-pressure digesters, either batch-operated or continuous, such as the Kamyr digester. The chips are impregnated with cooking liquors, which include warm black liquor (spent cooking liquor from the blow tank) and white liquor (a mixture of sodium hydroxide and sodium sulfide). In continuous digesters, the process is designed to complete the delignification reaction as the materials exit the reactor.

Delignification typically requires several hours at temperatures between 130-180°C (266-356°F), during which lignin and hemicellulose degrade into soluble fragments. The solid pulp, known as brown stock, is washed to separate residual cooking liquor. The combined effluent, known as black liquor, contains lignin fragments, carbohydrates, sodium carbonate, sodium sulfate, and other inorganic salts.

Fiber line and brown stock washing (BSW)

After cooking, the sulfate pulp is discharged to the blow tank and proceeds to the washing stage. Brown stock washing is essential for removing spent cooking liquors from the cellulose fibers. Typically, pulp mills use 3-5 washing stages in series, with further washing steps following oxygen delignification and bleaching.

The washing process includes thickening/dilution, displacement, and diffusion. The dilution factor represents the actual amount of water used compared to the theoretical amount required to displace the liquor from the thickened pulp. Optimizing this factor minimizes energy consumption while ensuring efficient removal of residual chemicals. Proper washing reduces organic material in the pulp suspension, lowering the Chemical Oxygen Demand (COD) and improving pulp quality.

Chemical recovery

Excess black liquor, initially containing about 15% solids, is concentrated in multiple-effect evaporators to 20-30% solids. Further evaporation raises this to 60-80% solids (heavy black liquor) before burning it in the recovery boiler to recover the inorganic chemicals for reuse in the pulping process.

Higher black liquor solid content increases recovery efficiency, but excessive viscosity can lead to fouling and equipment blockages. The molten salts (smelt) from the recovery boiler dissolve in process water, known as weak wash or weak white liquor. This weak wash, containing sodium carbonate and sodium sulfide, forms green liquor, which is recausticized with calcium hydroxide to regenerate white liquor for the pulping process.

The recovery boiler also generates high-pressure steam for electricity production and mill operations, making modern Kraft mills self-sufficient in energy.

Refractive index measurement applications

Optimizing the Kraft pulping process requires precise monitoring of critical process streams, and the KxS Retractable refractometer DCM-20 PASVE® plays a key role in ensuring efficiency and stability.

In brown stock washing, where the separation of cooking chemicals from pulp fibers is crucial for chemical recovery, the DCM-20 PASVE® provides real-time data to help mills optimize washing efficiency and reduce chemical losses.

Moving further into the recovery process, the refractometer ensures accurate black liquor concentration measurements before evaporation, preventing excessive viscosity and enabling efficient energy use. Similarly, in the recovery boiler feed, precise monitoring of black liquor solids helps mills balance combustion efficiency with equipment longevity.

Beyond these key process stages, the DCM-20 PASVE® contributes to improved green liquor clarification by providing real-time dissolved solids measurements before recausticizing. This ensures a well-balanced chemical cycle and minimizes scaling issues in the white liquor preparation process.

Throughout the mill, the ability to make real-time process adjustments based on reliable in-line refractometer data leads to reduced chemical and energy consumption, enhanced product quality, and improved environmental performance.

Instrumentation and installation considerations

Inline measurement sensors used in black liquor Dry Solids and green liquor Total Titratable Alkali (TTA) applications face extreme process conditions that can challenge measurement stability and reliability. These challenges vary depending on application and include high temperatures, pirssonite scaling, lime mud and calcium deposits, high pressures, process fluctuations, and chemical aggressiveness.

Refractometers used in these demanding environments must be purpose-built to withstand turbid, high-solids process fluids, which can scatter light and interfere with accurate measurement if not properly engineered with the right optics and advanced optical image detection software.

In black liquor applications, organic carryover and dissolved lignin can create a sticky residue on the sensor prism, impacting measurement reliability. In green liquor applications, heavy scaling can result in excessive build-up on the prism, which compromises accuracy. Purpose-built self-cleaning systems are critical to ensuring stable and reliable readings and trouble-free operation over time.

Measuring suspensions and filtrates during Brown Stock Washing (BSW) presents own kind of challenges. Standard retractable refractometers are not suitable for these applications. While automatic prism washing is rarely required, filtrates often contain fine sand, dirt, and residual wood fibers, which can be abrasive and damage the prism if the sensor is not properly shielded with mechanical protection to withstand these harsh conditions.

KxS has over 40 years of expertise in pulp and paper industry applications. This deep knowledge ensures that the DCM-20 PASVE® retractable refractometer is purpose-built to perform reliably in these challenging environments. Every aspect of its design considers the specific process conditions, fouling tendencies, and operational safety requirements.

The DCM-20 PASVE® refractometer integrates KxS's proprietary PASVE® isolation valve, an industry standard since the 1980s with over 60,000 installations worldwide. This design ensures secure process connection, superior operator safety, and minimal downtime without requiring a process shutdown during service checks.

KxS does not focus solely on product specifications, but delivers both superior technology and in-depth process expertise, making KxS the leading choice for reliable refractive index measurement in Kraft chemical pulp mill applications.