



Conductivity Measurement of White Liquor

BACKGROUND

Careful monitoring of the alkali concentration throughout the Kraft Process is very important in controlling flow rates, contact time, and ultimately cost effectiveness of the pulp mill. The Kraft Process uses strong chemicals (liquors) at very high pH to delignify the wood, turning it into pulp that can be formed into paper and paper products. Alkali concentration, expressed in terms of either active alkali ($\text{NaOH} + \text{Na}_2\text{S}$) or effective alkali ($\text{NaOH} + 1/2 \text{Na}_2\text{S}$), is the measure of how much wood can be processed for a given volume of liquor. These liquors are periodically measured using wet chemical (ABC) titrations. Electrical conductivity is an excellent adjunct to this practice since it provides an on-line measurement that correlates very well with the ABC titrations.

THE PROCESS

The Kraft Process relies on closed-loop cycles that regenerate the spent chemicals in a fairly complex manner (Figure 1). The pulping process itself takes place at 180°C (356°F) where the strong white liquor is combined with wood chips. This can either be a continuous process or a batch. The white liquor itself is produced from spent chemicals using a process called causticizing. The spent chemicals, in the form of smelt coming from the recovery furnace, are first dissolved and then clarified to remove solids. This mixture is called green liquor. Lime is added to the green liquor in a device called a slaker that regenerates the active caustic

(NaOH) from sodium carbonate (Na_2CO_3) by chemical reaction at a temperature near 100°C (212°F). This reaction is completed in large vessels called causticizers, and the product, white liquor, is then clarified before being sent to the digester. The products of the digester, wood pulp and spent liquors, are omitted from Figure 1 for the sake of clarity.

The lime used in the slaker forms solid calcium carbonate that is removed from the white liquor in the clarifier. This "lime mud" includes some white liquor that is washed from the lime mud and then used to dissolve the smelt. The lime mud itself is heated in a lime kiln to regenerate the lime for use in the slaker.

Measurements of alkali strength are useful in determining the following:

1. White Liquor Alkali - the volume of white liquor to send to the digester (more of a weaker liquor, less of a stronger one). Controlling the alkali charge to the digester is a key factor in reducing variability of the Kappa number, which indicates how well the wood chips have been "cooked."
2. Causticizing Efficiency - the amount of lime to add in the recausticizing section, where the spent liquor is regenerated for use in the digester. Sufficient lime must be added to allow the reaction to occur, but unreacted lime is hard to separate from the white liquor.
3. Green Liquor Total Alkali - the wash water from the lime mud washer contains some alkali and is used to maintain a total alkali strength prior to the slaker. The feed rate of weak wash liquor to the smelt tank is regulated to keep the density of the green liquor at the setpoint.

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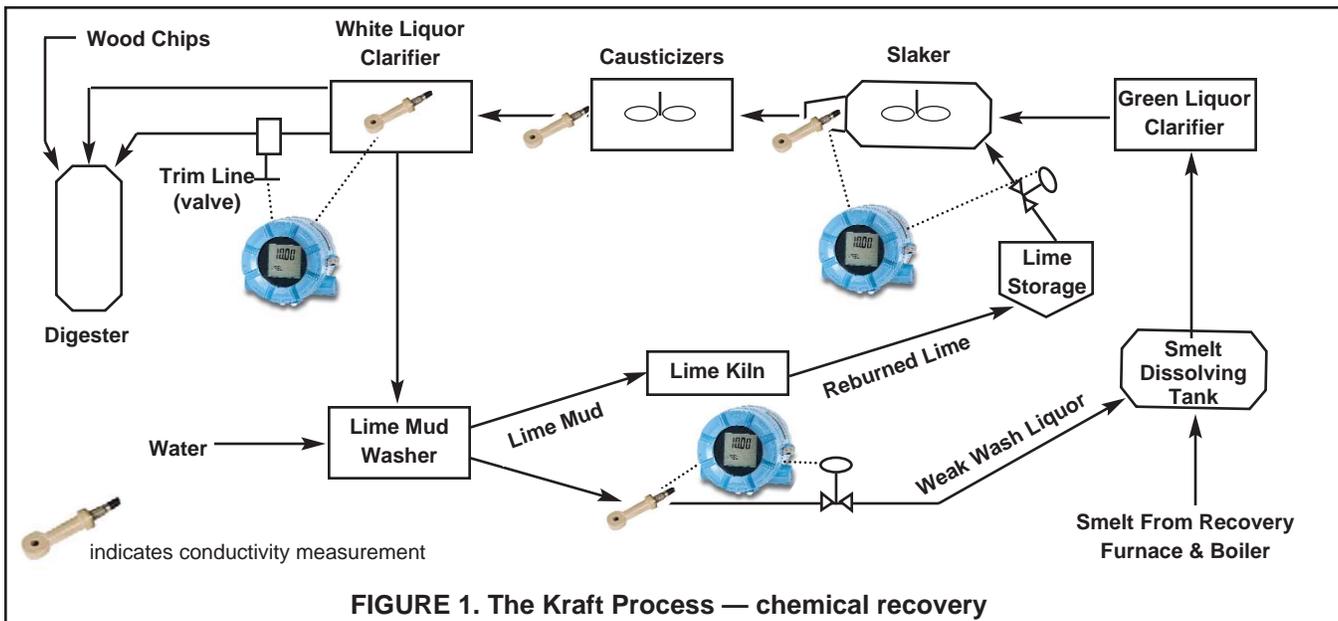


FIGURE 1. The Kraft Process — chemical recovery

THE MEASUREMENTS

Electrical conductivity is an additive and non-specific property. All acids, bases, and salts will contribute to the total value. In applications where mixtures are present, more information on the process is needed to provide quantitative information.

In general, conductivity is related to alkali strength because each ingredient in the liquor has a characteristic contribution and the total (active + spent) alkali concentration is controlled by other means. Thus, when conductivity is higher, more NaOH is present, and the liquor is "strong." When conductivity is lower, more Na₂CO₃ is present, and the liquor is "spent." Some process streams are simply diluted forms of a strong liquor and called "weak."

Each application contains varying amounts of other chemicals that contribute to the conductivity but are not considered "active" or "effective" alkali. Thus, a 450 mS/cm conductivity reading may mean a different alkali strength in each application.

THE PRODUCTS

Controlling alkali strength on-line helps decrease process variability during the intervals between chemical analysis. Preserving an accurate and repeatable conductivity reading is essential in providing feedback for this control. The sensor installed in the process must be resistant to the coating effects in the slaker and must be able to be installed in a safe and convenient manner.

INSTRUMENTATION

Model 228 Retractable Conductivity Sensor

- Convenient isolation of sensor aids in cleaning or replacement.
- Sensor is safely and easily inserted/retracted at high pressures.
- Flush ports on retraction assembly chamber facilitate sensor cleaning.
- High temperature PEEK sensor operates at temperatures up to 200°C (392°F).



Model 226 Toroidal Conductivity Sensor

- Toroidal (inductive) principle of measurement greatly reduces sensor fouling problems.
- Chemically-resistant materials withstand the effect of highly corrosive solutions.
- Large-bore design prevents plugging by solid particles.



The Rosemount Analytical **Model 226** Toroidal Conductivity sensor is ideal for use in the slaker because its large 1.87 in. bore is not easily plugged by the heavy lime solids present. The sensor is injection molded of polyetheretherketone (PEEK) and comes complete with an integral temperature compensator.

The Retractable **Model 228** sensor is designed for installation directly in the process line and is available with a unique screw and clamp design that allows safe operation at pressures up to 295 psig. It is ideal for inline applications and installation in the side of causticizer or clarifier tanks. Although smaller than its Model 226 cousin, the Model 228 is also molded of PEEK and uses the coating-resistant toroidal (electrodeless) method of measuring conductivity.

The new flow through **Model 242** sensor has an external design that does not block any portion of the process piping. This can be a great advantage in applications with solids such as lime slurries. The sensor is available in line sizes from 1" (2.5 cm) to 4" (10 cm).

Compatible toroidal conductivity analyzers include the Model 5081-T and Xmt-T DC-powered HART and FOUNDATION Fieldbus Analyzers, the Model 1055T analyzer, and the Model 54eC HART analyzer/controller. The **Model 5081T** is housed in a robust explosion-proof enclosure that is especially suited to the harsh pulp mill environment. Consult the appropriate Product Data Sheet for complete details.

Model 5081-T Two-wire Transmitter

- Automatic/Manual temperature compensation ensures accurate monitoring and control.
- Hand-held Infrared Remote Control (IRC) link activates all transmitter functions.
- AMS compatible.



Model 242 Flow-Through Toroidal Conductivity Sensor

- Now available in 4" pipe size.
- Toroidal measurement principle greatly reduces sensor fouling.
- Automatic temperature compensation with integral RTD.
- Externally-mounted toroids are protected from harsh processes.
- Modular design allows liner replacement without sensor replacement.



Emerson Process Management

Rosemount Analytical Inc.

2400 Barranca Parkway
Irvine, CA 92606 USA
Tel: (949) 757-8500
Fax: (949) 474-7250

<http://www.raihome.com>