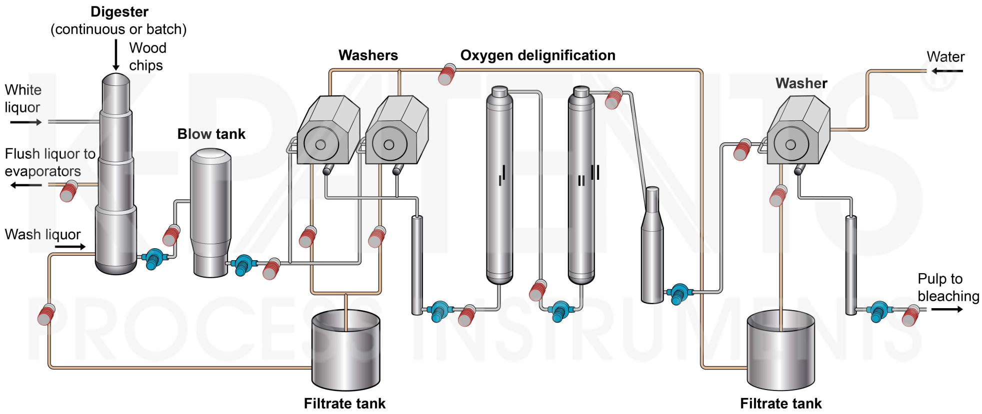
PULP AND PAPER

APPLICATION NOTE | **3.01.02**

KRAFT (SULFATE) PULP: BROWN STOCK WASHING

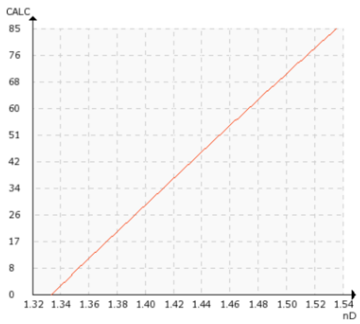


WEAK BLACK LIQUOR, BROWN STOCK WASHING FILTRATES

Typical end products

Unbleached Kraft pulp, bleached Kraft pulp.

Chemical curve: R.I. per black liquor conc% at ref. temp. of 20˚C



Introduction

Brown stock washing (BSW) can be considered the key operation influencing the economics of the pulping process, as well as the environmental load of the mill. The purpose of brown stock washing is to remove both organic and inorganic soluble compounds from the pulp suspension (brown stock), while using the lowest possible amount of wash liquor or water.

Through optimization of the brown stock washing process and raising the black liquor solids content, mills gain immediate profits, cleaner and better quality pulp for bleaching, as well as optimized use of water, chemicals and energy.

The performance of the washing process has traditionally been controlled in two main ways: using *wash loss* and *dilution factor* (DF). Wash loss refers to the quantity of washable compounds in the pulp suspension that could have been removed by washing.

The DF indicates the amount of water per ton of pulp added during washing, and which ultimately dilutes the black liquor.

Operators have found the washing process difficult to manage efficiently due to a lack of robust instruments that reliably measure wash loss in-line. For instance, conductivity is widely used for this purpose, even though it is based on the measurement of the ionic sodium species in the liquor (inorganic phase) and does not directly measure the organic phase, especially lignin and hemicellulose.

Other conventional methods also fail to measure the wash loss satisfactorily. Means of monitoring these variables, such as Chemical Oxygen Demand (COD) tests performed on the filtrate, only indicate organic compounds. Furthermore, off-line laboratory methods, such as standard dry solids analysis or COD analysis, have considerable time requirements, rendering them unsuitable for advance process control.

Total Dissolved Solids (TDS) has proven to be a reliable parameter for measuring washing efficiency, because it takes account of both the inorganic and organic fractions, thus all washable solids (real wash loss) are quantified (Figure 1). TDS can be measured in-line with a process refractometer that provides real-time wash performance information, while enabling a quick response to potential changes or disturbances in the process. The refractometer’s output can also be calibrated to read COD.

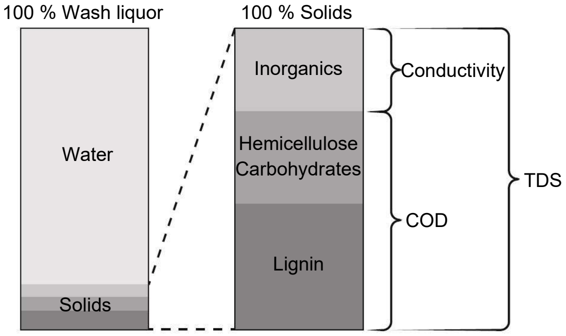


Figure 1. Comparison of measurement methods for dissolved solids in wash liquor.

Application

When examining the overall economic relationship between operating cost and efficiency, the first considerations are maximizing the solids yield due to its heat value in the recovery boiler and minimizing the dilution factor to save steam in the evaporators. The next key factors are the cost of make-up chemicals for replacing sodium losses and the cost of effluent treatment. Other important considerations include evaporator efficiency limitations in many mills and bleach chemical consumption in bleachable grade mills.

The development of K-Patents SAFE-DRIVE Process Refractometer PR-23-SD for the continuous measurement of dissolved solids content in a fiber suspension has made it possible to follow the performance of individual process steps continuously. TDS changes in the feed and outlet stock lines, as well as in incoming and outgoing filtrate lines, can be detected immediately.

Once a mill has the appropriate number of in-line total dissolved solids measurements, it can calculate and optimize its brown stock washing variables, such as the optimum Dilution Factor (DF), Displacement Ratio (DR), relative washing loss (1-Y), and the entire plant Efficiency Factor (E). This enables the implementation of upper level control in order to achieve the benefits of the full optimization of brown stock washing operations.

Digester washing zone and blow line

TDS measurement in the blow pulp suspension after the digester enables monitoring of the diffuser operation. Together with other measurements (e.g. filtrate and flush liquor) this provides the mill with the ability to control the performance of the washing zone in the digester. In addition, TDS measurement in the blow line allows the performance of the digester to be monitored, ensuring that it yields the correct concentration.

K-Patents recommends three TDS measurement points around a continuous digester: wash liquor feed to the washing zone, flush liquor outlet and blow line. The combination of these measurements facilitates continuous calculation of the mass balances and the creation of operating models of the digester.

In a batch digester, three measurement points are recommended: weak liquor inlet, liquor circulation flow and pulp out. Monitoring TDS in the liquor circulation flow of the batch digester helps to determine when the batch is ready.

Pulp feed to washers

Accurate and real-time TDS measurement within the feed pulp allows a quick response to process changes and prevents disturbances from being carried over into subsequent washing stages. Process variables, such as the dilution factor, can be controlled in accordance with the properties of the inlet pulp, and mass balances can be continuously monitored.

Washing stage

At this stage, in-line TDS measurements provide better control and help to determine the optimum dilution factor, right operation consistency and optimum concentration of solids in the stream to the recovery boiler. This prevents excess consumption of water in the washers, thus reducing the energy requirements of the evaporator and the need for make-up chemicals. Important TDS measurement points in all types of washers are the pulp inlet, pulp outlet, wash liquid feed and wash filtrate (Figure 2).

Pulp to oxygen delignification (OD)

The cost and performance of the OD process can be optimized using in-line TDS measurements. Wash loss reduction in the inlet pulp to the reactors decreases the amount of alkali. Alkali is consumed in neutralization reactions of the organic acids. In addition, the temperature of the reactor can be optimized and the amount of oxygen decreased.

Pulp discharge to bleaching

Reliable continuous measurements of wash loss in the discharge pulp make it possible to control the success of the washing process. By minimizing the wash loss, the subsequent process steps can be optimized. Lower wash loss in the outlet pulp will improve its quality while also decreasing the amount of chemicals required in the bleaching stage. Reliable

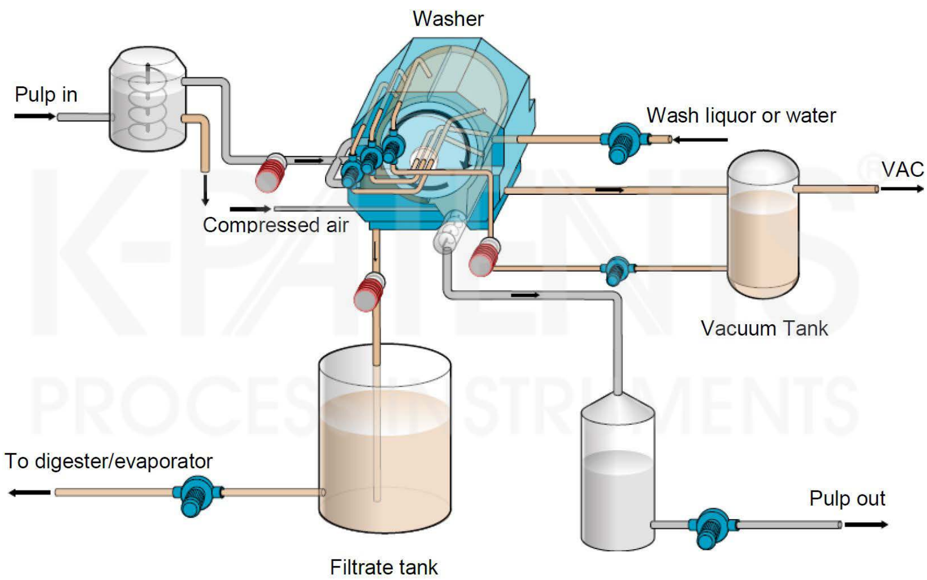


Figure 2. DD-washer control with K-Patents in-line TDS measurement.

measurements improve environmental performance and can reduce effluent treatment costs.

Instrumentation and installation

The K-Patents SAFE-DRIVE Process Refractometer PR-23-SD is installed at different points in the fiber line for real-time BSW control and optimization. There are two types of SAFE-DRIVE Process Refractometer systems specifically designed for reliability and easy installation directly in the process pipe line:

1. SAFE-DRIVE Process Refractometer PR-23-SD with Isolation valve SDI2-23-SN2-XS and steam wash for installations in the wash filtrates and weak black liquor.

2. SAFE-DRIVE Process Refractometer PR-23-SD with Isolation valve SD12-23-PL-SS and pulp line installation plate without wash for installations in the blow line and pulp stock line.

K-Patents can also provide a complete consultation service that begins with a pre-study and evaluation of the existing process, including potential bottlenecks. The service also offers recommendations on implementing total dissolved solids measurements for individual washing stages, and it provides guidance on connecting the technology to the existing process control system. The ultimate purpose of in-line measurements is to reveal the optimum changes required to achieve the greatest efficiency at each stage of the process.

Instrumentation	Description
	K-Patents SAFE-DRIVE Process Refractometer PR-23-SD for measuring black liquor dry solids and green liquor density or TTA in kraft chemical recovery process. K-Patents SAFE-DRIVE design allows for safe and easy insertion and retraction of the sensor under full operating pressure without having to shut down the process.
User Interface	Selectable multichannel MI, compact CI or a web-based WI user interface options allow the user to select the most preferred way to access and use the refractometer measurement and diagnostics data.
Automatic prism wash	Prism wash with steam, only for installations in filtrates or weak black liquor lines. The components of a steam wash system are a sensor with integral steam nozzle mounted at the SAFE-DRIVE valve, a shut-off valve for steam line and an indicating transmitter equipped with relays to drive the wash valves.
Measurement range	Refractive Index (nD) 1.3200 – 1.5300, corresponding to 0-100 % by weight.