

A RETRACTABLE PROCESS
REFRACTOMETER FOR
BLACK LIQUOR MEASUREMENT

VAISALA



Vaisala K-PATENTS® SAFE-DRIVE Process Refractometer
PR-23-SD

APPLICATIONS

WEAK LIQUOR FROM PULP WASHERS

Black liquor concentration is measured with the Process Refractometer to optimize the consumption of pulp chemicals and usage of water in the washing. The material balances can be calculated and the efficiency of the washing process can be maximized.

BLACK LIQUOR TO EVAPORATORS

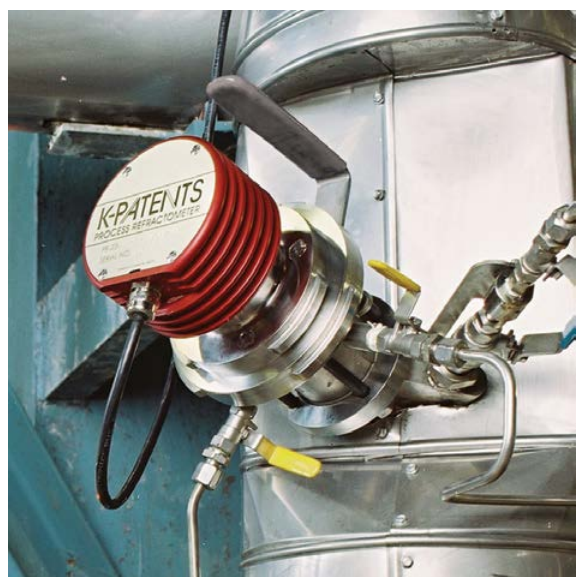
The concentration of feed liquor from washers to evaporation can be kept constant by controlling the mixing liquor with the Process Refractometer, thus allowing the capacity of the evaporators to be maximized. Using the refractometer in the intermediate stage the profitability can be increased in the form of minimized steam consumption.

GREEN LIQUOR TTA IN CAUSTICIZING

Better control of the green liquor in the causticizing process leads to increased capacity of the kraft cooking process. Green liquor total titratable alkali (TTA) content can be controlled by addition of weak wash liquor dilution. TTA has a good correlation with Refractive Index n_D , which provides an accurate measurement for the green liquor.

BLACK LIQUOR TO RECOVERY BOILER

Feeding low concentrations of black liquor solids to a kraft chemical recovery boiler burner can cause a steam explosion. The Process Refractometer measures black liquor in to prevent dangerously low black liquor concentrations from reaching the boiler.

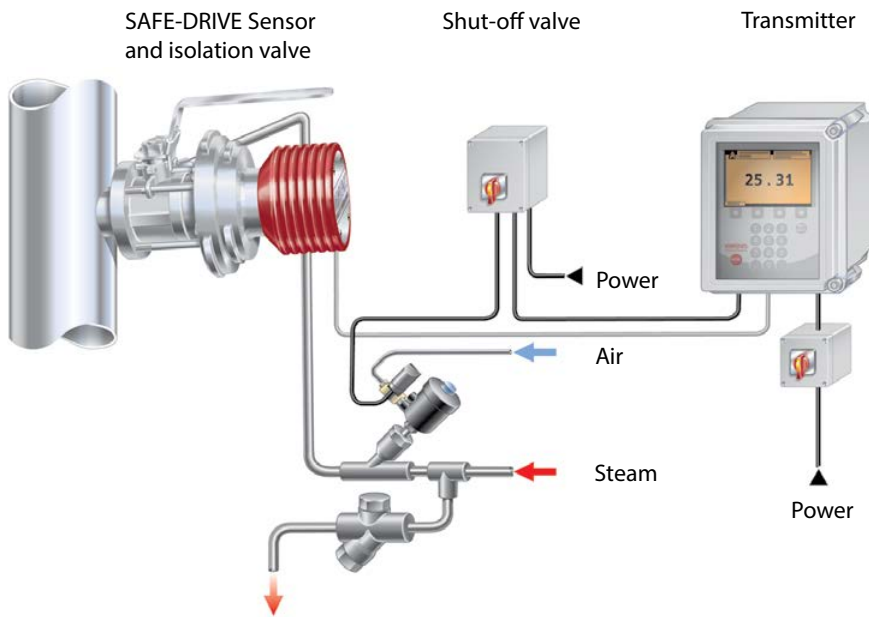


Vaisala K-PATENTS® SAFE-DRIVE Process Refractometer
PR-23-SD

SAFE-DRIVE SYSTEM

The SAFE-DRIVE Process Refractometer PR-23-SD is a complete heavy-duty system for measuring black liquor dry solids % b.w. in kraft chemical pulp mills. The SAFE-DRIVE Process Refractometer system consists of:

- Retractable SAFE-DRIVE Process Refractometer Sensor
- SAFE-DRIVE Isolation Valve
- SAFE-DRIVE Retractor
- Steam Wash system
- Indicating Transmitter



CORE-OPTICS

All SAFE-DRIVE Sensor's measuring components (light source, prism, temperature sensor and CCD-camera) are in one solid CORE-optics module. The patented CORE-optics is mechanically isolated from the influence of external forces such as temperature shocks, pressure peaks and vibration. Therefore, the CORE-optics module needs no mechanical adjustments.

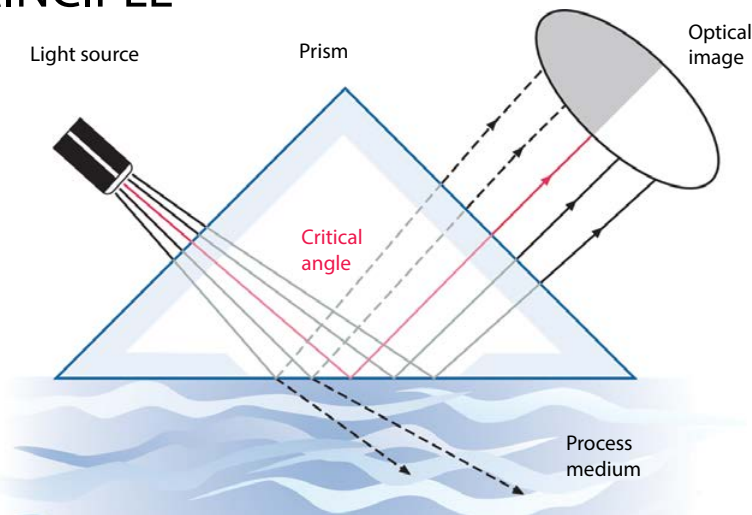
CALIBRATION

The SAFE-DRIVE Process Refractometer PR-23-SD is factory calibrated to measure refractive index n_D and temperature T in standard units. Each sensor has identical whole range calibration $n_D=1.32...1.53$ (corresponding to 0-100 %). Because the PR-23-SD sensors have identical calibration, and each sensor gives Refractive Index n_D and temperature as output, all sensors can be freely interchanged without any inconvenience of optical calibration or parameter changes.

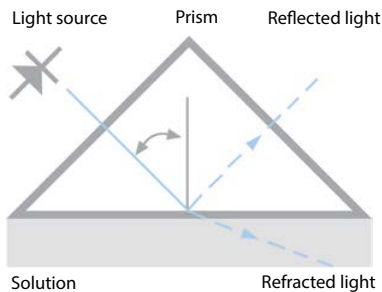
VERIFICATION

Our manufacturing process is ISO 9001 certified. We also support the verification within the user's own quality system. Each SAFE-DRIVE PR-23-SD Sensor is provided with a calibration certificate comparing a set of standard liquids to the actual sensor output. Therefore, the calibration and accuracy can be easily verified on-site using standard liquids and the transmitter's menu guided verification procedure.

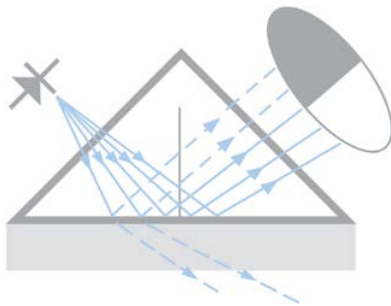
DIGITAL MEASUREMENT PRINCIPLE



The light source sends light against the interface between a prism and the process solution, where the rays meet the surface at different angles.

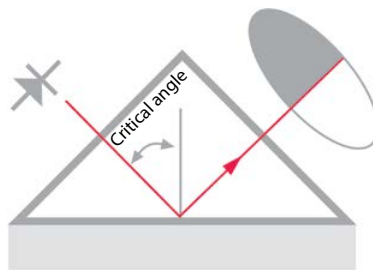


Depending on the angle, some rays are totally reflected. Some rays are only partially reflected, and most of the light is refracted into the process solution.



Thus an optical image with a dark sector and a light sector is created.

The angle corresponding to the shadow line is called the Critical angle of Total Reflection. The Critical angle is a function of the refractive index and therefore the concentration of the solution.



A digital CCD-camera detects the optical image and the shadow line. The camera transforms the optical image point-by-point to an electrical signal. The exact shadow line position is located and the refractive index n_D is determined.

A built-in temperature sensor measures the temperature T on the interface of the process liquid. The indicating transmitter converts the refractive index n_D and temperature T to concentration units.

The diagnostics program ensures that the measurement is reliable.

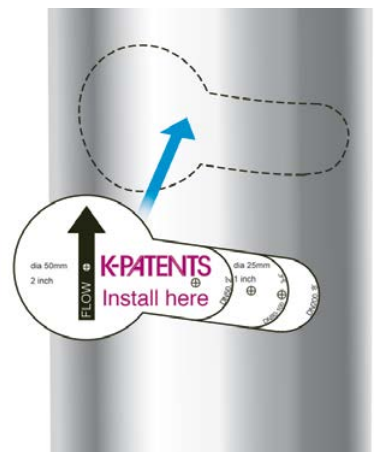
ETHERNET SOLUTION

The SAFE-DRIVE Process Refractometer PR-23-SD includes an Ethernet based communication solution which allows connection to computer networks (LAN) and to the Internet. Real-time measurement data and diagnostic information may be obtained through this interface.

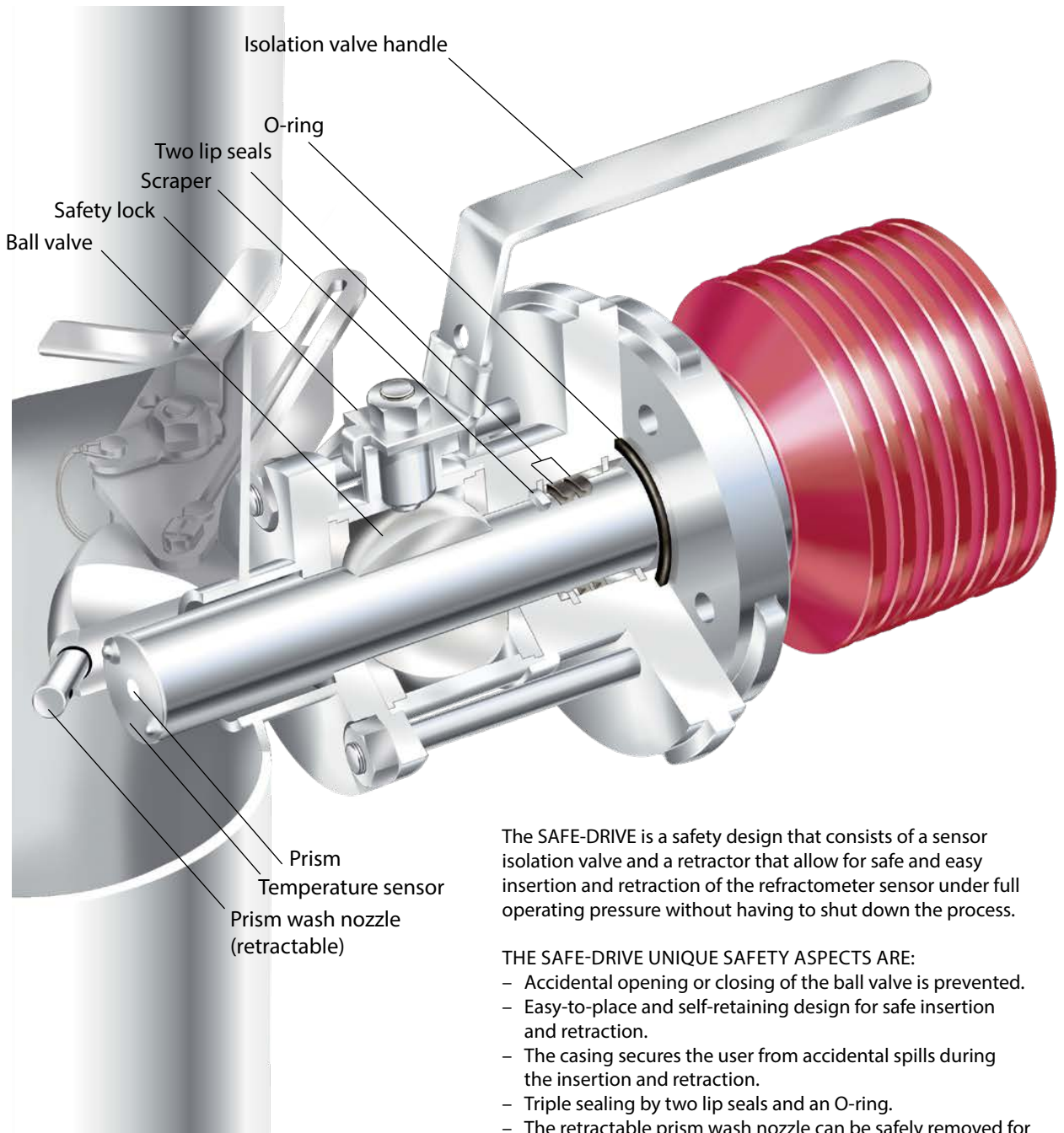
The SAFE-DRIVE PR-23-SD has also a built-in web server, which makes it possible to remotely review instrument data and diagnostics without having to go to the field.

INSTALLATION

The SAFE-DRIVE Process Refractometer PR-23-SD Sensor is very easy to install by welding to any vertical or horizontal pipe line with 2 inch or larger diameter. The need for separate spool pieces or pipe sections is minimized. A welding stencil guides the correct welding.



SAFE-DRIVE DESIGN



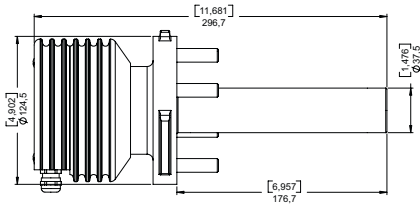
The SAFE-DRIVE is a safety design that consists of a sensor isolation valve and a retractor that allow for safe and easy insertion and retraction of the refractometer sensor under full operating pressure without having to shut down the process.

THE SAFE-DRIVE UNIQUE SAFETY ASPECTS ARE:

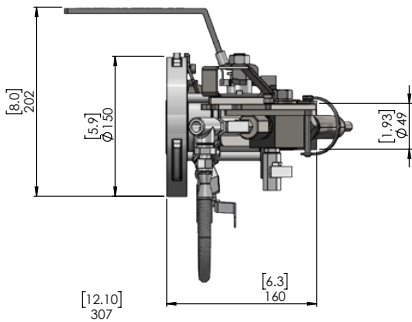
- Accidental opening or closing of the ball valve is prevented.
- Easy-to-place and self-retaining design for safe insertion and retraction.
- The casing secures the user from accidental spills during the insertion and retraction.
- Triple sealing by two lip seals and an O-ring.
- The retractable prism wash nozzle can be safely removed for service check.

SPECIFICATIONS

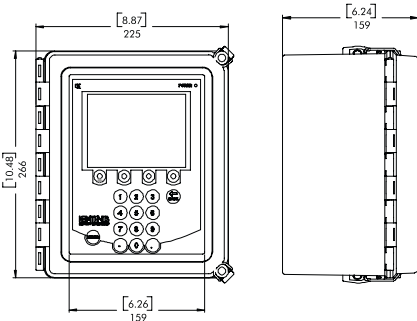
SAFE-DRIVE Sensor PR-23-SD



SAFE-DRIVE Isolation valve SDI-23



Indicating transmitter DTR



Refractive Index range:	Full range, $n_D = 1.3200...1.5300$ (corresponds to 0...100 % b.w.)
Accuracy:	Refractive index $n_D \pm 0.0002$ (typically corresponds to $\pm 0.1\%$ by weight) Repeatability $n_D \pm 0.0001$ (typically corresponds to $\pm 0.05\%$ by weight)
Speed of response:	1 s undamped, damping time selectable up to 5 min
Instrument verification:	According to ISO 9000 quality system: with standard R.I. liquids and Transmitter's menu guided procedure
Ambient temperature:	Sensor: max. 45°C (113°F), min. -20°C (-4°F) Indicating transmitter: max. 50°C (122°F), min. 0°C (32°F)
SAFE-DRIVE SENSOR PR-23-SD AND ISOLATION VALVE SDI-23	
CORE-Optics:	No mechanical adjustments
Digital measurement:	3648 pixel CCD element
Light source:	Light emitting diode (LED), 589 nm wavelength, sodium D-line
Temperature sensor:	Built-in Pt-1000, automatic digital temperature compensation
Isolation valve connection:	SAFE-DRIVE Flange ANSI 1.5 inch 150 lbs
Process pressure:	Static pressure up to 20 bar (300 psi)/operational pressure up to 10 bar (150 psi)
Process temperature:	-20°C...180°C (-4°F...350°F)
Sensor process wetted parts, standard:	SAF 2205/Duplex steel SS 2377, Werkstoff-Nr. 1.4462, UNS S31803/prism spinel, prism gaskets PTFE (Teflon®)
Sensor protection class:	IP67, Nema 4X
Isolation valve process wetted parts:	SAF 2205/Duplex steel SS 2377, Werkstoff-Nr. 1.4462, UNS S31803, AISI 316 L/ flange gasket Viton®/Lip seals Bronze Teflon® and ELGILOY/AISI301 spring
Isolation valve process connection:	By welding to pipe sizes of 2"-24", for both vertical and horizontal pipe lines
Prism wash:	Retractable steam wash nozzle with check valves
Sensor and Isolation valve weight:	10.5 kg (23 lbs)
SAFE-DRIVE RETRACTOR SDR-23:	
Retractor weight:	7.7 kg (17 lbs)
INDICATING TRANSMITTER DTR:	
Display:	320x240 pixel graphical LCD with LED backlight
Current output:	Two independent current outputs, 4-20 mA, max. load 1000 Ohm, galvanic isolation 1500 VDC or AC (peak), hold function during prism wash
Fieldbus and industrial Ethernet connectivity:	Through Fieldbus converter to Modbus/TCP, Modbus RTU and Ethernet/ IP networks
Power:	AC input 100-240 VAC/50-60 Hz, optional 24 VDC, 30 VA
Alarms/Wash relays:	Two built-in signal relays, max. 250 V/3 A
Sensor connectivity:	One or two sensors can be connected to the DTR. Sensors independent of each other: own parameter sets and usable in different applications. Two current outputs configurable independently to indicate process concentration or temperature of either sensor.
Transmitter protection class:	Polycarbonate enclosure IP66/ Type 4X (Indoor use); AISI 304 Stainless steel enclosure IP66 (Indoor use).
Indicating transmitter weight:	4.5 kg (10 lbs)
INTERCONNECTING CABLE:	IEC 61158-2 compliant two-wire cable
Interconnecting cable length:	Standard 10 m (33 ft), max. 200 m (660 ft)
PATENTS:	see www.kpatents.com
OPTIONS:	Stainless steel sensor housing, prism wash, cable fittings to the Indicating transmitter: European cable glands M20x1.5 or US conduit hubs
ORDERING INFORMATION:	<ul style="list-style-type: none"> - Desired measurement range and scale - Properties of process solution - Process temperature range - Process pipe size - Process flow rate - Supply voltage and frequency - Options and accessories

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