Pulp and Paper – Flowmeter Guide

Flow Measurement Criteria:

•Stable, accurate measurements that represent the actual flow.

•Reduce downtime and maintenance costs due to flow meter failure.

•Low total cost of ownership.

Magnetic Flowmeter Considerations:

•Noise mitigation methods for stock flows

•Material compatibility with Liquor and chemicals

•High temperature Liquor flows and permeation

There are many challenging flow measurements in a Pulp and Paper mill, from noisy stock flows, aggressive chemicals, abrasive materials, and high process temperatures, to varying steam quality and fuels. Selecting and installing the right technology and configuration is critical for effective flow measurement in the mill.

Flow Measurement Goals:
Stable, accurate measurements that represent the actual flow.
Reducing downtime and maintenance costs due to flow meter failure.
Low total cost of ownership.

Magnetic flow meters are widely used throughout the mill on stock, liquor, chemicals, lime mud and water. Magnetic flow meters are:
•Accurate
•Obstruction-less (fiber does not build up in meter)
•Can be configured with a range of materials to match process needs
•Non-plugging with no ports or impulse lines
•Full diameter with no pressure drop across meter
•Cost-effective in sizes from fractional through sizes larger than 36”
•Very low maintenance

While magnetic flowmeters are the primary flow technology in the mill, other technologies including vortex, DP and Coriolis are also frequently used to measure steam flow (Vortex and DP,) fuel flows (DP and Coriolis,) and high value chemicals and coatings (Coriolis.) These technologies will be covered in other sections.

Primary Process Flow concerns:
The primary concerns for process flows, including stock, liquor and process chemicals are process noise mitigation (impacts quality of the flow measurement and process control,) material compatibility (impacts meter life and process uptime,) and reducing the impact of permeation driven by aggressive chemicals at high process temperatures (impacts meter life and process uptime.)

Noise Mitigation Technology For Improved Stock Flow Control

Noise mitigation for improved control:

The fiber impinging on the electrodes results in high levels of noise on the electrodes, making it difficult to make consistent and accurate flow measurements. AC magnetic flow meters overcame process noise with brute force, applying full line current to the magnetic coils and generating a large signal that could be read above the noise. AC meters, however, have limited accuracy (made worse by unpredictable zero drift,) are inefficient, and are not very robust. DC flow meter technology improved accuracy, efficiency and reliability, however in some cases the signal noise caused the customer to add excessive damping to get a signal that could be used by the control system. Unfortunately, the damped signal often was not responsive enough to real changes in the flow and could not ultimately be used to automatically control the process. Rosemount has developed several noise mitigation techniques for their DC meters to overcome process noise while maintaining response including:

- Sensitive front end electrode signal conditioning
- Selectable Coil Drive Frequency
- Digital Signal Processing
- High Signal DC

Table: Process Noise Considerations

	5 Hz	37.5 Hz	37.5 HZ w/DSP
Stock Consistency	**0 – 6%**	**4 – 10%**	**6 – 10+%**
Chemical addition	**Add 1% point for chemical addition**		
Fiber Length	**Short fiber (recycle): subtract 1%**	**Medium fiber (writing paper): no change**	**Long fiber (container board): add 1%**
Velocity (normal flow)	**Less than 3 ft/s: subtract 1%**	**Between 3 and 10 ft/s: no change**	**Exceeds 10 ft/s: add 1%**
Viscosity	**Low Viscosity: no change**		**High Viscosity: add 1%**
Solids content	**No change when low solids content**		**Add 1% when large solids (knots, staples, etc.) are present**

This chart provides some basic considerations for when to use the default 5hz coil drive frequency, when to change the frequency to 37.5 hz and when DSP may provide additional noise mitigation. (Selectable coil frequency and DSP are standard features on the E-Series 8732 and 8712 transmitters.) If, for example, the customer is measuring a 5% stock at a velocity over 10 ft/sec with knots and staples, the effective stock consistency would be 5%+1%+1%, or 8%. If the signal appears noisy, the customer may want to move the coil drive frequency from the default 5 Hz to the higher coil drive frequency of 37.5 Hz. This change is easily done through the LOI, a 475 hand held or AMS. (Note: The transmitter must be Auto Zeroed whenever the coil drive frequency is changed. This is done after the frequency has been changed and with the tube full, and is also initiated through the LOI, 475 or AMS. Auto Zeroing initializes the transmitter and establishes a new zero reference at the new frequency.)

Typically, magnetic flowmeters operate at a fixed coil drive frequency. The flowmeter coils are pulsed at a low frequency, creating the magnetic fields used to measure flow and are optimized at a frequency that provides stable flow measurement of most chemical fluids. (Rosemount magnetic flowmeters are factory set for standard operation at 5 hz.)

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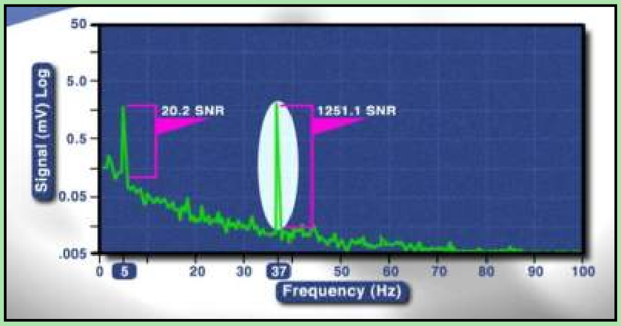
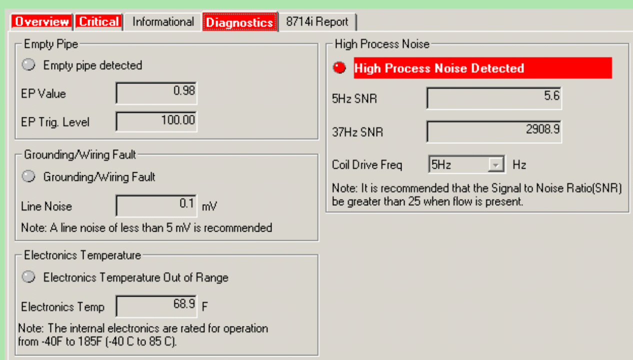
Impingement noise common to stock flows is typically highest at low frequencies, and decays naturally as the frequency increases, resulting in high levels of noise at the normal operating frequency of most magnetic flowmeters. The higher level of noise compared to the flow signal results in lower signal to noise ratios and inaccurate, irregular flow measurement.



- *Most magnetic flowmeters operate at low coil drive frequencies, where impingement noise can result in low signal-to-noise ratios*
- *Rosemount's selectable frequency capability allows the mill to increase the coil frequency to a frequency with less impingement noise, resulting in a higher signal-to-noise ratio*

Advanced Diagnostics Detect High Process Noise

The optional E-Series advanced flowmeter diagnostics include a process noise diagnostic, which monitors the signal to noise ratio and indicates when the ratio has fallen below acceptable levels for good control. The operator can access the signal to noise ratios at both available frequencies through the Local Operator Interface (LOI) or through AMS, and can easily change coil drive to the frequency that provides the strongest signal. (Note: For best performance, flowmeter must be auto zeroed when the coil frequency is changed.)



High process noise diagnostics via the LOI or AMS

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Material Selection for Extended Life and Improved Process Uptime

Selecting the right Materials

Selecting the best liner and electrode materials for the process is critical to extending the life of the flowmeter and reducing issues associated with meter failure. The harsh chemicals including caustic and high concentration bleach chemicals, high process temperatures and abrasion due to pulp stock solids provide unique challenges. Teflon is the most commonly used liner material in the mill due its good resistance to chemicals and abrasion. (Less expensive liner alternatives can provide good service in utility and water applications.) Electrode materials can be matched to provide corrosion resistance for the specific chemicals. Beyond basic material selection, the mill can take additional steps to significantly extend meter life in the most challenging applications.

- Combination of high temperature and harsh chemicals can increase permeation of Teflon liners
- Permeation shows up as "blisters" or "bubbles" and can cause premature failure and reduced up-time
  - Permeation rates are driven by temperature gradients

Teflon Blistering in a High Temperature
Black Liquor Application

High Temperature Liquors and Permeation

Black and White liquor are the most aggressive applications in the mill as the combination of high temperature and harsh chemicals can drive permeation in Teflon liners. Permeation is the molecular diffusion of a fluid or vapor through the liner over time, and shows up as "blisters", or "bubbles" and can cause premature failure and reduced up-time. Permeation rates can be effected by temperature gradients where the heat moves from the hot process fluid towards the ambient surroundings, driving fluid permeation. The movement within mills to increase production and efficiency by increasing temperature increases the incidence of permeation. Resistance to permeation can be increased through selection of the correct Teflon resin, manufacturing the liner in a manner that increases resistance, and increasing the amount of liner that must be permeated. (Resistance to permeation is increased proportionally to the square of the thickness.) Another method for reducing the rate of permeation is to reduce the temperature variation between the process and ambient, and will be covered later in this guide.

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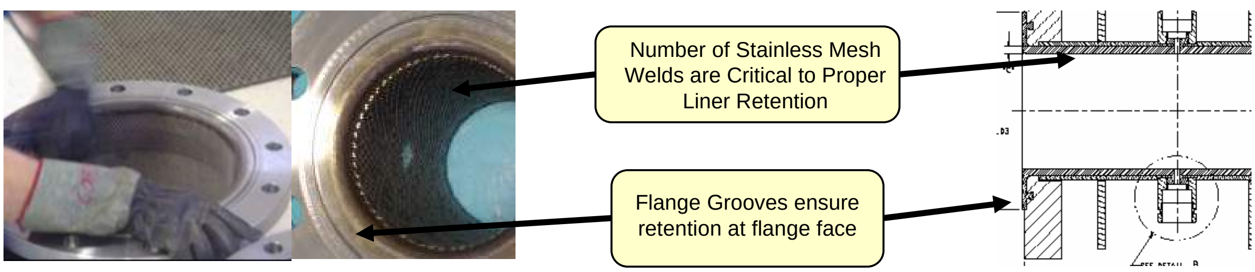
Liner Materials and Manufacture

There are many different Teflon resins and processes for manufacturing liners. PTFE is the most common form of Teflon, and generally the best value for most mill flows. When choosing a PTFE liner, select a PTFE liner that is sintered at very high pressures. This manufacturing process randomly meshes the crystalline structure of the Teflon, increasing the liner strength and providing additional chemical resistance. The most common method for forming PTFE liner sleeves is to mold the liner, which results in a directional crystalline structure which is weaker and less resistant to permeation. Rosemount uses a thick sintered PTFE liner on wafer and flanged flow meters.

- Sintered PTFE Teflon Liner Sleeves
  - **Sintering** under high pressure adds strength and resistance to permeation
  - **Thicker liner** increases resistance to permeation proportionally to the square of liner thickness.
- Virgin Transfer Molded PFA
  - No recycled PFA improves liner integrity
  - Stainless Liner Retaining Mesh with more spot welds for better retention
  - Flange Retaining Groove

PFA Teflon exhibits similar superior chemical resistance as PTFE Teflon, with improved physical characteristics including higher temperature ratings and higher resistance to permeation. PFA liners should be pure, with no recycled material used as this can result in impurities and voids which can reduce the resistance to permeation. Transfer molding results in a thick, uniform liner which has maximum resistance. A stainless steel retaining mesh welded to the flowtube and retaining grooves are used to secure the liner. PFA liners can extend the useful life in high temperature/aggressive chemical applications, such as hot black liquor in the digesters and the black liquor flow to the recovery boiler.



Reducing the Impact of Permeation

Installation Methods to Reduce Permeation

There are a number of applications in the mill at elevated temperatures. In our experience, gained working closely with our customers, the life of a mag meter can be extended by taking steps to reduce the rate of permeation. Temperatures as low as 95C (or about 200F) can increase the rate of permeation and reduce meter life. The best practices that apply most often include:

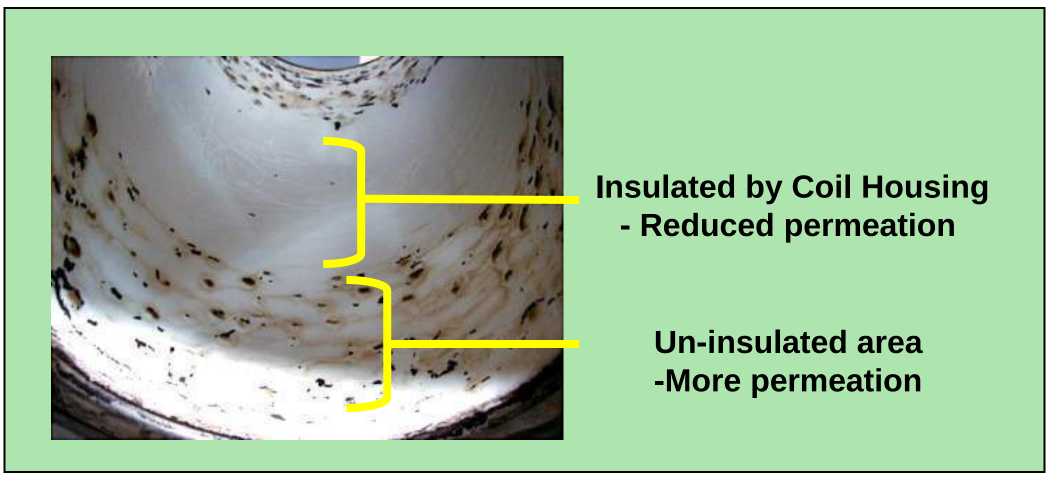
•Use only high quality sintered Teflon liners – and thicker liners are better!

•Use high temperature options, like the TA option on 8700 flanged magnetic flow sensors, that channel any fluids that permeate away from areas where they can cause failure.

•Insulate the flow sensors to reduce the temperature difference between the process and the ambient temperature. This gradient drives permeation.

TA Option

Overtime, permeation will result in some fluid passing through the liner to the inside of the sensor. The TA option provides a path that channels the permeate away from active components, further extending the life of the flow sensor.



Teflon Blistering in Insulated and Un-Insulated Meter Sections

Insulation to Reduce Temperature Driven Permeation

The picture shows the inside of a flow sensor where permeation contributed to failure. The dark spots located on the ends of the liner are due to permeation of the Teflon. You can see that the center of the liner is clean with no visible permeation blisters. This is due to the insulating effect of the coil and housing, which keeps this area of the sensor at a temperature closer to the process temperature (less temperature gradient.) Insulating the sensor between the coil housing and the flange will reduce the temperature gradient and slow the rate of permeation.

Flowmeter Guidelines for Pulp and Paper

The following tables contain guidelines for material selection for typical mill applications. These guidelines are for consideration only. Ultimate responsibility for material selection remains with the end user.

The data presented in this guide is based on field experience and published data. However, because of the wide variety of processes and applications it is impossible to guarantee material compatibility in a given process without performing corrosion tests under actual operating conditions. Therefore the final decision on materials resides with the user.

General Application Guidelines

Application	***Liner***	***Electrode***	***Other***
Pulp Mill – General Purpose	PTFE	Nickel Alloy 276	
Bleach Plant – General Purpose	PTFE	Nickel Alloy 276	
Paper Machine – General Purpose	PTFE	Nickel Alloy 276	
Lime Kiln	PTFE	Nickel Alloy 276	

Exceptions to the General Guidelines

Application	***Liner***	***Electrode***	***Other***
Black Liquor (High Temperature)	PFA	Titanium or Platinum	
Black Liquor to Recovery Boiler	PFA	Titanium or Platinum	
Green Liquor	PTFE	Titaniu	
White Liquor	PTFE	Titaniu	
Lime Slurry	PTFE	Titaniu	
Sludge Press/Lime Sludge after Kiln	PTFE	Titaniu	
Chlorine Dioxide	PTFE	Titaniu	
Hydrogen Peroxide	PTFE	Titaniu	
Sodium Hydrosulfite	PTFE	Titaniu	
Water	Neoprene	Nickel alloy 276	
TMP Pulp	PTFE	Nickel alloy 276	

Flowmeter Selection Guidelines for Other Flows

Application	***Technology***	***Comments***
Stuff Box Chemical Feed	MMI Coriolis	High value fluid, Drip flow
Saturated Steam	8800MV Mass Vortex	Energy Use
Superheated Steam	3051SMV Mass DP	Energy Use
Gas and Fuel Oil	MMI Coriolis or 3051SMV	Fuel efficiency, Fuel Cost
Coatings/ Coating Kitchen	MMI Coriolis of Magnetic Flowmeter	High value fluid, Density

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