GE Sensing

Ultrasonic Flow Measurement for Resid

Abstract

Measuring the flow of Resid to Coking and Vacuum Distillation Furnaces, presents a challenge for conventional measurement technologies. Coke Fines in these feed streams create significant plugging problems. This presentation focuses on one refinery's efforts to improve the reliability and performance of this measurement. Further, how Bundled Waveguide Sensor Technology facilitated the virtual elimination of flowmeter maintenance, significantly reduced the risk of shutdown and drastically improved the performance and reliability of the flow measurement. The presentation will also address the limitations of vortex and wedge meter technologies, when used for this application.

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Application Details

- **Applications/Issues:**
  - **Delayed Coker and Vacuum Distillation Furnace Feeds**
  - **Flow measurement of Heavy Crude feed streams, containing coke fines.**
  - **Improve Reliability.**
  - **Reduce the Cost of Maintenance.**
  - **Reduce the Risk of Unit Shutdown.**

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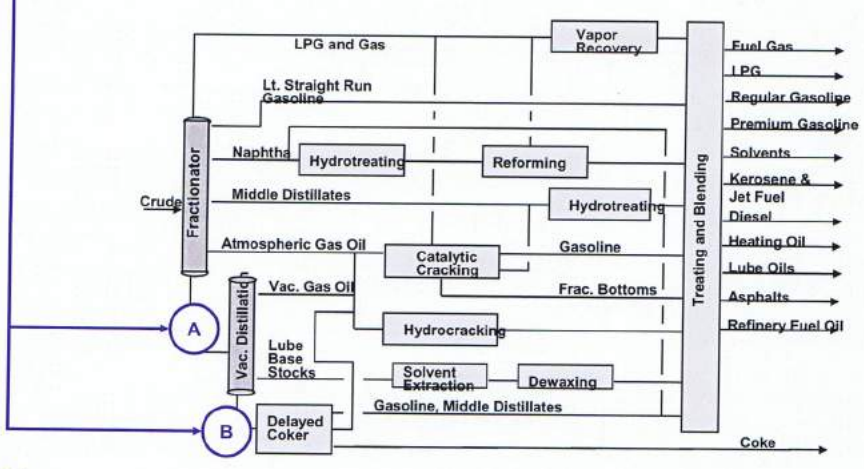
Application Details

Focus on Furnace Feeds



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Application Details

- Meter Requirements:
  - DC Furnace Feed
    - 3" 600# RF SCH XXS
    - Flow: 0 –600 SBPH
    - Pressure: 420-700 psig
    - Temp: 620-680 deg F
  - VDU Furnace Feed
    - 4" 300# RF SCH 120
    - Flow: 0 –1200 SBPH
    - Pressure: 258-285 psig
    - Temp: 656-710 deg F
- Available Technologies
  - Vortex
  - DP
  - Other….

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Application Details

- Metering
  - Typical meter types include Vortex and Wedge meters
  - Existing Flow Measurement Technology: Vortex
- Installation
  - Eight lines feed VDU and DCU
    - Improves heat transfer in unit
    - Lines are flashed into furnace at low pressure
  - Loss of flow to furnace will cause shutdown
    - Prevents damage to unit
    - Requires hydro blast to clean
- Safety guidelines
  - If unit loses two of eight flows, the furnace would trip and shut down the unit

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Application Details

- Issues with Vortex installation
  - Dual head meter had difficulty with the application
    - Flow deviation between dual head readings
    - Flow read as zero with no response to valve opening
  - To prevent unit shutdown, maintenance was required.
    - Bypass opened to allow steam cleaning of meter
    - Some meters would not recover when put back in service
  - Full time maintenance was required for both the VDU and DCU applications.

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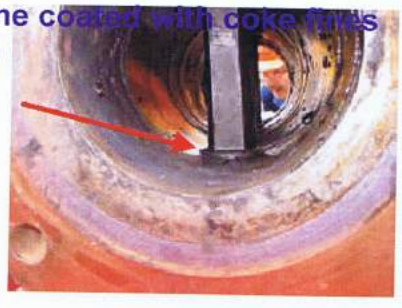
Application Details

- Diagnosis
  - The integral design of the electronics was considered a possible issue, due to exposure to extreme process temperatures. Steam cleaning the line brought the meters back into operation, suggesting temperature was not the primary issue.
  - Vortex bluff body became coated with coke fines and particles interfered with bluff body movement, making the measurement unreliable.



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Resolution

This customer sought a more reliable flow measurement technology, to replace the existing vortex applications. Eliminating failures to reduce maintenance cost, was the primary goal.

DP Meters:
Known to work in industry. Potential for clogging due to DP restriction and impulse lines.

Ultrasonic, Transit Time:
Unknown performance at the time with promising benefits. Test unit/installation was commissioned for evaluation.

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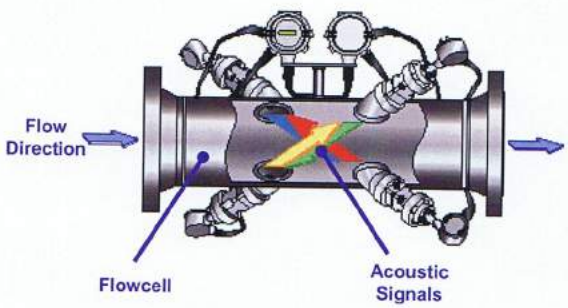
Ultrasonic Flow Meter

The Technology: Transit Time

Flow = Distance / Time
Distance = Flowcell Section Dimensions
Time = Time of flight of ultrasonic signals



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Ultrasonic Flow Meter

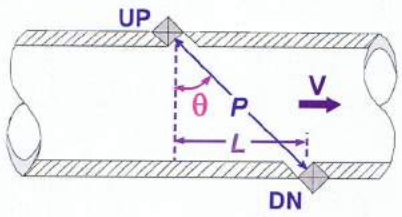
The Technology: Transit Time

Flow = Distance / Time
Distance = Flowcell Section Dimensions
Time = Time of flight of ultrasonic signals

$$V = \frac{P^2}{2L}\left(\frac{1}{t_{dn}} - \frac{1}{t_{up}}\right)$$

Q = Velocity × Cross-Sectional Area

$Q = V \times A$



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Ultrasonic Flow Meter

The Technology: Transit Time

- **Advantages of Ultrasonic Flow Measurement Technology**
  - **No Obstruction**
  - **No Pressure Drop**
  - **No Moving Parts, Nothing to Wear Out**
  - **Accuracy and Repeatability are stable**
  - **High turndown (1 ft/s to 40 ft/s) w/ Excellent Low-End Resolution**
  - **Maintenance Required: Average…Once every (2) years**
  - **Sensor is Retractable, Under Flowing Conditions**
  - **Single, Redundant and Triple-Redundant Configurations Available**
  - **Retrofits: Match Face-to-Face of existing meters**

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Ultrasonic Flow Meter

Temperature Limits

Flowmeter transducers use Piezoelectric crystals. These have a temperature limitation. Exposure to temperatures above 400F, will permanently damage
the sensor.

Solution: The transducer must be relocated, away from the process heat.

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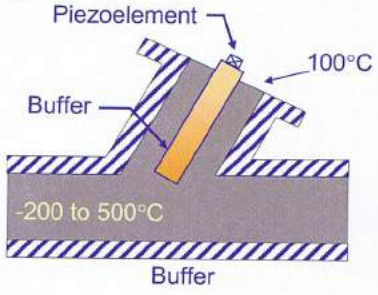
Ultrasonic Flow Meter

Temperature Limits

Initial Solution: Solid Buffer Rod

By placing a buffer between the sensor and process heat, the sensor is isolated from the process heat. The challenge was to design a buffer, capable of producing an adequately strong signal to the process fluid.



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Ultrasonic Flow Meter

Temperature Limits

Initial Solution: Buffer Rod

- Solid Buffers work well for High Frequencies
- High Temperature Liquid applications require lower frequencies:
  - 0.2 to 1.0 MHz
  - Requires significantly wider solid buffer to avoid dispersion
  - Challenge to find small diameter buffer

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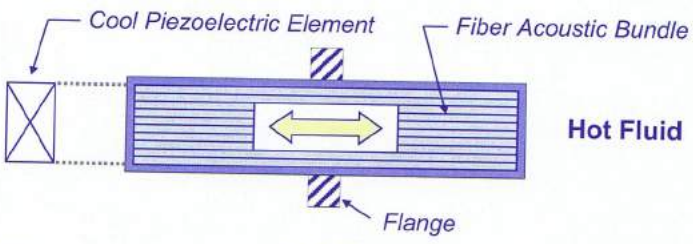
Ultrasonic Flow Meter

Temperature Limits

Ultimate Solution: Bundled Waveguide Technology

- Bundled Waveguide Technology™ (BWT)
  - Uses large number of thin metallic conductors to efficiently transmit the ultrasonic signal
  - Analogy: Fiber optics



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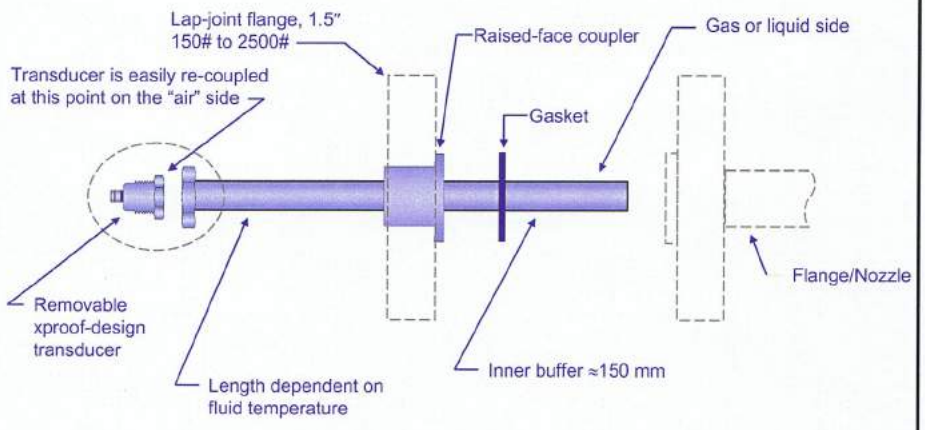
Ultrasonic Flow Meter

Bundle Waveguide Technology™ (BWT)



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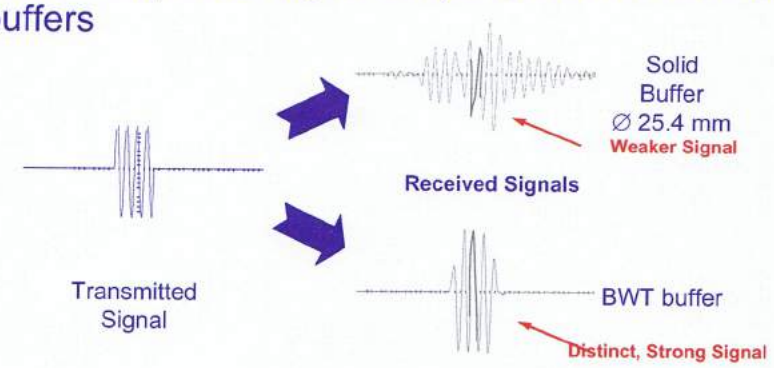
Ultrasonic Flow Meter

Bundle Waveguide Technology™ (BWT)

BWT™ improves signal shape and SNR over solid buffers



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BWT - Summary

BWT SYSTEM	
Applications:	>1200 World-Wide
Installation:	Wetted: Flanged, Socket-Welded or Threaded
Max Temperature:	600°C
Min Temperature:	-200°C
Pressure Rating:	150# - 2500#
Material:	316 SS, Ti
Fluid Types:	LNG, Gas, Steam, Liquid, 2-phase sonically conductive
Frequencies:	0.2, 0.5 & 1.0 MHz

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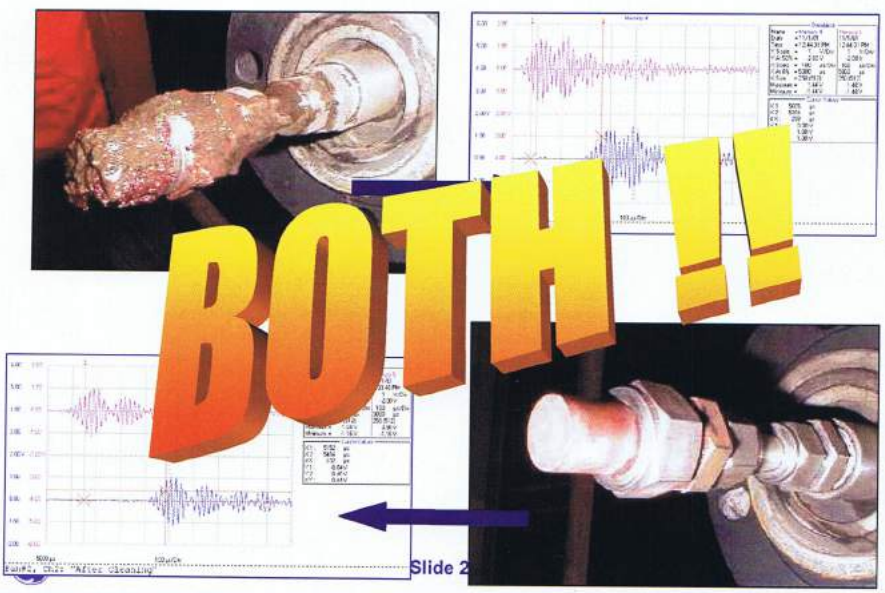
Which transducer works?



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Tolerant to Fouling

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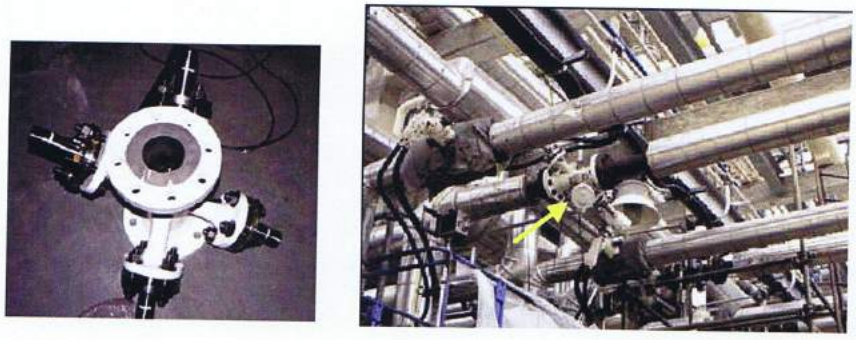
Ultrasonic Flow Measurement for Resid

Test meter on Atmospheric Bottoms flow to the Vacuum Distillation Feed.



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Ultrasonic Flow Measurement for Resid

Test/Evaluation results:

- Installation Straightforward
- Solid performance over two weeks
- Decided to move forward to replace vortex installations in Delayed Coker and Vacuum Distillation Furnace Feed Lines.

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Ultrasonic Flow Measurement for Resid

4-Year History:

- Failures: 1 Keypad failure
- No flow measurement failures
- Units never shutdown, due to 2 out 3 voting
- (0) Loss days, due to meter failure
- Words of End User: "We never touch those meters."
- Routine: Verify diagnostics periodically to monitor health of the meter

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Coker Furnace Feed Applications/BWT Users List (partial)

1. ConocoPhillips Sweeny, TX (Coker/VDU Furnace Feeds)
2. Tesoro Martinez, CA (New Installation)
3. ExxonMobil Torrance, CA (New Installation)
4. BP Torrance, CA (New Installation)
5. Shell Per+ The Netherlands
6. YPF Mendoza, Argentina
7. Shell Anacortes, WA (Asphalt Unit)
8. Marathon Garyville, LA (Vacuum Bottoms)
9. Chevron Pascagoula, MS (Vacuum Bottoms)

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Ultrasonic Flow Measurement for Resid

Conclusion:

For over (4) years, the Ultrasonic meters have provided a reliable measurement, requiring virtually no maintenance or downtown. BWT™ technology is not susceptible to the plugging problems that plague vortex or differential pressure technologies.

Significant Maintenance Cost Savings were realized, due to the installation of Bundled Waveguide Technology.

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Ultrasonic Flow Measurement for Resid

Cost Savings Analysis

Assumptions:

- Approximately (1) Vortex failure or maintenance cycle per week
- 90% of these incidents were addressed with steam blow down
  - (2) Operators required, to bring the application back
  - Up to (4) hours labor required
- 10% of these incidents required removing the meter from the process
  - Up to (5) Operators, Pipe Fitters, Instrument Tech's required
  - Up to (6) hours labor required
- Labor Cost Average: $50/hr

Annual Cost to maintain Vortex meters:

	Failures	Hours Work	Labor rate	# People	Cost
Steam clean	47	4	$ 50.00	3	$ 28,200
Pull out	5	6	$ 50.00	5	$ 7,500
Total Failures:	52	Total Annual Maintenance Cost:			$ 35,700

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Ultrasonic Flow Measurement for Resid

Bundle Waveguide Technology™ (BWT)

Two Path PanaFlow featuring BWT™ technology.

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Ultrasonic Flow Measurement for Resid

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