Ultrasonic Transit Time Flow Measurement for Coker Furnace Feed

Coking.com
Safety Seminar
Galveston 2008

Application

- Delayed Coker Furnace Feed: Coke Fines produced in this process are recycled through the furnace. These particles promote coating and inhibit flow, which create multiple problems for conventional flow measurement technologies.
- This presentation focuses on one refinery's efforts to reduce maintenance costs and improve the reliability and performance of this measurement.

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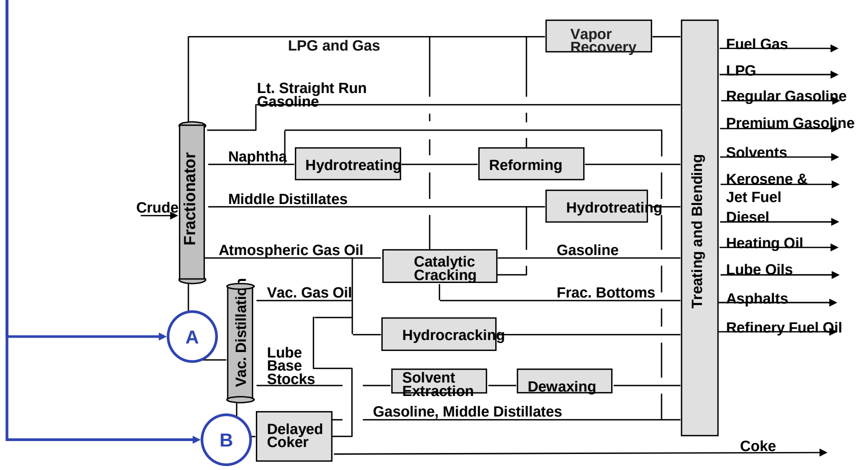
Objectives

- Reduce Maintenance Costs
- Improve Reliability
- Increase Production and Efficiency
- Reduce the Risk of Shutdown and Trips

Application

- Focus on Furnace Feeds



Application Details

- Application Data:
    - 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

- Initial Flow Measurement Technology Choice:
    - Vortex

Application Details

- Furnace Design
  - (8) pass lines per furnace (VDU and DCU)
  - Redundant Flow Measurements for each line
- Shutdown Logic
  - Loss of (2) pass line flow measurements, shuts the unit down

Application Details

- Vortex Performance
  - Unreliable:
    - Flow rate deviation between meters in same pass line
    - Some meters were unresponsive to valve opening and closing
    - Shedder bar caused plugging problems
  - Action Required:
    - Steam bypass opened to clear pass line

Application Details

Diagnosis:

- Integrally mounted electronics was considered a possible issue, due to exposure to extreme process temperatures.
- Clearing the line with steam restored feed flow and brought most meters back into operation, suggesting temperature was not the primary issue.
- Some meters would and some would not recover, when put back into service.

Application Details

- Diagnosis:
  - Vortex bluff body became coated with coke fines and solid chucks. Coke particles interfered with bluff body movement, rendering the measurement unreliable.

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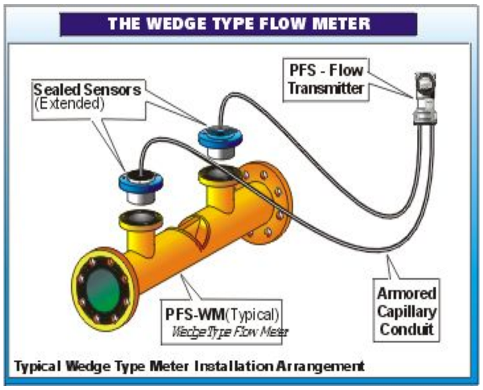
Alternatives

- This customer sought a more reliable flow measurement technology, to replace the existing vortex applications. Reducing maintenance cost, was the primary goal.
- Differential Pressure (Wedgemeters): Common Flow Measurement Technology for this application. Causes some degree of plugging and requires a high degree of maintenance



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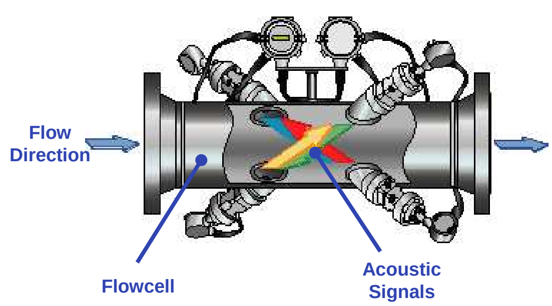
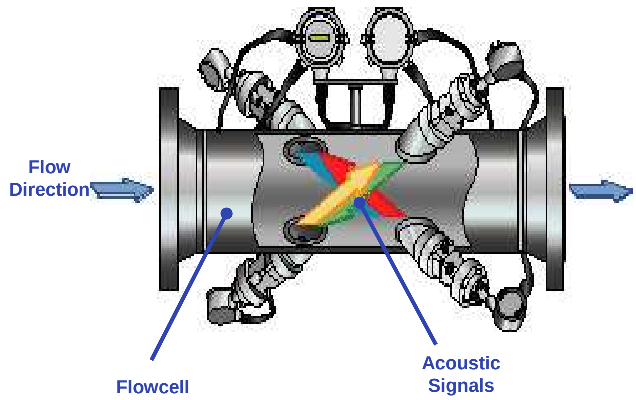
Flare Gas Flow Measurement Technology

Alternatives

- Ultrasonic, Transit Time Technology: Identical Flow Measurement Technology on flare gas. Unproven history with furnace feed applications, but with promising benefits. Test unit was commissioned for evaluation.

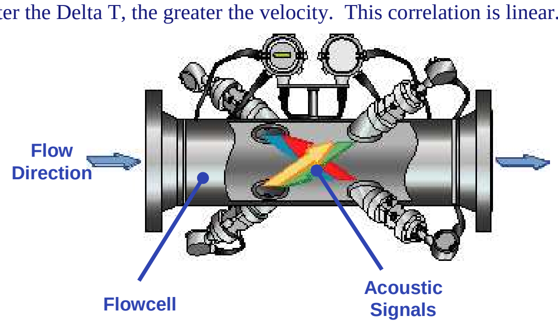


How Transit Time Technology Works



Ultrasonic Transit Time Flow Measurement Technology

-Each flow measurement requires (2) Sensors (one pair) and (1) Transmitter. A Redundant configuration is shown below. In principal, a pair of Sensors are mounted directly across the process line from each other and though 1 ½” flanged nozzles. In addition, one Sensor is always mounted, upstream from the other. An Element residing in a sensor is “hit” with mV/electronic pulse from the transmitter to produce a sound pulse. This sound pulse travels to the other sensor. When sound “hits” a sensor, it produces a mV/electrical pulse back to the transmitter, facilitating the measurement of “Transit Time”, between the sensors. The system alternates in sending and receiving pulses to continually measure the difference in transit time….upstream, then downstream…and so on (the signal traveling downstream and with the flow, will arrive milliseconds sooner than the pulse traveling against the directional flow). This difference in Transit Time, is directly proportional to the velocity of the flowing fluid. The greater the Delta T, the greater the velocity. This correlation is linear.



Existing Sensor Technology

•Standard Sensors have Temperature Limits of 536F, or less. Higher temperatures will damage the sensor

•Redesign Sensor Configuration: Design a sonic conductor (buffer), capable of transferring sound from the sensor into the high temperature fluid, enabling relocation of the sensor out of the process heat

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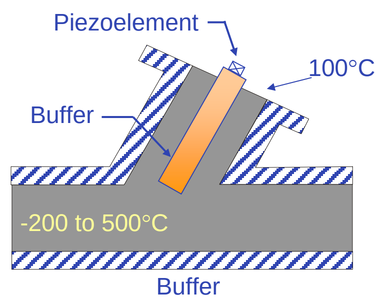
Buffer Design

Initial Solution: "Solid Buffer Rod"

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



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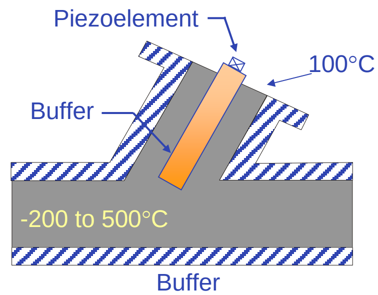
Buffer Design

Initial Design: Solid Buffer Rod

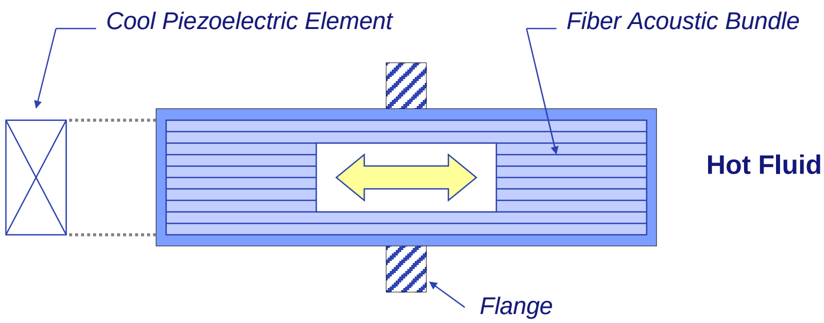
-1", Solid Rod Buffer works well for high frequencies (5MHz)
-High Temperature Liquids require lower frequencies (200 KHz to 500 KHz)
-Lower Frequencies require wider buffers to avoid dispersion
-Find a solution for a 3 to 4 inch line size.



Buffer Design

Ultimate Solution: Bundled Waveguide Technology

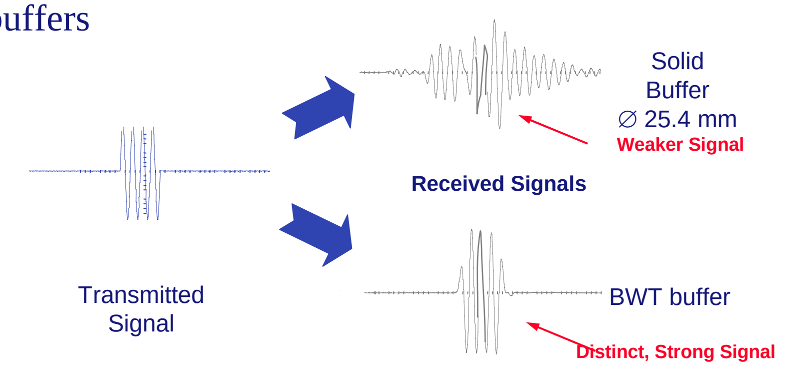
- Bundled Waveguide Technology™ (BWT)
  - Uses large number of thin metallic conductors to efficiently transmit the ultrasonic signal (Similar to Fiber Optics)



Buffer Design

Bundle Waveguide Technology™ (BWT)

BWT™ improves signal shape and SNR over solid buffers



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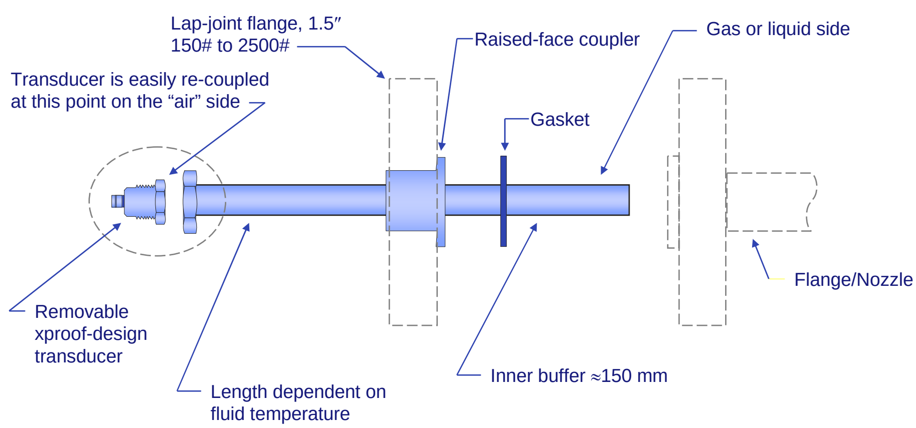
Buffer Design

Bundle Waveguide Technology™ (BWT) Standard Offering:



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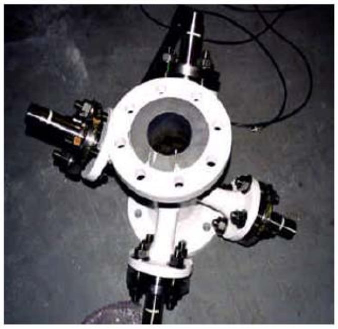
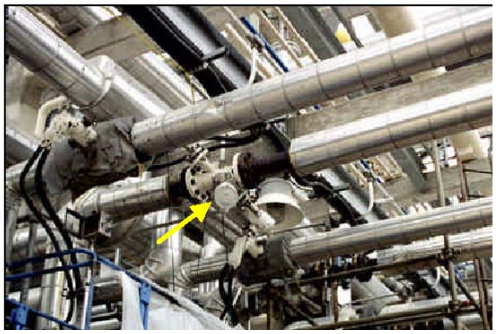
BWT, Buffer & Spoolpiece Design

First Evaluation Unit: 4 inch, VDU Furnace Feed Line
(2) Flow Measurements: Control & Shutdown





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Ultrasonic Transit Time Flow Measurement Technology with Bundled Waveguide Sensor Technology

•Performance:

- •No Calibration or Maintenance Required
- •No Obstruction or Pressure Drop
- •Accuracy (1% of Reading) & Repeatability (0.5%), never changes
- •No Moving Parts, Nothing to Wear Out
- •High turndown (1 ft/s to 40 ft/s)/Excellent Low-End Resolution
- •Sensors are Retractable under flowing conditions
- •Single, Redundant and Triple-Redundant Configurations Available
- •Retrofits: Match Face-to-Face of existing meters

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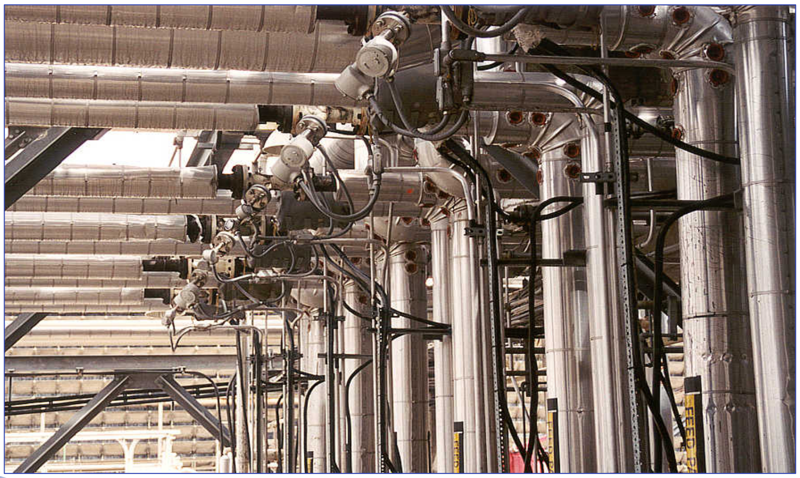
After (2) weeks of evaluation, the refinery installed the remaining (31) applications for the VDU and Coker Furnace Pass Lines



BWT Performance

Since 2001 installation of (16) Redundant Furnace Feed Flow Applications:

-(1) Transmitter Display Failure

-(0) Flow Measurement Failures

-No Lost Production, Off-spec Product, Trip or Shutdown, due to Flowmeter unreliability

-Words of the End User: "We never have to touch those meters"

-Maintenance Routine: Verify diagnostics periodically to monitor the health of the meter

Scheduled Maintenance

Pulled Buffers to Inspect

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Points to Ponder

-How much more productive and efficient will the process be with Accuracy (1% of Reading) and Repeatability (<0.5% of Reading) of Bundled Waveguide Technology?

-How much does it cost to maintain Wedgemeters each year? BWT's require no maintenance or calibration.

-What is the value of eliminating the Risk of Shutdowns and Furnace Trips, due to Furnace Pass Flowmeter problems?

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The Future of Bundled Waveguide Technology

-Bundled Waveguide Technology will become the standard for Coker Furnace Feed Applications

-Will replace Wedgemeter Technology for High Temperature Liquid Flow Applications

-Future Capitol Cost of Bundled Waveguide Technology

-Efficiency Realized by Eliminating Pressure Drops

-Cost of Ownership:

- -No pressure drop, maintenance or calibration
- -High Degree of Reliability
- -Reduced Risk of Shutdown, Fire, Equipment Damage and Injury
- -Proven Technology

Questions and Discussion