Panaflow HT

Reliable flow measurement at extreme temperatures

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Theory of Operation

Transit Time Technique

= Transducer is *both* the *transmitter* and *receiver*
= Ultrasonic Pulses

\( t \) = Transit Times

- Upstream direction, \( t_{up} \)
- Downstream direction, \( t_{dn} \)

\( t_{up} \) = Ultrasound is *decelerated* by flow
\( t_{dn} \) = Ultrasound is *accelerated* by Flow

\[ V = f(t_{up}, t_{dn}) \]
\[ Q = V \times A \]
Advantages of Ultrasonic Flowmeters

• No maintenance
  - No periodic calibration required
  - No drifting readings
  - No moving parts that require maintenance
  - Low total cost of ownership

• No restrictions in the pipe
  - No risk of solid particulates damaging the flowmeter or clogging the line

• Fluid Independent
  - Measurement of transit time is independent of the flowing fluid
  - Transit time technique provides soundspeed as a diagnostic that can be used to identify changes in stream composition

• High turndown ratio
  - 400:1 (0.1-40 ft/s or 0.03-12.2 m/s) in liquids
  - Larger turndown in gas

• Advanced Diagnostics
  - Soundspeed, Signal to Noise (SNR), and other diagnostics allow detail understanding of flowmeter and process.

• Bi-direction flow measurement

• Multiple ultrasonic flowmeters available
  - Custody transfer to portable clamp-on measurements
PanaFlow HT Overview

PanaFlow HT is a wetted ultrasonic flowmeter for measurement of liquids in either nominal or extremely high or low temperatures.

Complete assembly includes:
(1) XMT900 electronics, (2) BWT transducers, (3) FTPA buffers, (4) Meter body
Advantage #1 of PanaFlow HT
• Bundle Waveguide Technology™ (BWT)

- Advantages of buffers
  - Transducers are outside of the extreme temperatures
  - Transducers avoid thermal shock with risks of cracking crystals
  - Transducers are removable and can be replaced without shutting down the process
Advantage #1 of PanaFlow HT

• Bundle Waveguide Technology™ (BWT)

• Advantages of Bundled Waveguide Technology
  - Better signal shape and SNR over solid buffers
  - Measurements up to 600°C (1112°F)
  - Measurements down to -200°C (-328°F)
Advantage #1 of PanaFlow HT

• Bundle Waveguide Technology™ (BWT)

• Advantages of Bundled Waveguide Technology
  - Available up to 2500# flange rating
Advantage #1 of PanaFlow HT

• Bundle Waveguide Technology™ (BWT)

• Advantages of Bundled Waveguide Technology
  - A strong history of successfully measuring in difficult applications
  - Tolerant to fouling
Advantage #2 of PanaFlow HT

• Time Measurement.

  • Time of Flight = $T_w$ (time in buffer “dead time”) + $T_f$ (time in fluid)
  • To improve measurement, $T_w$ must be eliminated
  • Using Pulse-Echo technique allow for active $T_w$ elimination
  • Pulse-Echo is the reflection of signal at the end of the buffer
  • As a result, $T_f$ is measured very accurately with changing temperatures
Advantage #3 of PanaFlow HT

• SIL Certification

• SIL Certification: We will be the first company to have a **SIL certified** ultrasonic liquid flowmeter!!!
  - Third party certification on design
  - SIL2 Certification = Confidence in flowmeter measurement (reliable)!
  - Extensive testing and documentation required to obtain SIL certification

• What is SIL?
  - SIL = Safety Integrity Level
  - SIL is discrete level (ranked 1 to 4); SIL4 is the highest level of safety (less chance of failure) and SIL 1 is the lowest
  - SIL level is used for specifying the safety integrity requirements of the Safety Instrumented Functions (SIF) to be allocated in a Safety Instrumented Systems (SIS).
  - For PanaFlow HT, the probability of failure on demand (PFD) or dangerous failure has been determine through extension testing and documentation.
  - PanaFlow HT can be used for your safety system or process control system.

<table>
<thead>
<tr>
<th>Level</th>
<th>Average PFD per Year (low demand mode)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIL 4</td>
<td>10-5 to 10-4</td>
</tr>
<tr>
<td>SIL 3</td>
<td>10-4 to 10-3</td>
</tr>
<tr>
<td>SIL 2</td>
<td>10-3 to 10-2</td>
</tr>
<tr>
<td>SIL 1</td>
<td>10-2 to 10-1</td>
</tr>
</tbody>
</table>
Performance specifications

• **Accuracy**
  - ± 0.5% of reading
  - Range: 3 to 40 ft/s (0.9 to 12.2 m/s)
  - Calibration fluid: water (three points)

• **Repeatability**
  - ±0.2% of reading, 3-40 ft/s (0.9-12.2 m/s)
  - Range: 3 to 40 ft/s (0.91 to 12.19 m/s)

• **Range (bidirectional)**
  - -40 to 40 ft/s (-12.19 to 12.19 m/s)

• **Rangeability (overall)**
  - 400:1

• **SIL certification**
  - IEC61508 certified
  - SIL2 certification with signal design system
  - SIL3 certification achievable with redundant design system
Case study cokers

• Summary
  • Delayed coking unit objective: convert low value residual products to lighter products of higher value and produce a coke product for resale.
  • Conversion accomplished by heating the feed to high T&P and introducing into a large drum to provide soaking or residence time for the reactions to take place
  • Typical applications: measure feed stock to the vacuum distillation and coking units

• Typical application details
  – Locations: VDU and DCU
  – Fluid: Heavy, sour, low-cost crude
  – Requires high T&P to convert to useable liquids and gas.
  – “Coke chunks” are issues
  – Typical 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
Case study cokers

• General issues
  • Safety guidelines
    If unit loses two of eight flows, furnace would trip and shut down the unit (and $$$)
    EHS concerns with working in DCU/VCU areas (high temperatures and pressures)
  • Reliability and maintenance
    Full time flow meter maintenance required
    Questioning reliability of flow meters
    Concerns about low end accuracy of meters

• Vortex meters
  • Installation issues
    Dual head meter had difficulty with the application
    • Flow deviation between dual head readings
    • Flow read zero with no response to valve opening
    To prevent unit shutdown, maintenance required.
    • Bypass opened to allow steam cleaning of meter
    • Some meters did not recover when back in service

  − Root cause: vortex bluff body became coated with coke fines and solid chucks. This caused the bluff body not to float properly, causing flow measurement to diverge or fail.
Case study cokers

- DP meters (orifice or wedge meters)
  - Typical meter used in the field before ultrasonics
  - Potential for clogging due to DP restriction and impulse lines (solid particulates).
    - Requires cleaning with either steam or hot hydrocarbon liquid
  - Wedge begins to pit over time
  - Wedge meter nozzles or orifice plates can plug
  - Diaphragm can coat with fines
  - Manufactures suggests pulling meter to send back for recal/repair of transmitter, refilling the impulse lines, and having the wedge reshaped
  - User must clean meter prior to shipment
  - Recalibration required
Case study cokers

- **Solution**
  - Customer CTQ: A more reliable technology for the flow measurement
  - Solution: GE ultrasonic flow meter with BWT technology
    - No routine maintenance required
    - No issues with solid ‘coke’ build up buffers
    - No pressure drop or obstructions
    - High turndown (40:1) with excellent low end resolution
    - Drift free operation
- **Advantages**
  - Improves feed reliability with no false furnace “trips” due to poor measurements
  - Provides a safer workplace and reduces exposure time in units
  - Better overall system control and productivity
  - Reduces maintenance costs for feed flow meters
  - Field proven since 1998
Cost Savings

• Assumptions
  Approximately one “other” meter failure or maintenance cycle every other week
  90% fixed with steam or other fluid blow down
• Two operators to get it running
• Up to four hours of labor
• Example: LNG measurements
  10% required removing from service
• Up to five operators, pipe fitters, technicians
• Up to six hours labor
  Labor cost average = $50/hour

<table>
<thead>
<tr>
<th>Failures</th>
<th>Hours Work</th>
<th>People</th>
<th>Labor Rate</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam Clean</td>
<td>23</td>
<td>4</td>
<td>2</td>
<td>$50/Hr</td>
</tr>
<tr>
<td>Pull Out</td>
<td>3</td>
<td>6</td>
<td>4</td>
<td>$50/Hr</td>
</tr>
<tr>
<td>Total Failures</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Annual Maintenance Cost: **$12,800***

* Note
- Does not include cost of installing of wasted steam ($$ through energy costs) or high temperature hydrocarbon liquid (loss of production)
- Does not include cost of any incorrect shutdown, which is more significant than calculation.
PanaFlow HT Summary

• PanaFlow HT is a wetted ultrasonic flowmeter for measurement of liquids in either nominal or extremely high or low temperatures.

General Specifications
• Pipe sizes: 3” to 16” standard (>16” upon request)
• Accuracy: +/- 0.5% (calibrated)
• SIL certification (by design) pending
• Active Tw Measurement
• Meter bodies: CS, SS, or 9Cr-1Mo standard options
• Temperature Range: -190 to 600°C
• Pressure Range: MAOP (150# to 600#) or 3480 psi
• Certification: CSA/FM, ATEX, and IECEX pending
• 3 Meter Configurations:
  • 1 path, tilted diameter, one meter
  • 2 path, mid radius, one meter
  • 2 Path, tilted diameter, two meter
• Typical Outputs: 4-20mA/HART/SIL or FF
• New PC Software: Vitality
PanaFlow HT
Panametrics Ultrasonic Liquid Flow Meter

• Questions?
Backup Flexible Solutions.... Yes

• Alternative materials, sizes, flanges, and designs are available
• Application and engineering support
• Manufacturing and supply chain expertise
Backup PanaFlow HT Details

• XMT900 Transmitter
  • Enclosure: Epoxy coated aluminum (IP67)
  • Power: 85-260 VAC or 12-28 VDC
  • Display: Local display with built-in magnetic, six-button keypad, for full functionality operation

  – Communication
    • Option “A”:
      » One SIL rated analog/HART output
      » Two digital outputs
      » Modbus (RS485) / Service Port
    • Option “B”
      » One SIL rated analog/HART output
      » Additional analog output (not SIL rated)
      » Two digital outputs
      » Modbus (RS485) / Service Port
  • Note: Digital output programmable as:
    » Totalizer Pulse
    » Frequency
    » Alarm Control
    » Control Output

• Transducers/Buffers (0.5 or 1 MHz)
  – High Temperature: -200 to 600oC
  – Normal Temperature: -200 to 315oC

• System Rating (Pending)
  – FM Explosionproof, C1, Div 1, Group B-D
  – ATEX Flameproof, II 2 G Ex d II C T6
  – IECEX Flameproof, II 2 G Ex d II C T6
Backup PanaFlow HT Details

- Configurations:
  - Z1H: 1 Path, Tilted Diameter, One Meter
    Standard design for quality measurement
  - Z2H: 2 Path, Parallel Mid Radius, One Meter
    Additional path for redundant measurement
  - R2H: 2 Path, Staggered Tilted Diameter, Two Meters
    • Completely redundant system for increased security in measurement
Backup PanaFlow HT Details

- **Meter Body:**
  - **Size:**
    - 3” to 16” standard
    - Up to 36” available upon request
  - **Schedule/Flange Rating:**
    - ANSI 150# RF (WN) / Std Sch
    - ANSI 300# RF (WN) / XS Sch
    - ANSI 600# RF (WN) / XS Sch
- **Design:**
  - ASME B31.3 & NACE MR0103
  - PED & NACE MR0103
  - ASME B31.3, CRN registered, nd NACE MR0103
- **Material:**
  - Carbon steel (ASTM A106 Gr. B - ASTM A105)
  - 316/316L Stainless Steel (ASTM A312 Gr 316/L - A182 Gr. 316/L)
  - 9Cr-1Mo meter body (ASTM A335 Gr. P9 - ASTM A182 Gr. F9)

- **Electronics Mounting:**
  - Local ($T_{max} = 302^\circ F/150^\circ C$)
  - Remote
    - 25, 50, or 100 Feet