BAKER HUGHES
a GE company

Panaflow HT

Reliable flow measurement at extreme temperatures

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REFCOMM®
ROTTERDAM
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SIL Certified

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- Advantages of Ultrasonic Flowmeters
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Transit Time Technique

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

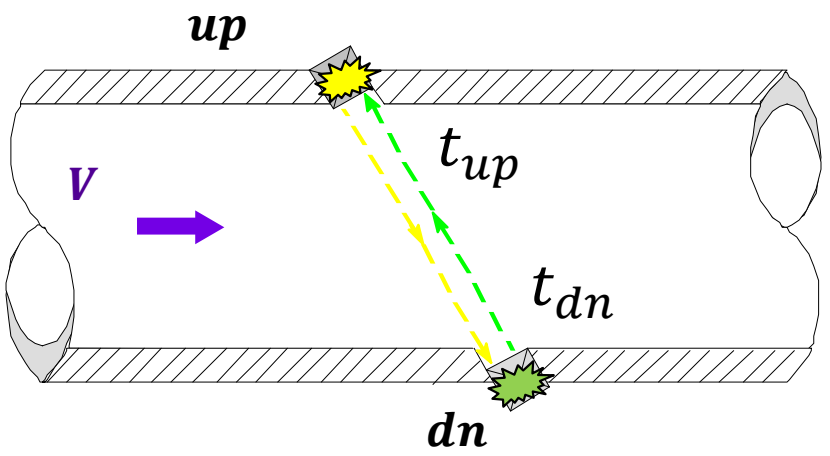
= Ultrasonic Pulses

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



$$t_{up} > t_{dn}$$

$$V = f(t_{up}, t_{dn})$$

$$Q = V * A$$

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

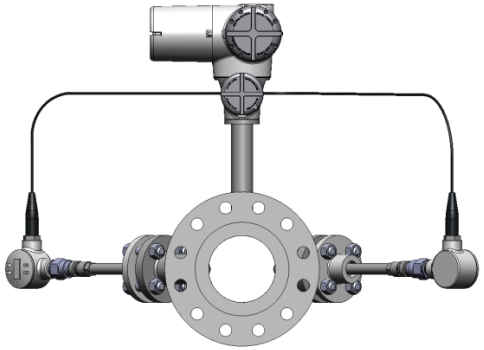
Advanced Diagnostics

- 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



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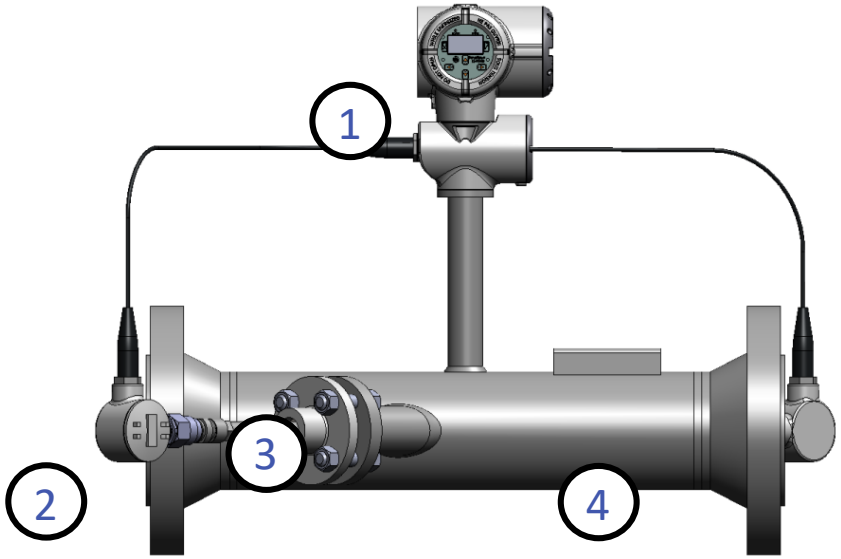
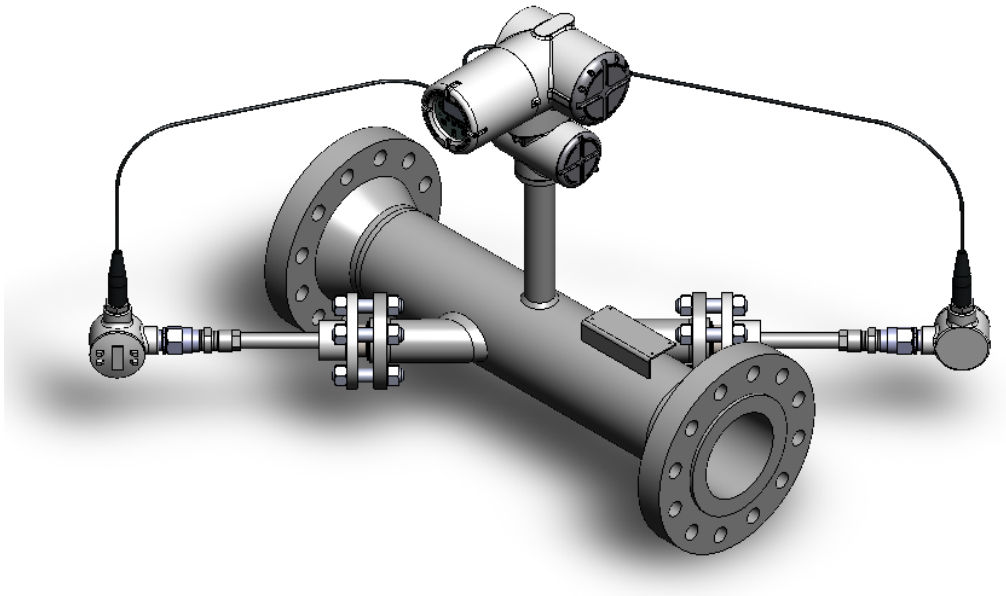
PanaFlow HT Overview

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

Complete assembly includes:

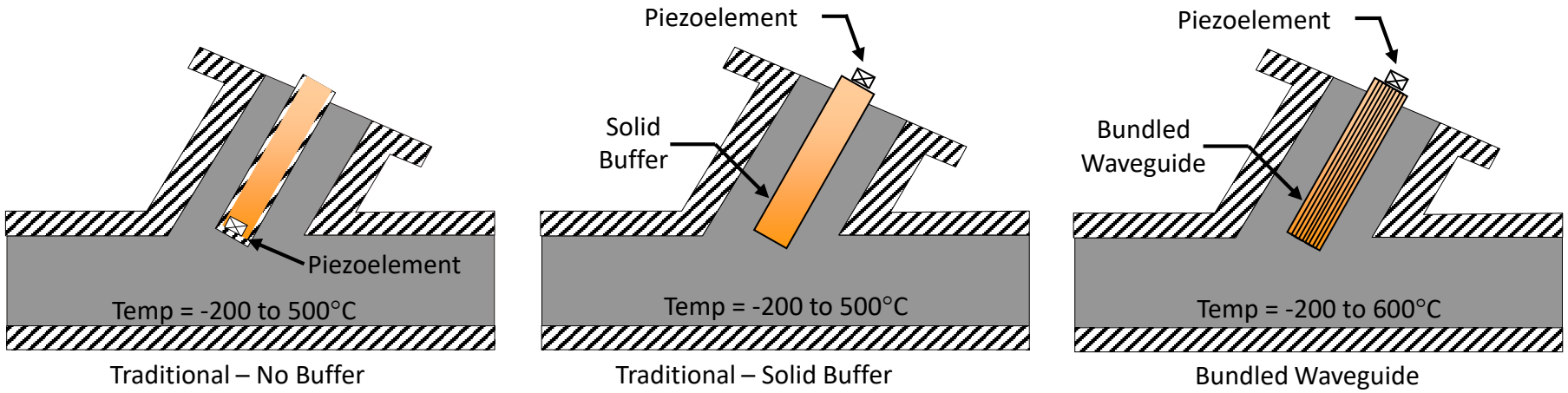
(1) XMT900 electronics, (2) BWT transducers, (3) FTPA buffers, (4) Meter body





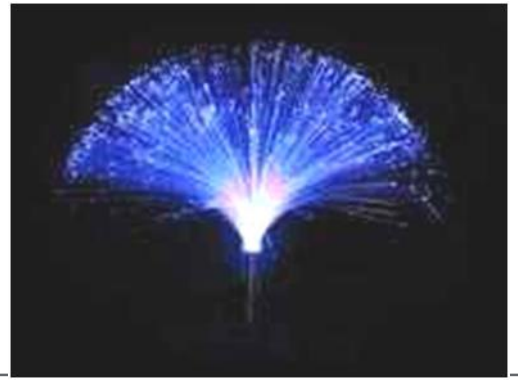
Advantage #1 of PanaFlow HT

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



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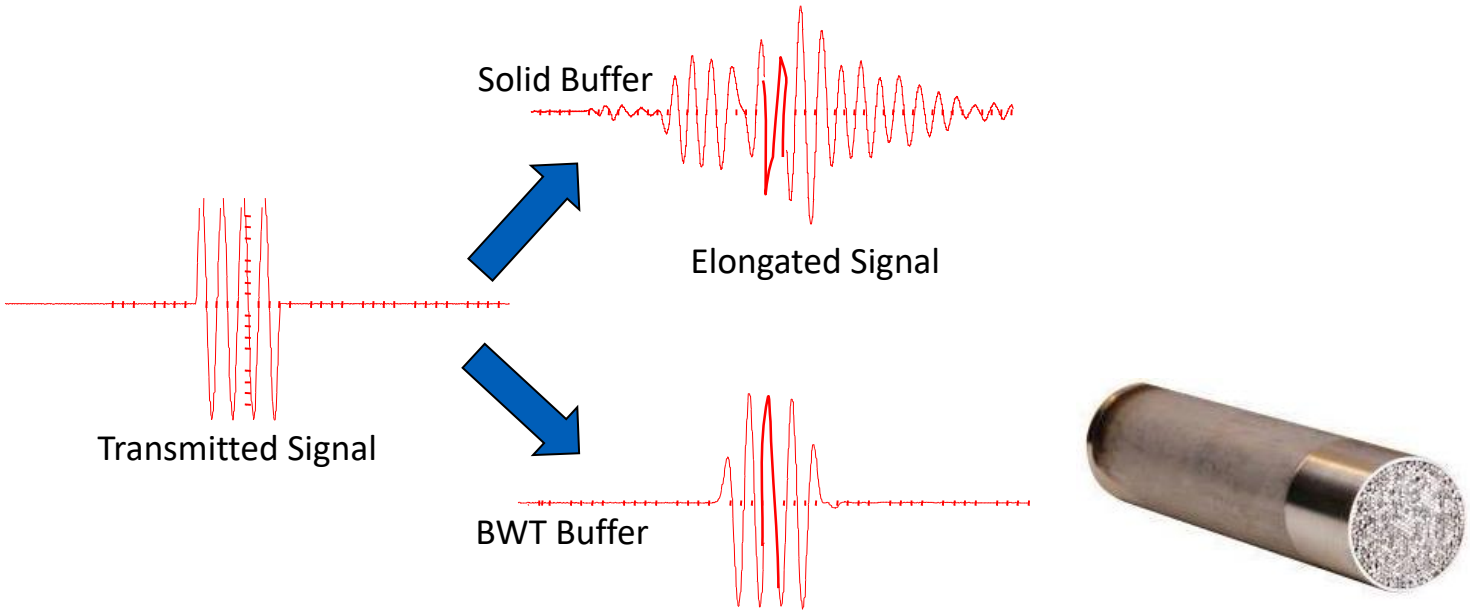
Advantage #1 of PanaFlow HT

Bundle Waveguide Technology™ (BWT)

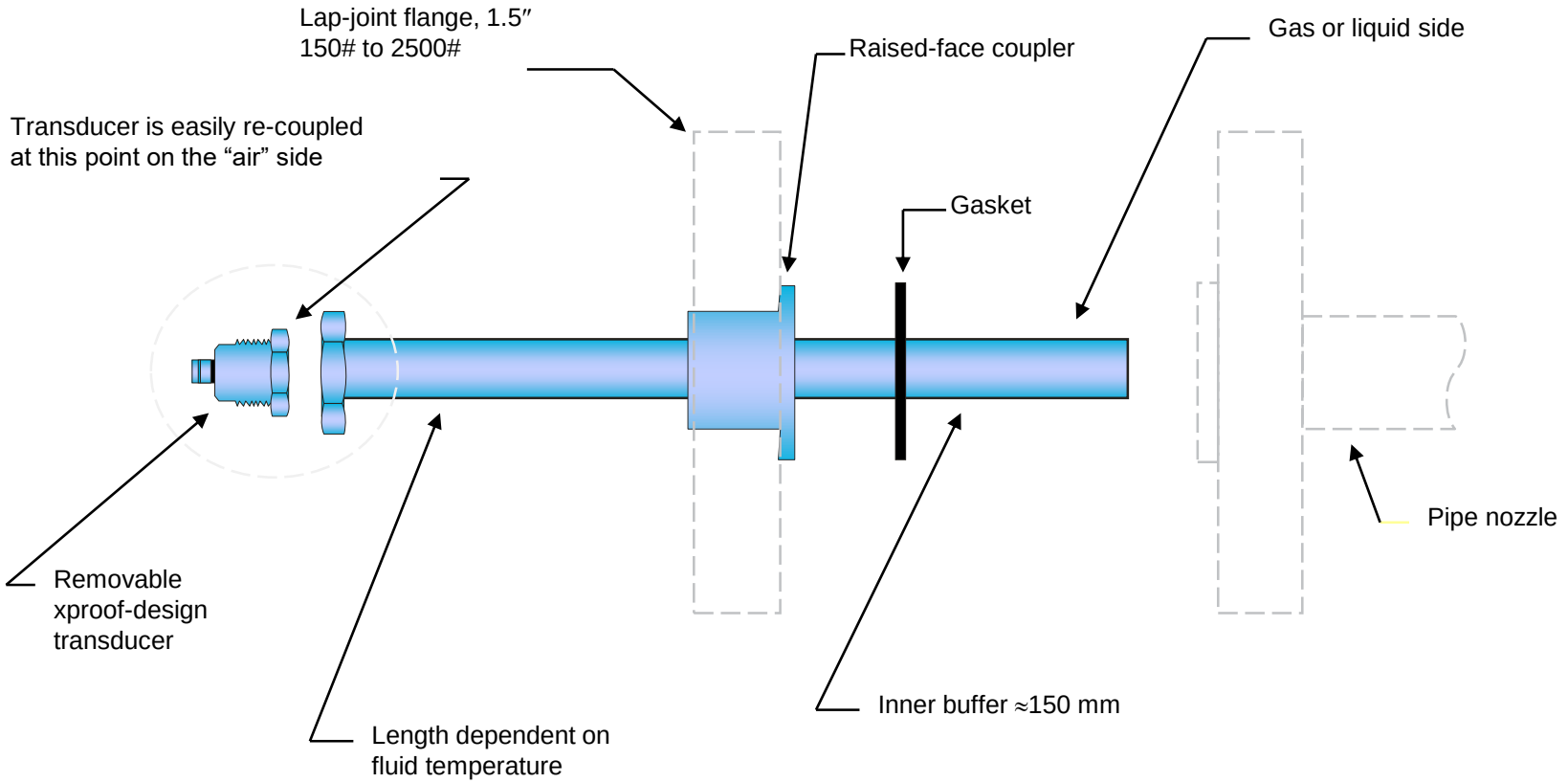
Advantages of Bundled Waveguide Technology

- 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)



Advantage #1 of PanaFlow HT

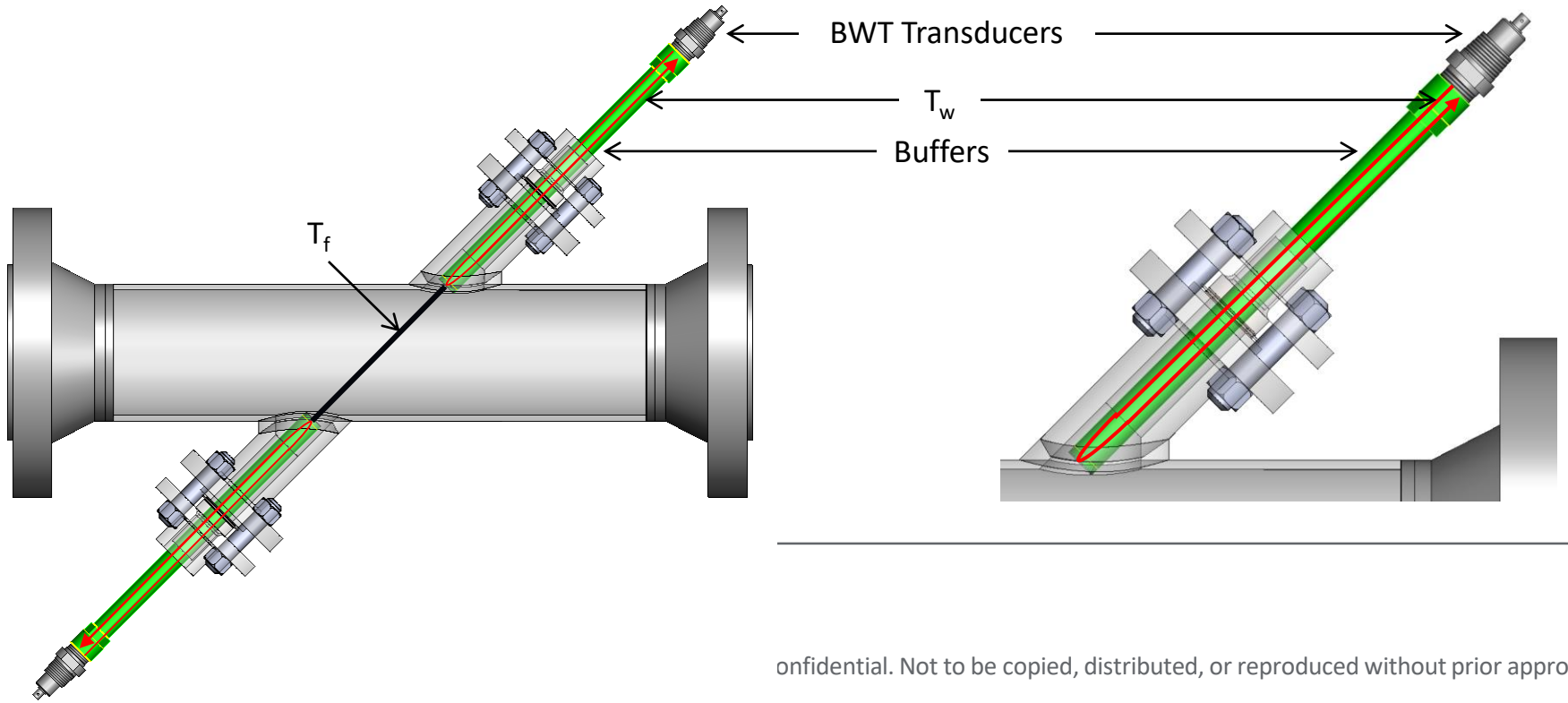
Bundle Waveguide Technology

- Introduced 1998
- 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 Tw 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



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Advantage #3 of PanaFlow HT

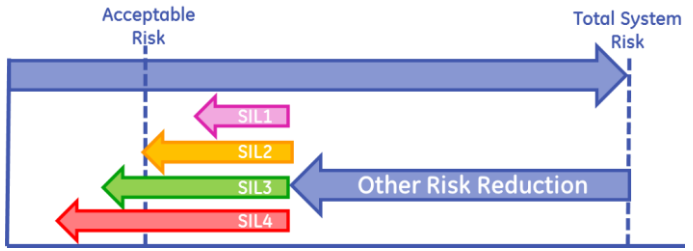
SIL Certification:

- We are the first company to have a SIL certified ultrasonic liquid flowmeter!!!
- Third party certification on design according IEC61508.
- 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.

Level	Average PFD per Year (low demand mode)
SIL 4	10-5 to 10-4
SIL 3	10-4 to 10-3
SIL 2	10-3 to 10-2
SIL 1	10-2 to 10-1



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Application Example
Delayed Coking

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Delayed Coking

What customers are looking for?

- Get **reliable and accurate flow measurement** on the feed furnace lines as this is a **safety critical process** which can require SIL rating. Failure to achieve these could lead to wrong decisions resulting in a potential furnace blast
- **Minimize costly process disruptions** due to lack of reliability generating **high OPEX**
- Effectively evaluate Delayed Coker operations
- **Safe working conditions** for staff and environment

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Delayed Coking

What are the current challenges?

- Traditional technologies like Wedge meters, Venturis, orifice plates and vortex, all have many drawbacks due to the **clogging** nature of the heavy residue feed: High OPEX
- Unclogging process requires **permanent or regular purging** using distillates and/or steam = high cost, impact of unit yield and safety risk for staff
- High safety requirements = redundant measurements (2, 3 or 4). But **large inconsistencies** within the same pass line = unable to efficiently control the process

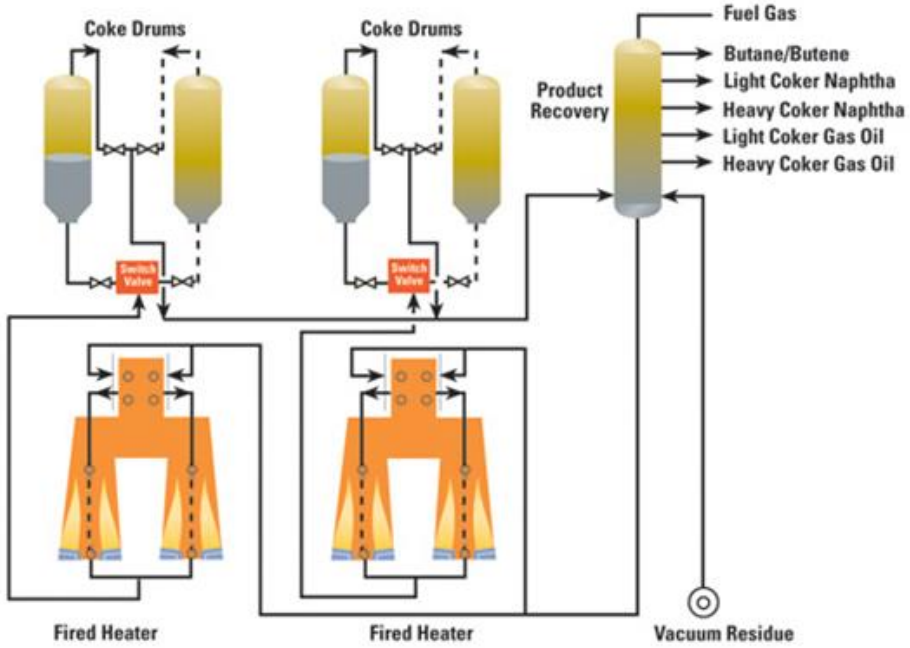
Delayed Coking

Who cares?

- Process Engineers, Operation Managers, Instrument Technicians with the furnace feed lines

Concerns

- Safety: Furnace tube plugs & ruptures and unit shutdown
- Reliability:
  (1) Decreased performance between decoking processes or
  (2) Unnecessary shutdowns due to incorrect flow measurements



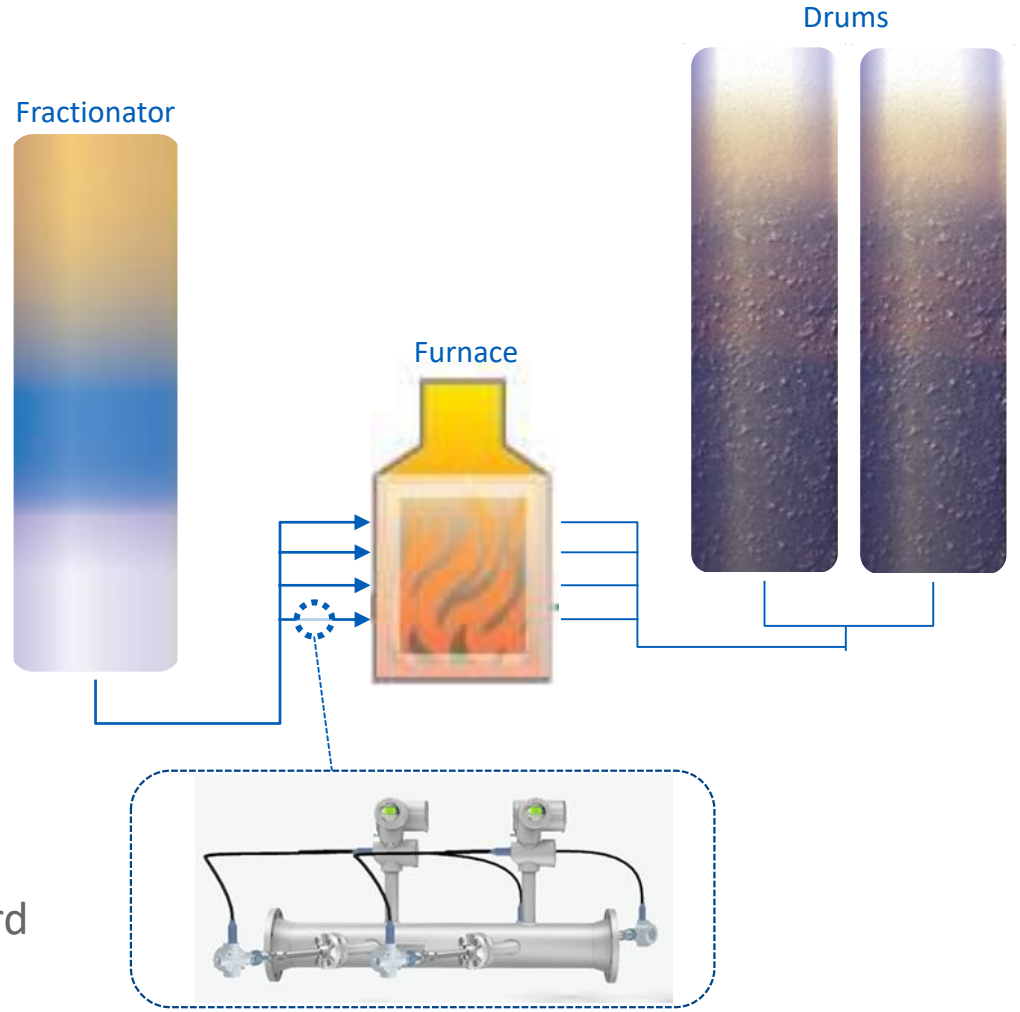
Delayed Coking Unit

Where do we fit in? Furnace feed line

- 1 to 2 DCUs per refinery capacity
- 1 to 3 heaters based on DCU capacity
- 4 to 6 heater passes per heater
- 2 to 4 measurement points per heater pass
  - 1 for process control
  - 1 to 3 for safety system

One Customer Example

- 30 passes with 4 points of measurement each
- $68K per pass (four measurements per spool)
- Overall **$2.0M** win!
- Why? Benefits of ultrasonic flowmeters with proven track record



Delayed Coking

Delayed Coker Savings using Ultrasonic Meters

- **Facts and Assumptions**
- 8 Pass Lines/ Furnace
- 24 Flow measurement points (2 for ESD, 1 for Process Control)
- 48 Impulse lines for orifice plates
- 40,000 bpd capacity
- $14 profit/ bbl

Total Operating Cost Per Year	
Purging	$364,000
Maintenance	$43,000
Unplanned Shutdown	$560,000
Total	**$43K to $967K!**

Routine Maintenance

- Calibrate pressure sensor, replace DP element
- Assume 24 hrs/ year/ measurement point
- 24 hrs * 24 meters * $75/hr = $43 k

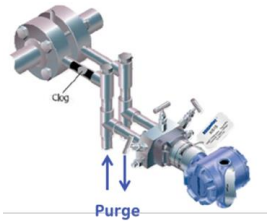
Purging

- 1.5 bpd purge rate/ impulse * 48 impulse = 72 bpd
- 72 BPD = 26,000 bbl/ year
- 26,000 bbl/year * $14 lost profit/ barrel = $364 k/ year

Unplanned shutdown

- **$14 profit/ bbl * 40,000 bbl = $560** k/ day in lost profit per day DCU is shut down

Customers have options….. But with high maintenance & low reliability

	Orifice Plates 	Wedge Meters 	Vortex Meters 
Theory	• Differential pressure measurement • A flat metal plate with an opening restricts the flow • Flow rate is calculated based on pressure differential.	• Differential pressure measurement • A flat metal plate with an opening restricts the flow • Flow rate is calculated based on pressure differential.	• Frequency measurement • A bluff body is placed in the process stream creating alternating shedding vortices • Flow rate is proportional to the shedding frequency.
Advantages	• Basic element is robust and entirely mechanical with no moving parts • DP-transmitter isolatable for calibration • Cheap installation cost • SIL certification on transmitter	• Small pressure drop • Basic element is robust and entirely mechanical with no moving parts • Membrane reduces need for heat tracing of impulse line • SIL certification on transmitter	• No moving parts to wear • No routine maintenance required • Stable long term accuracy and repeatability • Larger rangeability • SIL certification available
Disadvantages	• Asphaltenes stick to the surface walls as the fluid cools • Risk of clogging in impulse lines • Pipe shut down for exchange of primary element • Limited turndown range • Effected by changes in density, pressure and viscosity • Pressure tubing needs trace heating	• Asphaltenes stick to the surface of the membrane reducing sensitivity • Pipe shut down for exchange of primary element • Limited turndown range • Effected by changes in density, pressure and viscosity	• Cannot be used for low velocities • Pulsating flow vortices adversely affect measurement accuracy • Not for high viscosity fluids • Coke on bluff body causes heavy drift • Frequent steaming necessary for cleaning (very costly maintenance)

https://m.kaon.com/c/ge

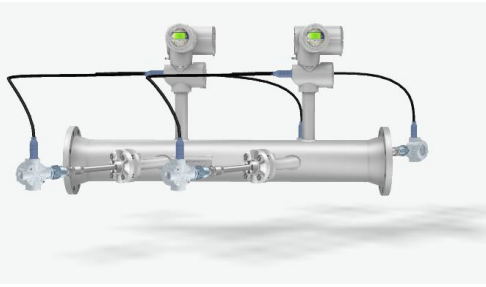
PanaFlow HT

Summary

- PanaFlow HT is a wetted ultrasonic flow meter. Designed for measurement of liquids in nominal or extreme process temperatures
- PanaFlow HT is the world's first ultrasonic flow meter to be SIL certified to IEC61508. **Certification by design** establishes reliability and safety
- 3rd party certification with extensive testing
- SIL2 certification with single design system
- SIL3 achievable with redundant design system

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



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PanaFlow HT
Panametrics Ultrasonic Liquid Flow Meter

- Questions?

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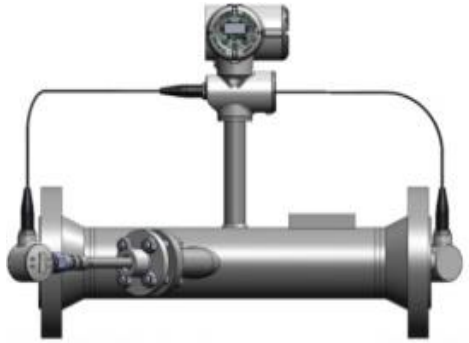
Backup SIL 2 and 3 PanaFlow HT

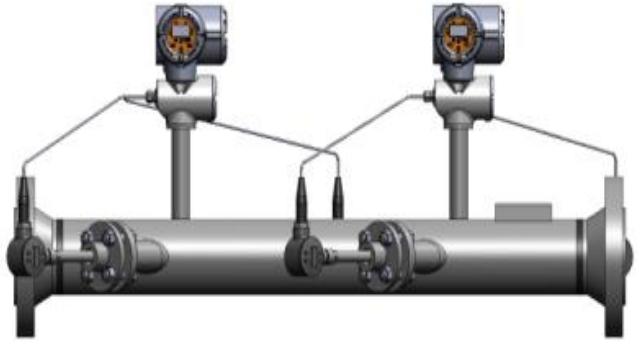
Configurations

- Z1H: 1 Path, Tilted Diameter, One Meter. Standard design for quality measurement Sil 2.
- Z2H: 2 Path, Parallel Mid Radius, One Meter. Additional path for redundant measurement Sil 2.
- R2H: 2 Path, Staggered Tilted Diameter, Two Meters in one body. Completely redundant system for increased security in measurement Sil 3.



Z1H

Z2H



R2H

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Backup Track Records Heavy Residue Applications

Petronor (Repsol Group)
Bilbao - Spain

Motiva
Port Arthur, TX – USA

Dow Chemical
Tarragona - Spain

Shell Per+
Pernis - The Netherlands

Saudi Aramco
Rabigh - Saudi Arabia

ConocoPhillips
Sweeney, TX - USA

ConocoPhillips
Wood River, IL - USA

Marathon Petroleum
Garyville, LA - USA

Chevron
Pascagoula, MS – USA

Shell
Anacortes, WA - USA

Repsol
La Coruña, Spain

Yanbu Export Refinery Project –
Yanbu, Saudi Arabiar

Tupras
Izmit - Turkey

Total
Antwerp (Optara), Belgium

Socar - STAR project
Izmir - Turkey

Petromanagas
Venezuela

BP Whiting
Indiana – USA

Hunt Refining Company
Alabama – USA

Total
Feyzin – France

Total
Port Arthur, TX – USA

Cepsa
San Roque - Spain

Takreer,
Ruwais, UAE

Orpic
Sohar, Sultanate of Oman

Preem Refinery
Lysekil - Sweden

Lotos Refinery
Gdańsk – Poland

Backup Flexible Solutions…. Yes

- Alternative materials, sizes, flanges, and designs are available
- Application and engineering support
- Manufacturing and supply chain expertise

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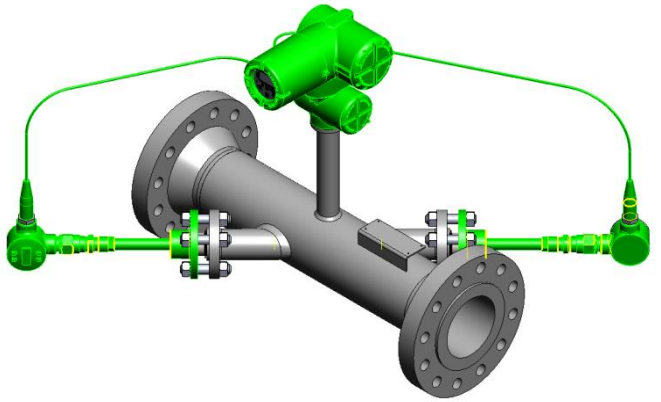
Backup PanaFlow HT Details

- 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 EEx d II C T6
  - IECEX Flameproof, II 2 G EEx d II C T6

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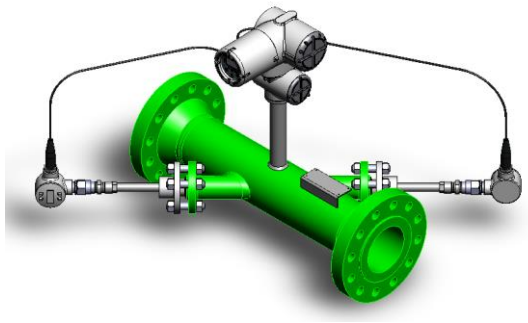
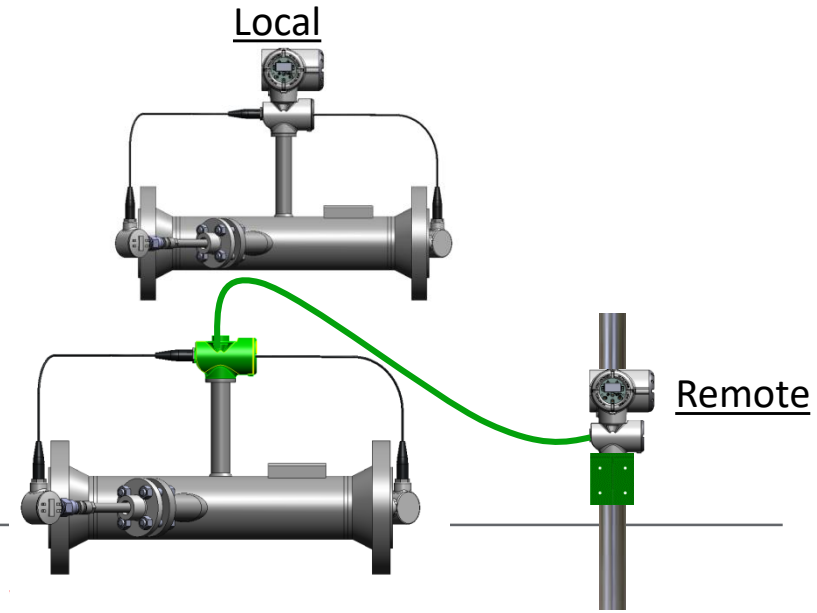
Backup PanaFlow HT Details

- 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, and 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°F/150°C)
  - Remote
    - 25, 50, or 100 Feet



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Backup 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


GE
Measurement & Control

PanaFlow HT
Panametrics Ultrasonic
Flow Meter for Liquids

Applications

PanaFlow HT is a wetted ultrasonic flow meter used for measurement of liquids in either nominal or extremely high or low temperatures for:

- Crude distillation
- Vacuum distillation
- Crackers
- Hydrotreaters
- Visbreakers
- Crude oil
- Liquefied natural gas (LNG)
- Any application where reliable flow measurement is required

Features & Benefits

- No drifting flow measurement
- No periodic calibration required
- No maintenance
- No restriction in the pipe
- Reliable measurement by design – (IEC61508 certification pending)
- Flow measurement in extremely high-process temperature (600°C/1112°F) applications
- Flow measurement in extremely low-process temperature (-200°C/-328°F) applications
- Bi-directional measurement

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