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RAECO Customer Webinar

Six Critical Things You Can Learn From a Flow Spot Check

Speaker: Dan Kilpatrick
GE Measurement & Control

imagination at work

Agenda

Ultrasonic Meter Basics

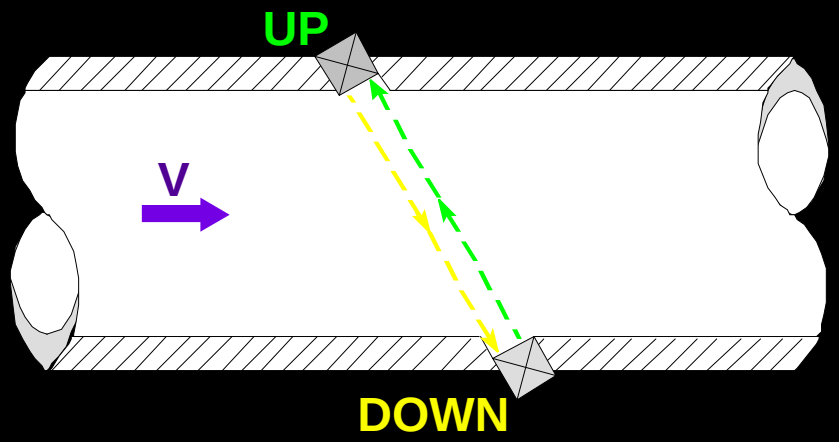
Application Considerations

Six Things You Could Learn

Questions

Theory: Transit Time Technique

- Transducer is Both Transmitter and Receiver
- Ultrasonic Pulses
- Transit Times
  - Upstream direction, t_{up}
  - Downstream direction, t_{dn}
- t_{up} = Ultrasound is Decelerated by Flow
- t_{dn} = Ultrasound is Accelerated by Flow
- Analogous to a Flowing River



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

$$\Delta t = t_{up} - t_{dn}$$

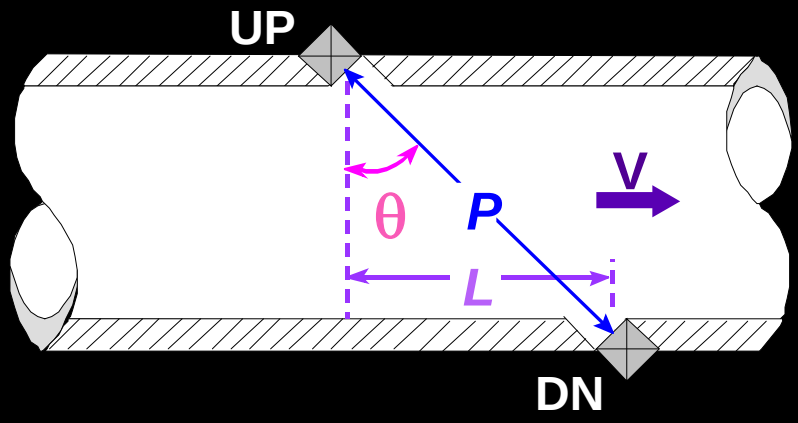
$$V = f(\Delta t)$$

$$Q = V \times A$$

Theory: Transit Time Technique

$$DISTANCE = RATE \times TIME$$

$$TIME = \frac{DISTANCE}{RATE}$$



NO FLOW

$$t_{up} = \frac{P}{c}$$

$$t_{dn} = \frac{P}{c}$$

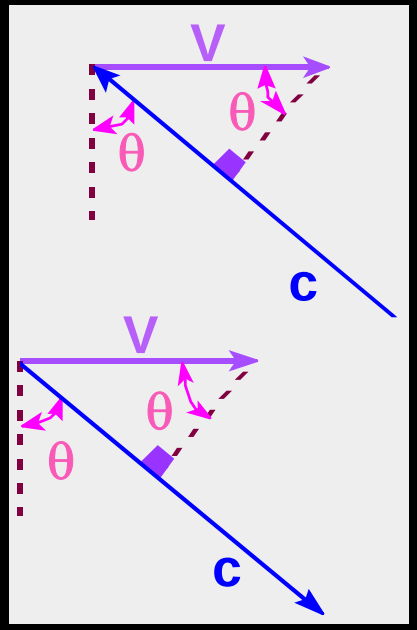
$$\Delta t = t_{up} - t_{dn} = 0$$

WITH FLOW

$$t_{up} = \frac{P}{c - V\sin\theta}$$

$$t_{dn} = \frac{P}{c + V\sin\theta}$$

$$\Delta t = t_{up} - t_{dn}$$



Theory: Transit Time Technique

VELOCITY

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

VOLUMETRIC

Q = Velocity × Cross-Sectional Area

$$Q = V \times A$$

SOUND SPEED

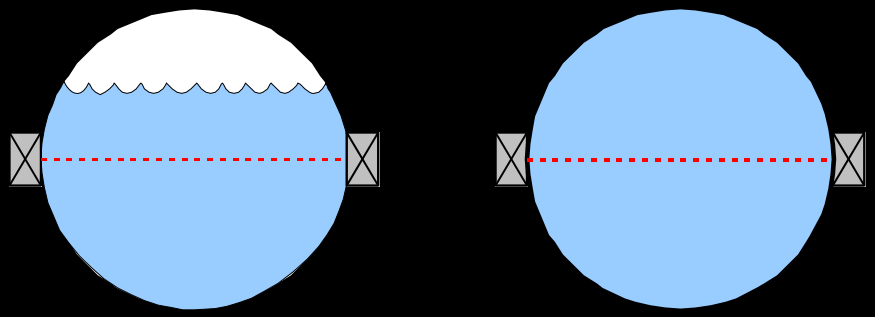
$$t_{avg} = \frac{t_{dn} + t_{up}}{2}$$

$$c = \frac{2P}{t_{avg}}$$

Liquid Flow Application Considerations

Full Pipes Only

- Accuracy
- Signal Loss

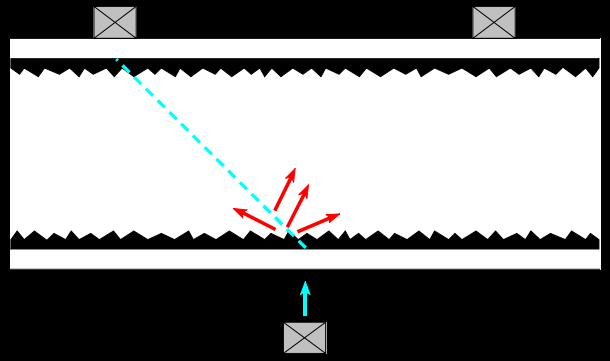


$$Q = V \times A$$

Liquid Flow Application Considerations

Pipe Condition

- Single versus Double Traverse Configuration



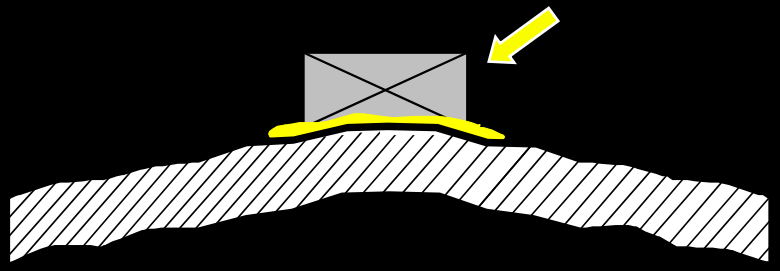
As the drawing above shows, the location at which the signal coming from the first transducer bounces off the wall towards the second transducer is an area with high potential for attenuation.

Liquid Flow Application Considerations

Pipe Condition

- Clean Outside Surface (to eliminate “bumps”caused by rust and excessive amount of paint)

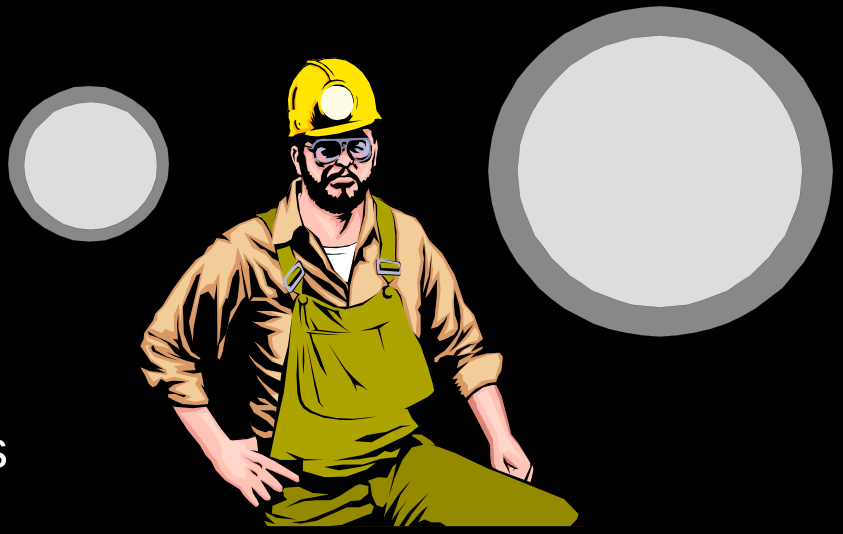
- Also, don’t forget to use couplant (for good contact)



Liquid Flow Application Considerations

Pipe Size

- Overall Range: 1/2” to 200” (12 mm to 5 m)
- Transducer Selection
  - 1/2” to 2”
  - 2” to 200”
- Clamping Fixture Selection
- Transducer Frequency
  - 1.0 MHz for standard applications
  - 0.5 MHz for large pipes
  - 4.0 MHz for small pipes
  - 2.0 MHz for special applications



Liquid Flow Application Considerations

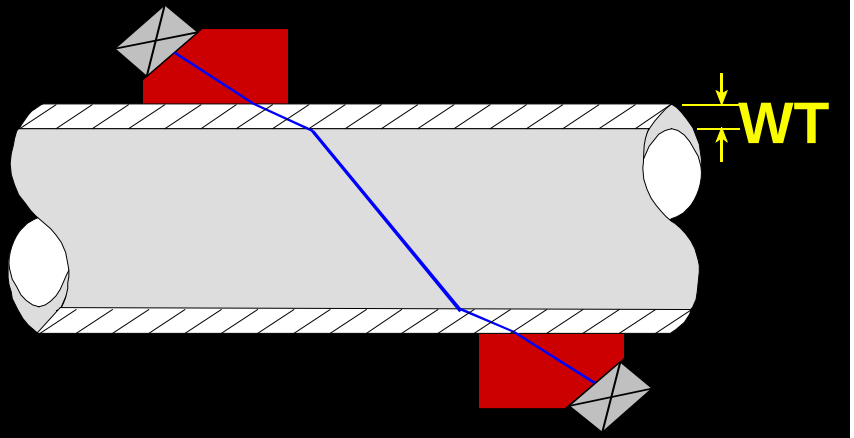
Large Pipes

- 2” to 200” OD
- Standard & Special Clamping fixtures

Liquid Flow Application Considerations

Pipe Material

- Metals
  - Carbon Steel
  - Stainless Steel
  - Copper
  - Aluminum
  - Cast Iron
  - Brass
  - Ductile Iron
- Plastics
  - Polypropylene
  - Polyethylene
  - PVC
  - CPVC
  - PVDF
  - Nylon
  - Acrylic



Liquid Flow Application Considerations

Straight Run Requirements

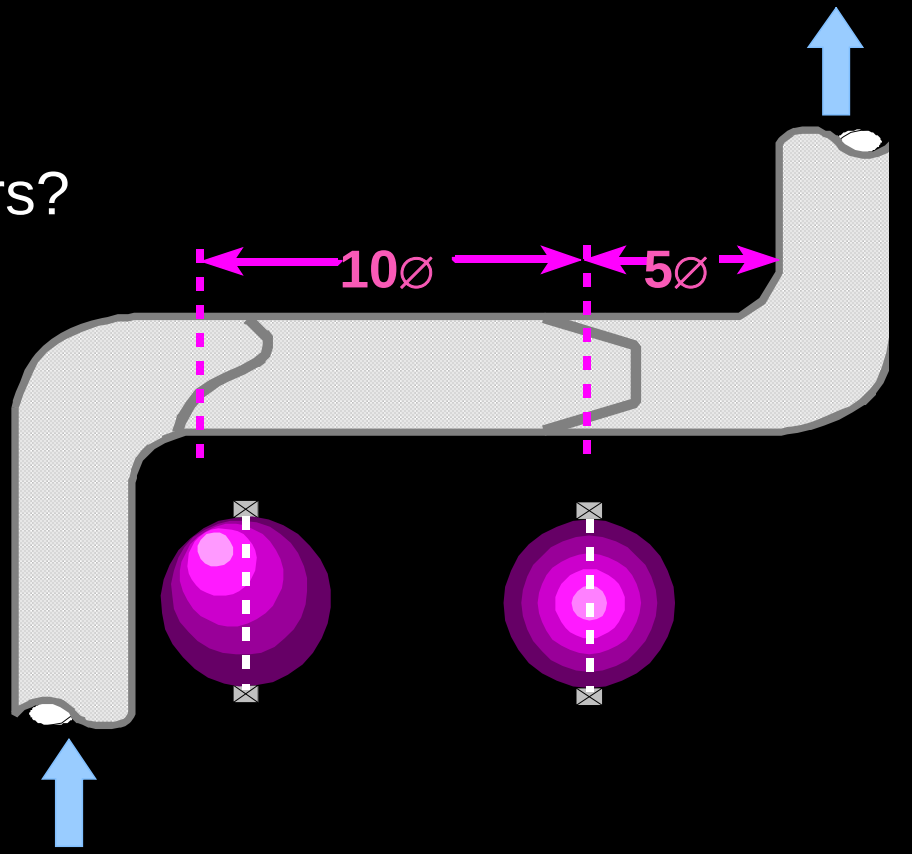
GOOD LOCATIONS

BAD LOCATIONS

Liquid Flow Application Considerations

Straight Run Requirements

- Fully Developed Flow Profile
- 10 Upstream/5 Downstream Diameter
- What If I Don't Have 15 Diameters?
  - 2/3 up, 1/3 down
  - Multipath
  - Flow straighteners
  - Accuracy cannot be quantified
  - Repeatability



Liquid Flow Application Considerations

Straight Run Requirements

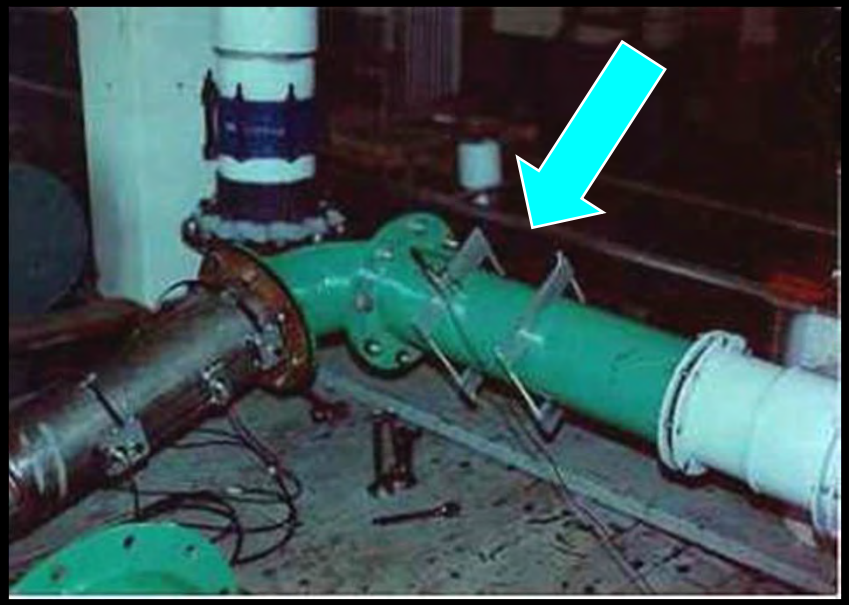
- The more diameters of straight run available, the better the measurement will be

Liquid Flow Application Considerations

Straight Run Requirements

- The good vs. the “not-so-good” locations

AFTER...

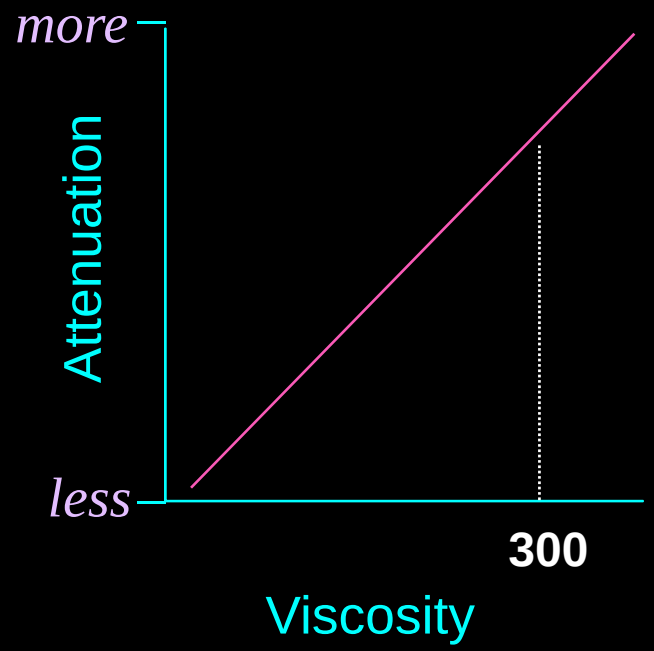


BEFORE...

Liquid Flow Application Considerations

Viscosity Range

- Maximum ~300 centistokes
- Attenuation
- Low Reynolds Number



Liquid Flow Application Considerations

Velocity Range

- Minimum Detectable Velocity = 0.1 ft/s (0.03 m/s)
- Maximum Detectable Velocity = 40 ft/s (12m/s)
- Resolution of Δt: Higher Velocity, More Δt
- Good: V $\geq$ 1.0 ft/s (0.3 m/s)
- Use the Slide Rule

Equations

- Area = $\pi \left(\frac{ID}{2} \right)^2$
- $Q = V \times A$

Number 1

Validate Pump /Control Valve Operation & Performance

Capable of measuring up to 750 F

Boiler Feedwater Applications

Utility and PowerGen

Number 2

Identify Leaks

Same set of Transducers can measure 2” to >36”

Datalogging allows for comparative analysis over time between multiple meters installed on same line

Verify positive valve shutoff

Number 3

Verify Other Flowmeters within Facility

Magmeters, Vortex meters, Impeller, DP

Use USM diagnostic data to confirm measurement

- Signal Strength (SS)
- Sound Speed (SDSP)

Number 4

Balance CW or HTHW Loops

Energy Management Feature Converts Flow to BTU's, and Tonnage

Campus Energy/Central Utility Plants

Technicians use for troubleshooting other meters as well as identifying locations for permanent ultrasonic flowmeters

Number 5

Help Properly Size Ancillary Plant Equipment

Facility Upgrades

Heat Exchangers

Cooling Towers

Enable Process/Plant Engineers to Make Informed Decisions Regarding Upgrade Projects

Number 6

Chemical Plant Mass Balance

Ultrasonic meter can be programmed for measurement of variety of chemicals

Chemical compatibility not an issue due to non-contact measurement

Bonus

Confirm Flow Direction and Pipe Line Conditions

- Old undocumented pipes
  - Meter measures bi-directional flow
- Water/Wastewater Industry
  - Verify if pipe is full by meter diagnostics

Thank you.

We Look Forward to Scheduling a Measurement with You!

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