



Bronkhorst®

Ultrasonic Flow meter for very small flow rates

- ◆ Introducing ES-FLOW™ series
- ◆ How to measure low flow rates of liquids using ultrasonic waves?
- ◆ Benefits of the ES-FLOW™ Ultrasonic Wave Technology
- ◆ How do conventional ultrasonic flow meters work?
- ◆ Key features & specifications
- ◆ Applications & opportunities
- ◆ Company
- ◆ Bronkhorst Flow Measurement Principles
- ◆ Conclusion



Revolutionary Ultrasonic Flow Meter

- ◆ Innovative non-intrusive flow measurement technology
- ◆ Designed to measure low flow rates: 4...1500 ml/min
- ◆ Liquid independent
- ◆ Hygienic design
- ◆ Integrated PID controller



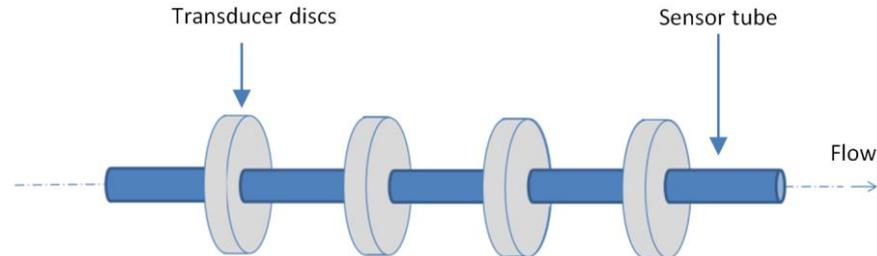
Ultrasonic Liquid Volume Flow Meter

- ◆ Low pressure drop
- ◆ CIP cleanable
- ◆ Straight sensor tube with zero dead volume
 - ID = 1.3 mm
 - Length = 11 cm
 - Surface roughness = 0.4 Ra
- ◆ Ability to measure temperature



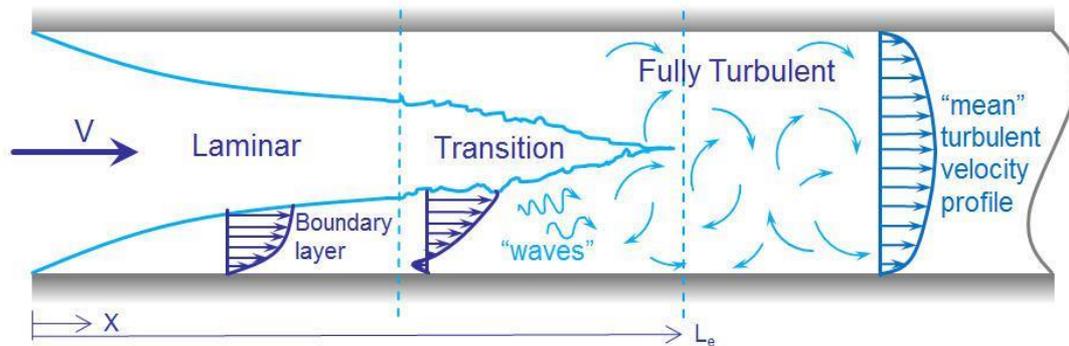
Ultrasonic Wave - innovative measurement technology

- ◆ Straight tube with multiple transducers at the outer surface
- ◆ Ultrasonic waves are generated by radially oscillation
- ◆ All up- and down-stream combinations are recorded and processed
- ◆ Measuring time difference in nanoseconds
- ◆ Calculations of flow velocity, speed of sound & volume flow



Benefits of the ES-FLOW™ Ultrasonic Wave Technology

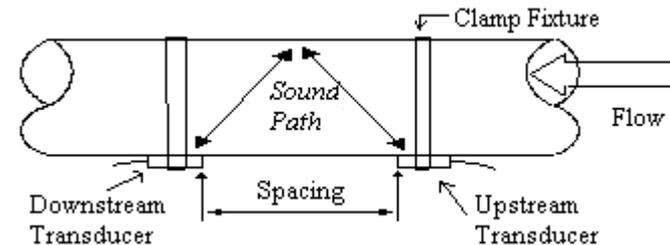
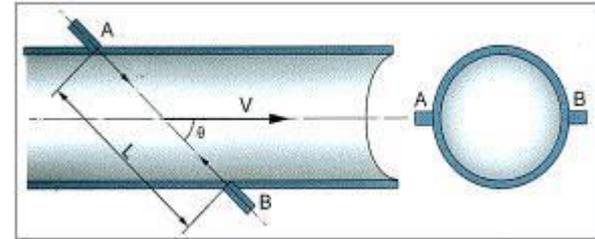
- ◆ Sound waves across the entire diameter
- ◆ Flow profile independent
- ◆ Actual speed of sound measurement (liquid independent)
- ◆ Calibration per fluid is not necessary



Transit Time

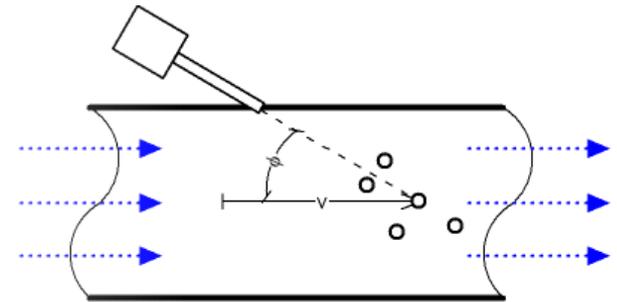
- ◆ Only possible in large bore tubes
- ◆ Signal must traverse the pipe
- ◆ Transducer configurations: Z, V and W
- ◆ Transducers are usually in contact with the fluid

- ◆ Clamp-on method
- ◆ Installation
- ◆ Wall thickness



Doppler Effect

- ◆ Require particles or bubbles for reflection, cannot be used with pure fluids,
- ◆ Transducers are usually in contact with the fluid
- ◆ Accuracy is sensitive to velocity profile
- ◆ Flow rate must be high enough to keep the solids suspended



Five Key Features of the ES-FLOW

- ◆ One sensor for multiple liquids
- ◆ Hygienic design
- ◆ Vibration insensitive
- ◆ Integrated PID controller and fast response
- ◆ Installation in any direction and user friendly, 'plug-and-play' device

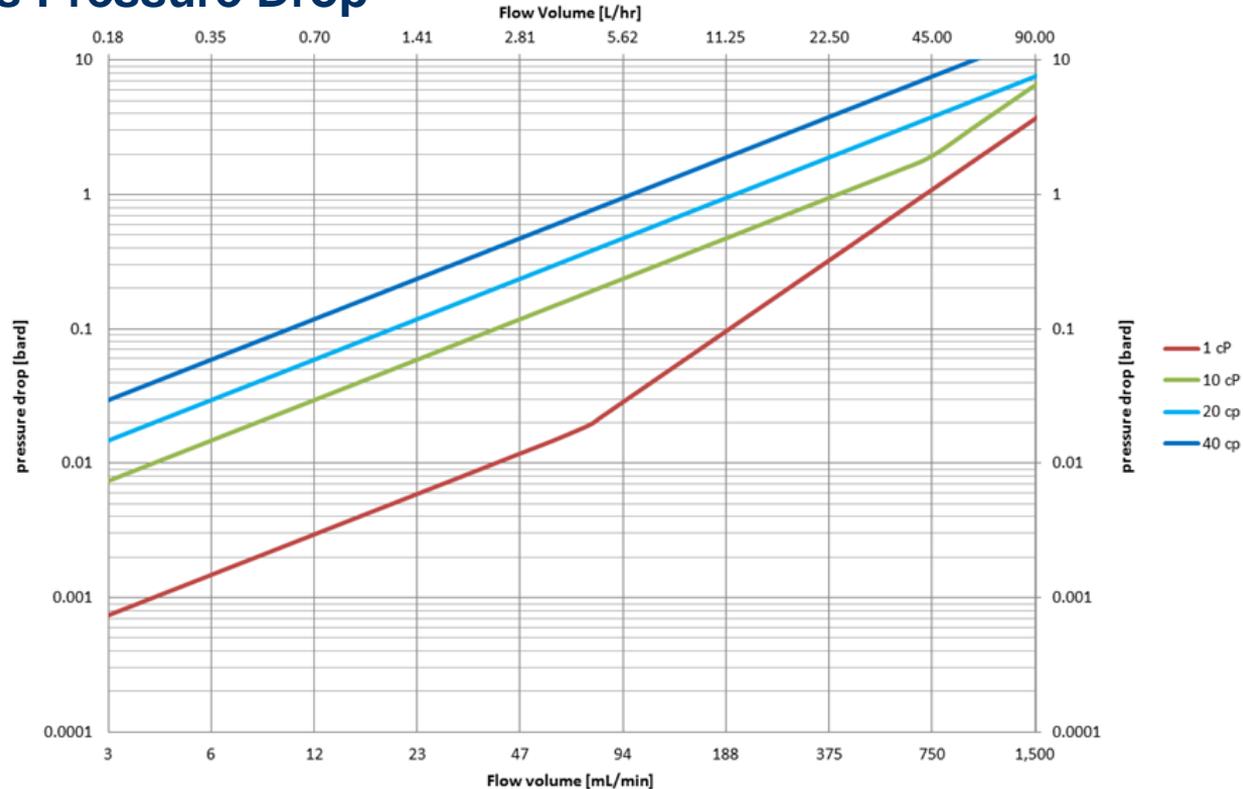


Current specifications

- ◆ Flow range : Capacity 4...1500 ml/min
- ◆ Accuracy : $\pm 1\% \text{ Rd} \pm 1 \text{ ml/min}$
- ◆ Repeatability : $\leq 0.1\% \text{ Rd} \pm 0.05 \text{ ml/min}$
- ◆ PC-board : Integrated PID Controller
- ◆ Outputs : Digital, Analog or Pulse
- ◆ Fieldbus : Modbus, Profibus DP, DeviceNet & Flowbus (M12 5-pin connector)
- ◆ IP class : IP67
- ◆ Material wetted parts : SS316L
- ◆ Seals : None
- ◆ Response time (t98%) : $\leq 200 \text{ msec}$
- ◆ Refresh (cycle) time : $\leq 10 \text{ msec}$

Key Features & Specifications

Flow Rate vs Pressure Drop



Advantages compared to other flow measurement technologies

Possibility of measuring non-conductive liquids

Low pressure drop

Easy installation & insensitive for vibrations

Medium independent & no conversion factors

Modest pricing and good accuracy level

Hygienic design and integrated PID controller





Food, Beverage & Pharma

H₂O₂ for sterilization

Concentrated additives

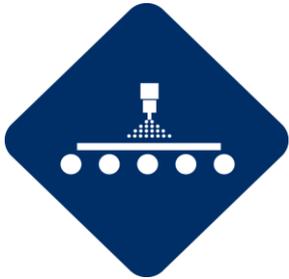
Water solutions & demineralized water



Chemical

Catalyst & Reagent Dosing

R&D & pilot-plant applications



**Surface
treatment**

Thermal spraying

Powder in liquid



Miscellaneous

Fuel consumption

Colorant dosing for packaging

Bronkhorst, Performance for Life

- ◆ Development & manufacturing of flow meters and controllers
- ◆ Leader in **low flow** fluidics handling technology
- ◆ HQ located in NL
- ◆ Over 450 employees world wide

Innovation

- ◆ Market-driven approach in development and process improvement
- ◆ 20% of employees active in R&D and Engineering
- ◆ 15% of annual turnover is invested in R&D



Round the clock support



**ISO 17025
ACCREDITED
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Flow Measurement Principles



Thermal Mass Flow



Coriolis Mass Flow



Ultrasonic Volume Flow

Conclusion

ES-FLOW

- ◆ Versatile & robust liquid flowmeter
- ◆ Suitable for low flow rates
- ◆ Liquid independent
- ◆ Straight sensor tube with zero dead volume

Bronkhorst®

- ◆ Your partner in low flow fluidics handling
- ◆ Helps innovating and optimizing your processes
- ◆ 35 years of knowledge & experience
- ◆ Wide range of products and multiple flow measurement techniques
- ◆ Complete solution from one supplier





Bronkhorst® Performance for Life

Innovation - Experience - Responsibility

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