

# What is an ultrasonic flow meter?

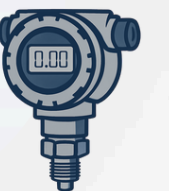
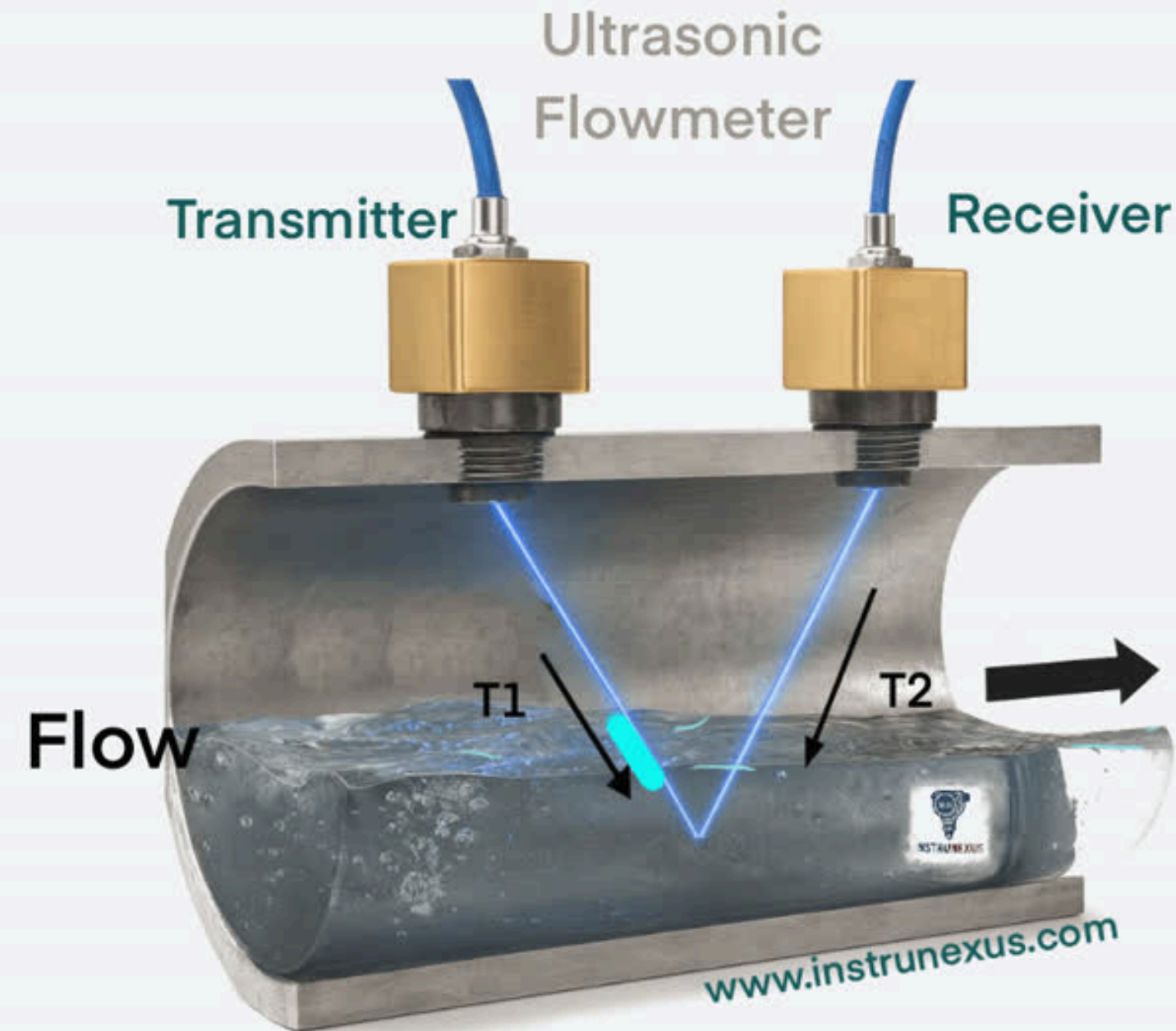
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An ultrasonic flow meter measures fluid velocity by using sound waves.

It sends high-frequency ultrasonic pulses through the fluid, and based on the time difference or frequency shift, it calculates flow rate.

It is **non-intrusive**, has **no moving parts**, and is widely used for liquids and gases.

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# What is the working principle of ultrasonic flow meters?

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Two main principles:

## Transit-Time (Time-of-Flight):

Measures the difference in travel time between ultrasonic pulses moving with and against the flow.

**Doppler Effect:** Uses frequency shift when sound reflects from particles or bubbles in the fluid.



Time Difference Measurement



Flow Velocity Measurement



Frequency Shift Analysis



Particle Movement Detection



Transit-Time Method



Doppler Effect Method

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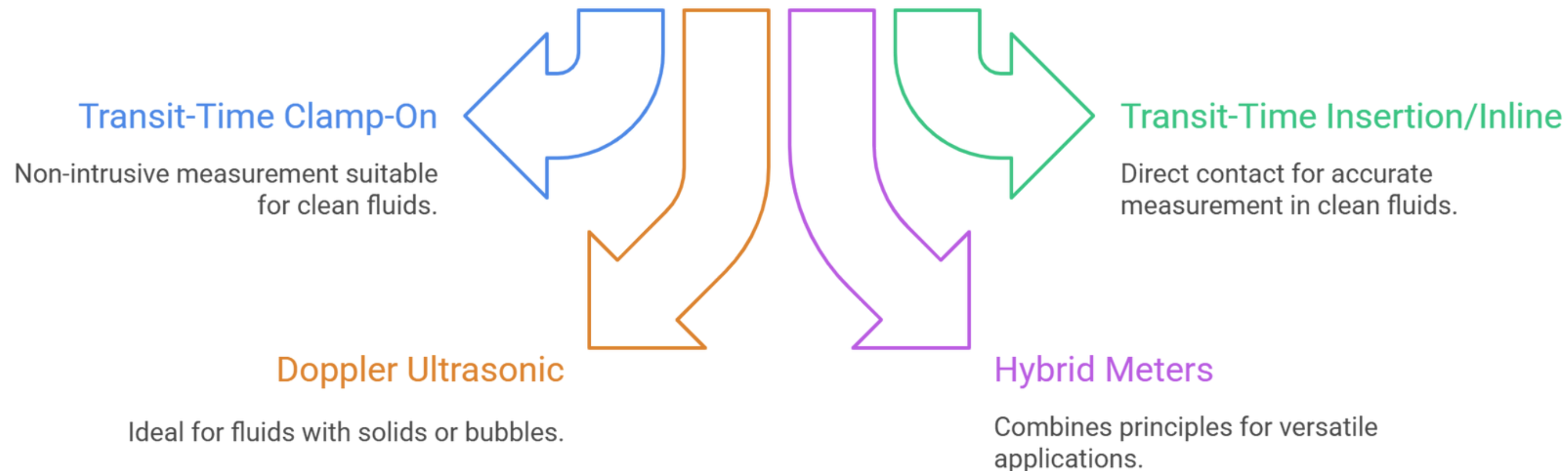
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# What are the main types of ultrasonic flow meters?

Transit-Time Clamp-On (non-intrusive).  
Transit-Time Insertion/Inline (direct contact).  
Doppler Ultrasonic (for fluids with solids/bubbles).  
Hybrid Meters (combine both principles).

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Which type of ultrasonic flow meter should be used?



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# What is the difference between transit-time and Doppler ultrasonic flow meters?

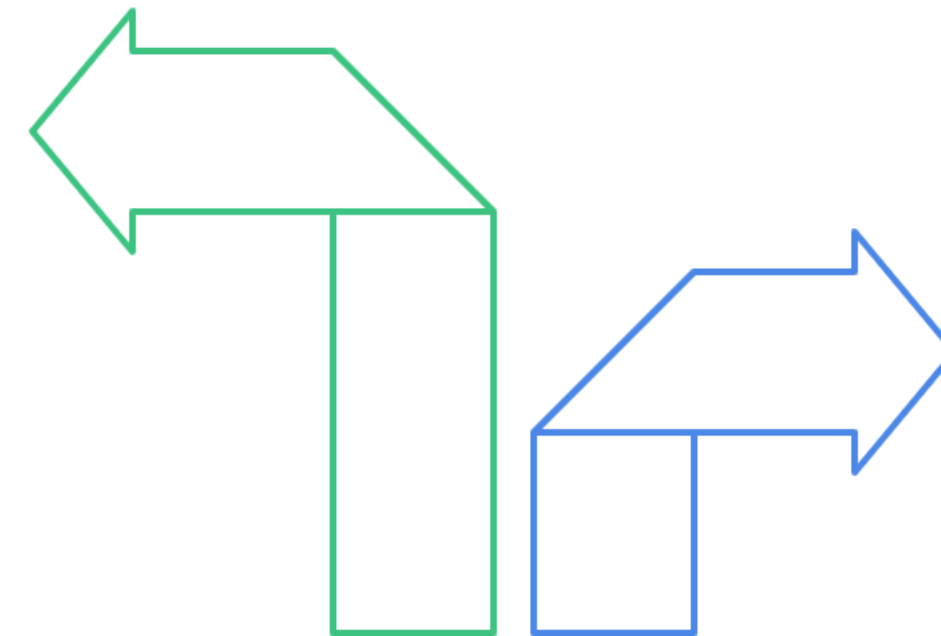
**Transit-Time:** Best for clean fluids with minimal suspended particles or bubbles.

**Doppler:** Best for dirty or slurry fluids with suspended solids, bubbles, or aeration.

Which flow meter type should be used for fluid measurement?

## Doppler Flow Meter

Suitable for dirty or slurry fluids with suspended solids or aeration.



## Transit-Time Flow Meter

Ideal for clean fluids with minimal particles or bubbles.

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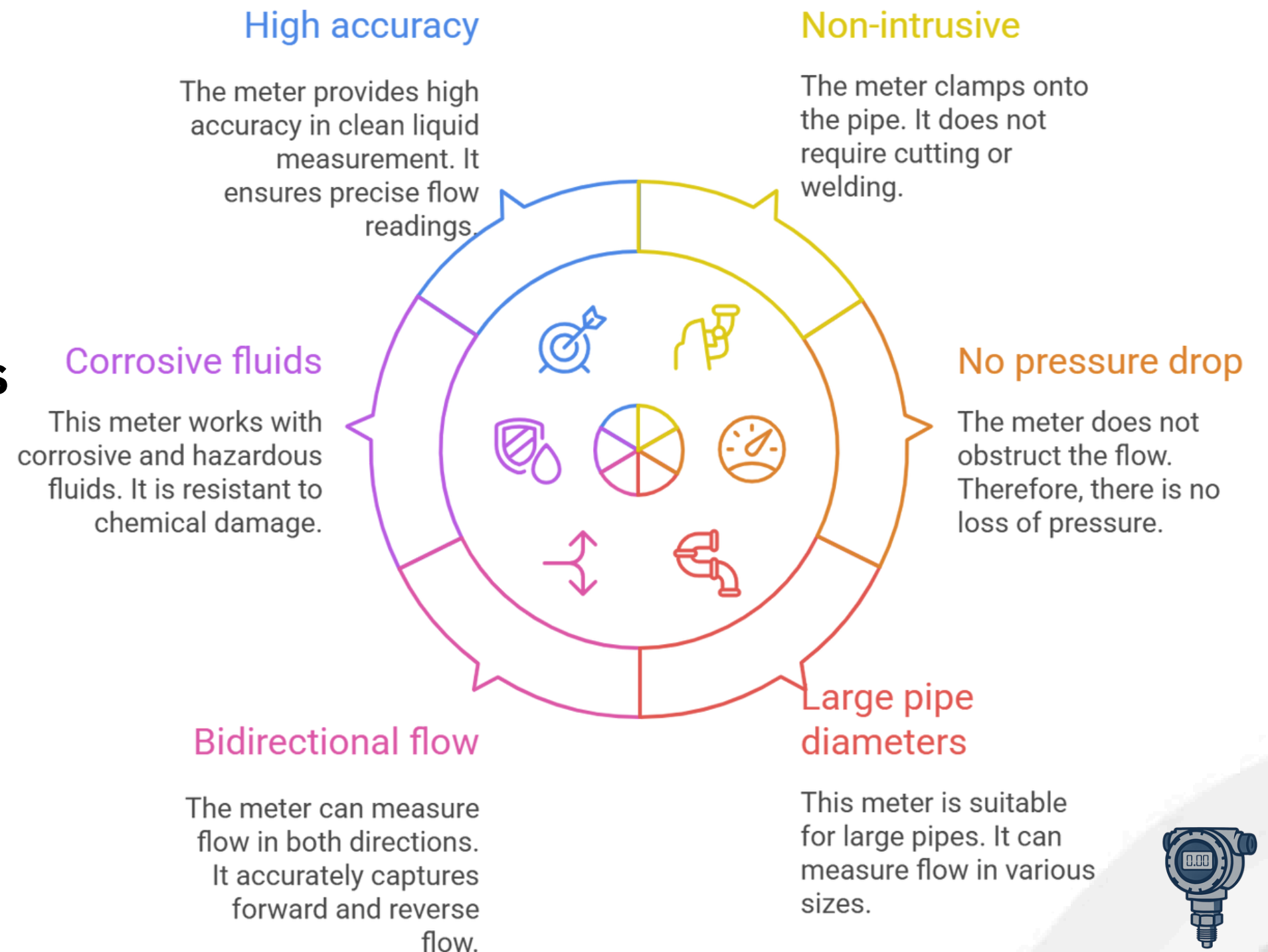
# What are the advantages of ultrasonic flow meters?

- **Non-intrusive (clamp-on type).**
- **No pressure drop.**
- **Suitable for large pipe diameters.**
- **Can measure bidirectional flow.**
- **Works with corrosive and hazardous fluids.**
- **High accuracy in clean liquid measurement.**

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## Flow Meter Advantages

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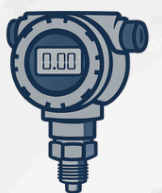
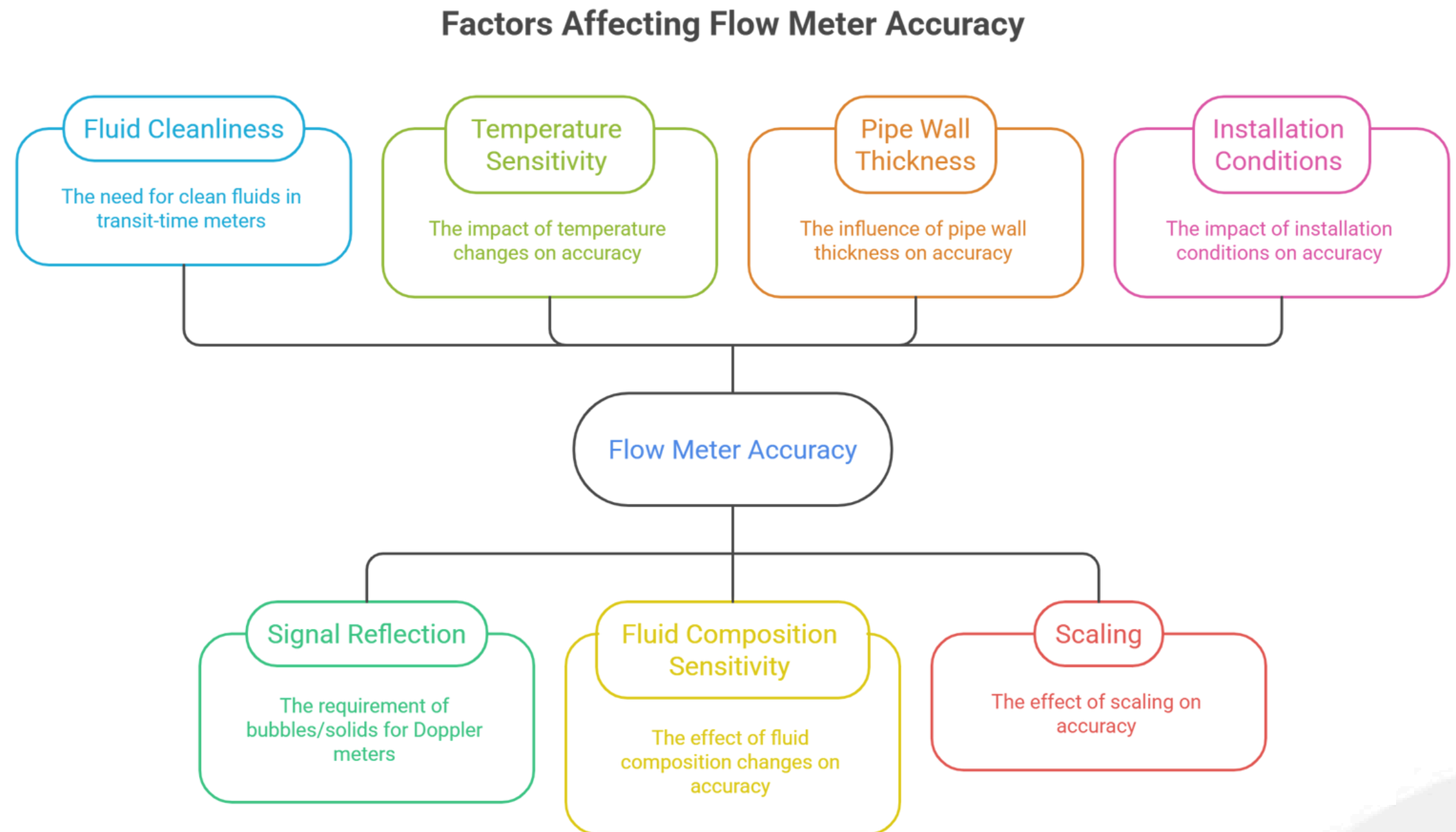
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# What are the limitations of ultrasonic flow meters?

- **Transit-time** meters require clean fluids.
- **Doppler meters** need bubbles/solids to reflect signal.
- Sensitive to temperature and fluid composition changes.
- Accuracy can be affected by pipe wall thickness, scaling, and installation conditions.

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# What are typical accuracy levels for ultrasonic flow meters?

- **Transit-Time:**  $\pm 0.5\%$  to  $\pm 1\%$  of reading (for clean liquids).
- **Doppler:**  $\pm 2\%$  to  $\pm 5\%$  of reading (for dirty liquids).
- **Clamp-On:** Slightly less accurate than inline meters.



**Transit-Time**

Accuracy of  $\pm 0.5\%$  to  $\pm 1\%$  for clean liquids.

Accuracy of  $\pm 2\%$  to  $\pm 5\%$  for dirty liquids.

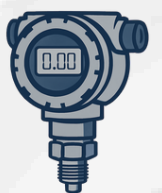
**Doppler**



**Clamp-On**

Slightly less accurate compared to inline meters.

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# Can ultrasonic flow meters measure gases?

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Yes, but with limitations. Specialized ultrasonic gas meters are used in **natural gas pipelines, custody transfer, and flare gas measurement.** They require precise calibration and multiple transducers.



## Ultrasonic Technology

Uses sound waves for precise gas flow measurement.



## Calibration

Ensures accuracy through meticulous adjustment processes.



## Multiple Transducers

Enhances reliability with multiple sensing devices.

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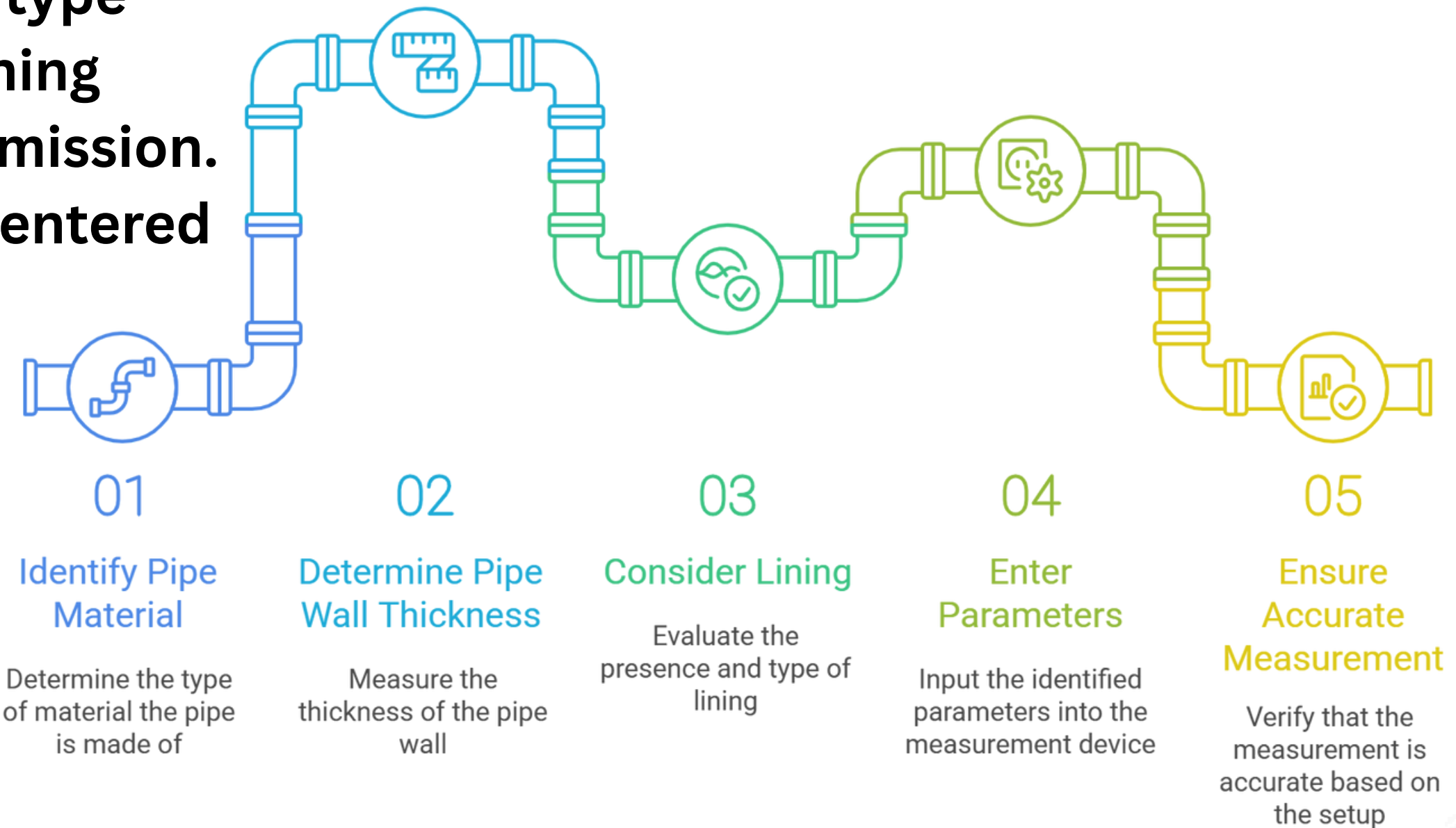


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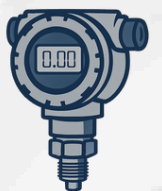


# What is the effect of pipe material on ultrasonic flow meters?

Pipe wall thickness, material type (steel, PVC, concrete), and lining affect ultrasonic signal transmission. Correct parameters must be entered during setup for accurate measurement.



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# How do clamp-on ultrasonic flow meters work?

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Clamp-on meters use external transducers mounted on the pipe wall.



**Pipe Diameter Input**

Entering the correct pipe diameter into the meter

They send and receive ultrasonic pulses through the pipe and fluid.



**Acoustic Coupling Gel**

Applying gel to ensure good contact between transducer and pipe

They require proper pipe diameter input, acoustic coupling gel, and installation alignment.



**Installation Alignment**

Aligning the transducers properly on the pipe

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# What industries commonly use ultrasonic flow meters?

- **Oil & Gas:** Custody transfer, flare gas monitoring.
- **Water & Wastewater:** Leak detection, distribution.
- **Power Plants:** Boiler feedwater, cooling systems.
- **Chemical & Pharma:** Corrosive liquids, batching.
- **Food & Beverage:** Milk, juices, slurries.



# How do you install ultrasonic flow meters for accuracy?

Ensure adequate straight-run piping (typically **10D upstream, 5D downstream**).

Use **coupling gel** for clamp-on sensors.

Avoid **air bubbles** and **solids** for transit-time type.

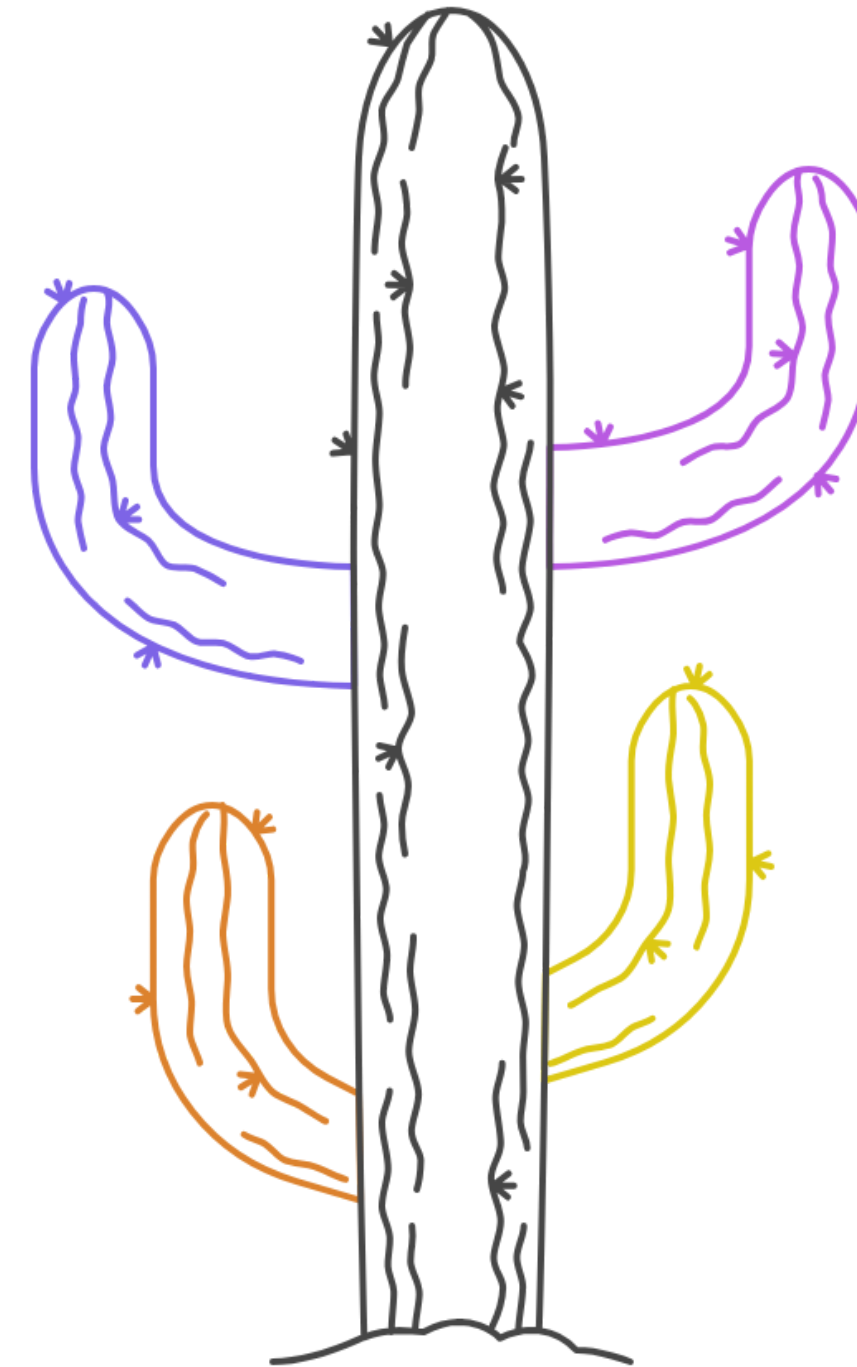
**Proper alignment** of transducers is critical.

No Reading

Incorrect setup parameters

Weak Signal

Alignment and coupling issues



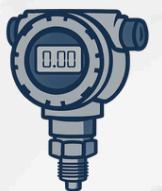
Drift in Zero

Requires frequent recalibration

Erratic Readings

Air bubbles affect the flow

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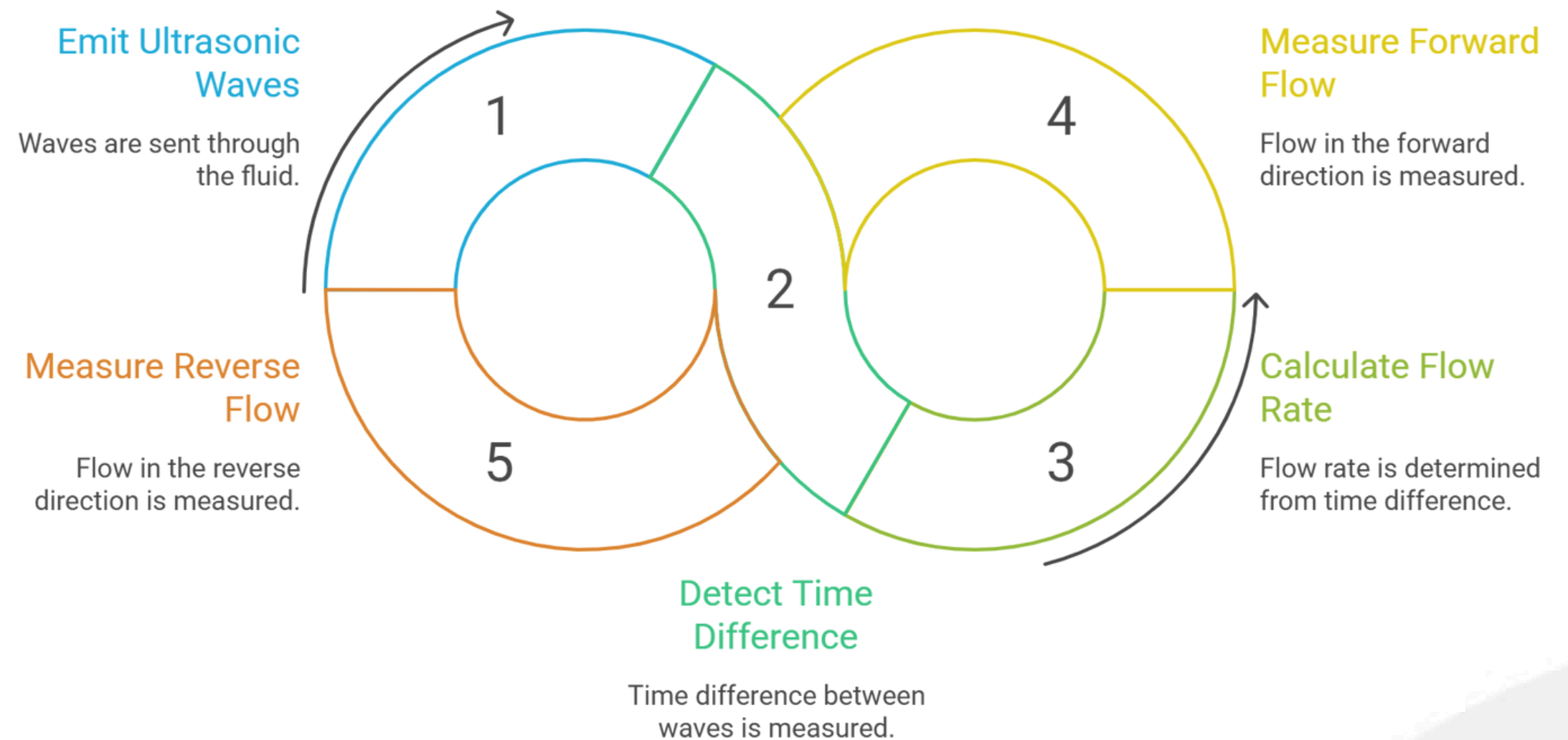
# What is Reynolds number requirement for ultrasonic flow meters?

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Transit-time meters require fully developed turbulent flow (**Re > 10,000**).

At lower Reynolds numbers, flow profile distortion may cause inaccuracy.

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# How do temperature and pressure affect ultrasonic flow meters?

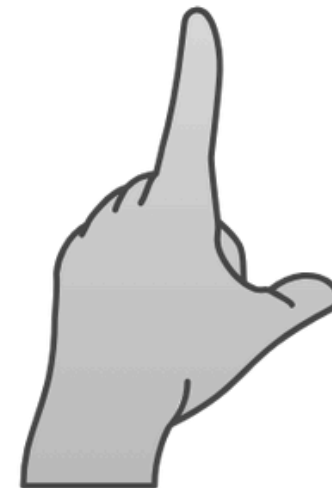
**Temperature:** Affects speed of sound in fluid, requiring compensation.

**Pressure:** Minimal effect, but extreme conditions require specialized transducers. Modern meters auto-correct for these variations.



**Temperature Compensation**

Adjust for changes in the speed of sound due to temperature variations.



**Pressure Considerations**

Use specialized transducers for extreme pressure conditions.



**Automatic Correction**

Rely on modern meters to automatically adjust for variations.



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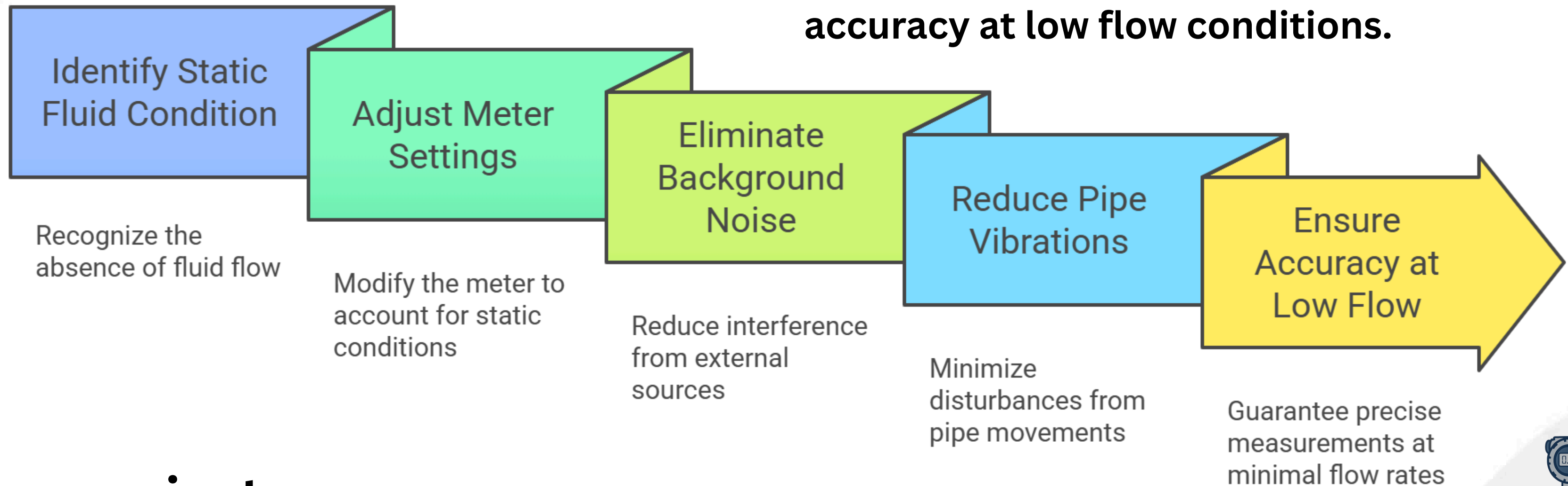


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# What is zero-flow calibration in ultrasonic flow meters?

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It is the process of adjusting the meter when the fluid is **static (no flow)**. This eliminates background noise, pipe vibrations, and ensures accuracy at low flow conditions.



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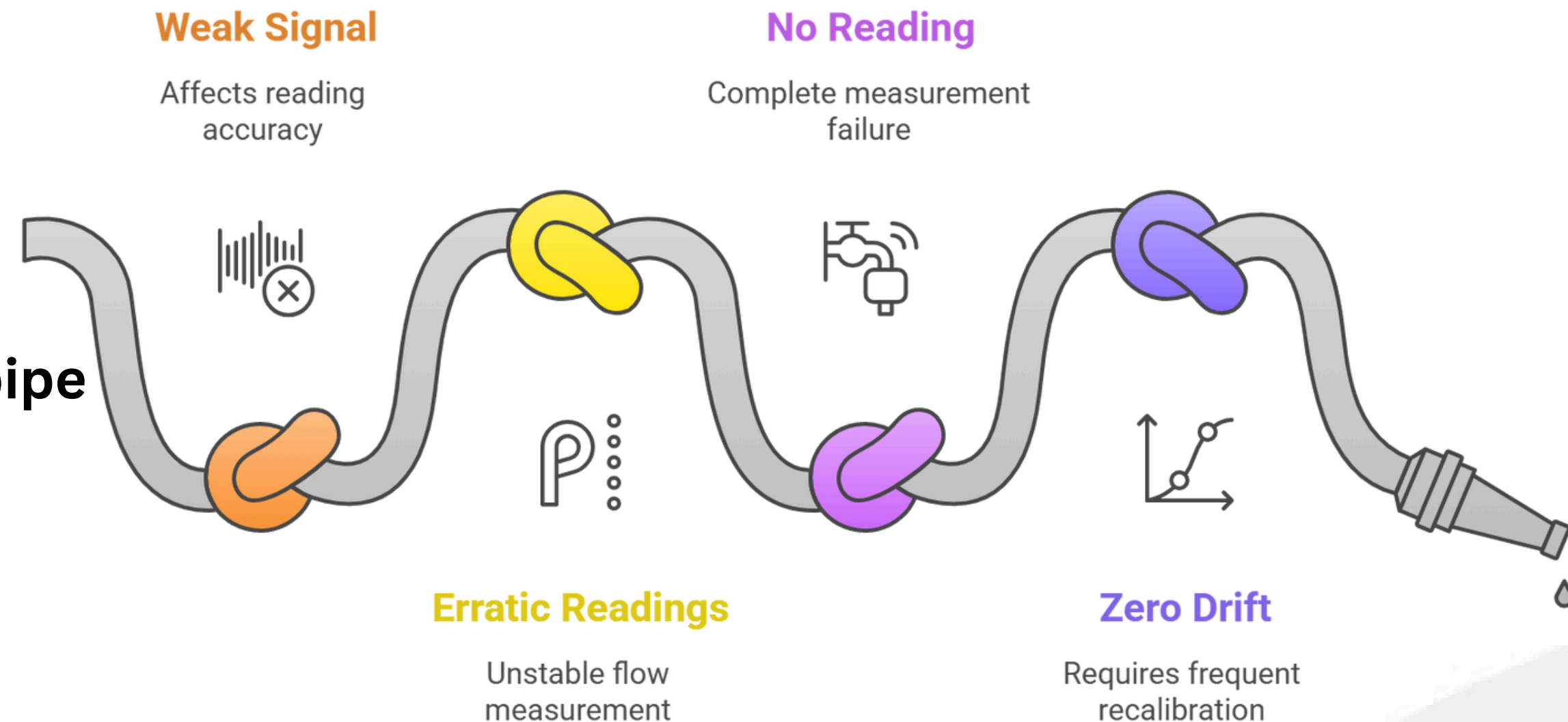


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# What are common troubleshooting issues in ultrasonic flow meters?

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- **Weak signal:** Poor transducer alignment, dirty pipe, wrong coupling.
- **Erratic readings:** Air bubbles, cavitation, multiphase flow.
- **No reading:** Incorrect setup (pipe material, diameter), faulty transducer.
- **Drift in zero:** Requires recalibration.



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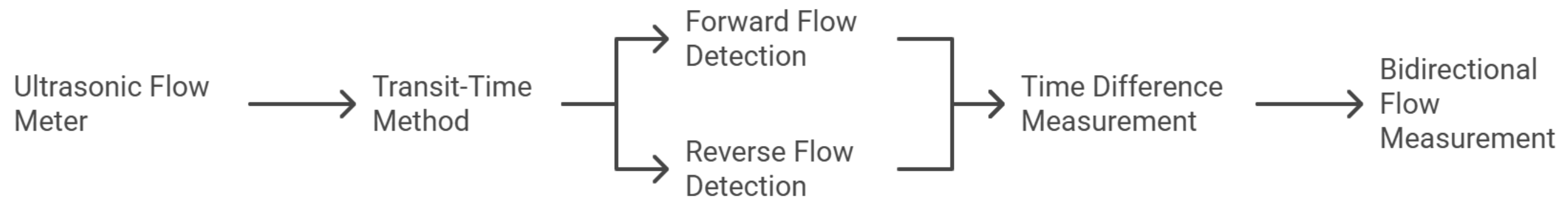


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# Can ultrasonic flow meters measure bidirectional flow?

**Yes.** Transit-time ultrasonic meters can measure both forward and reverse flow by detecting time difference in both directions.

## Ultrasonic Flow Meter Bidirectional Measurement



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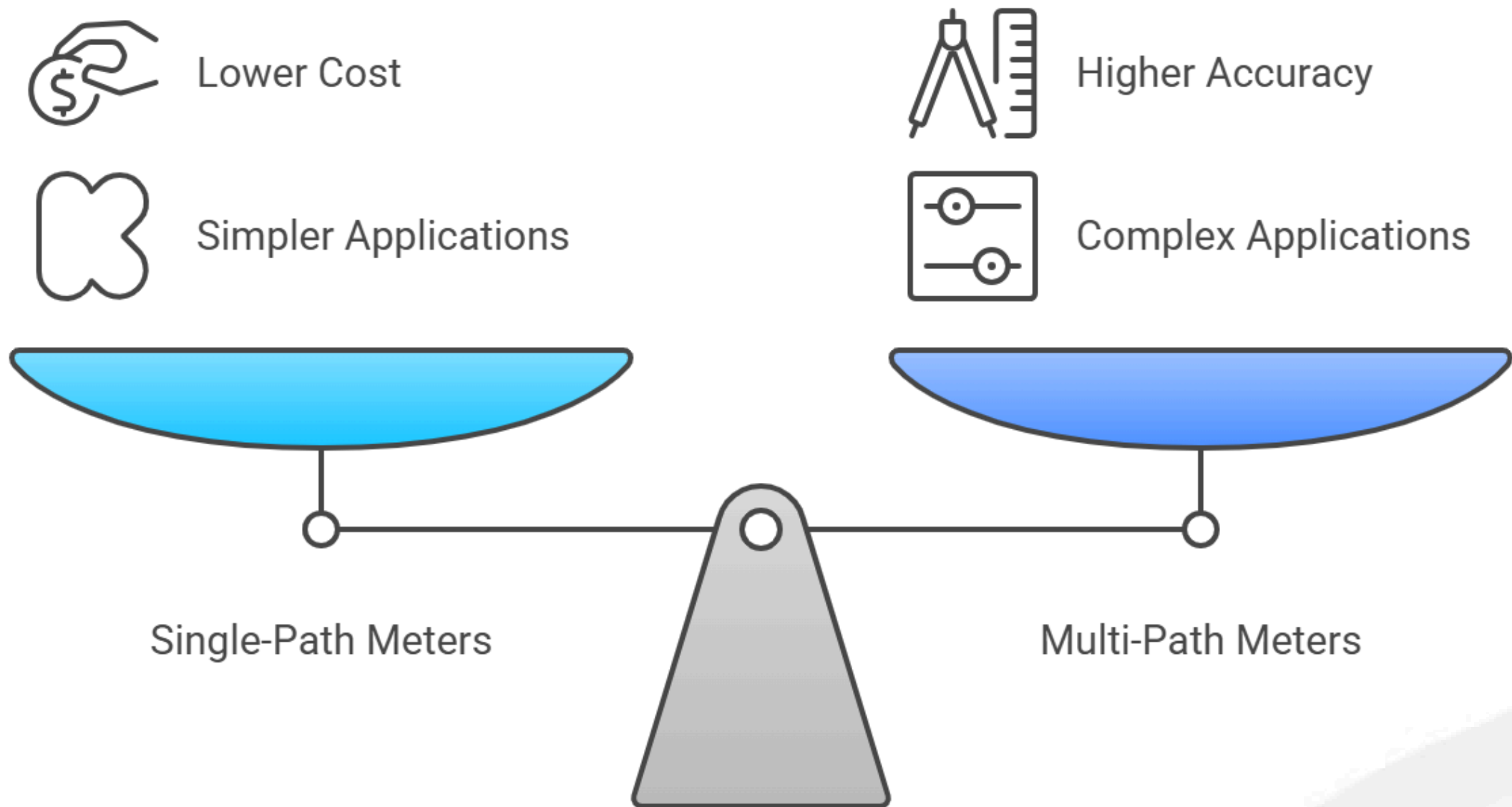
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# What is the difference between single-path and multi-path ultrasonic flow meters?

- **Single-Path:** One pair of transducers; lower cost, less accurate.
- **Multi-Path:** Multiple pairs across pipe diameter; higher accuracy, used in custody transfer and large pipelines.



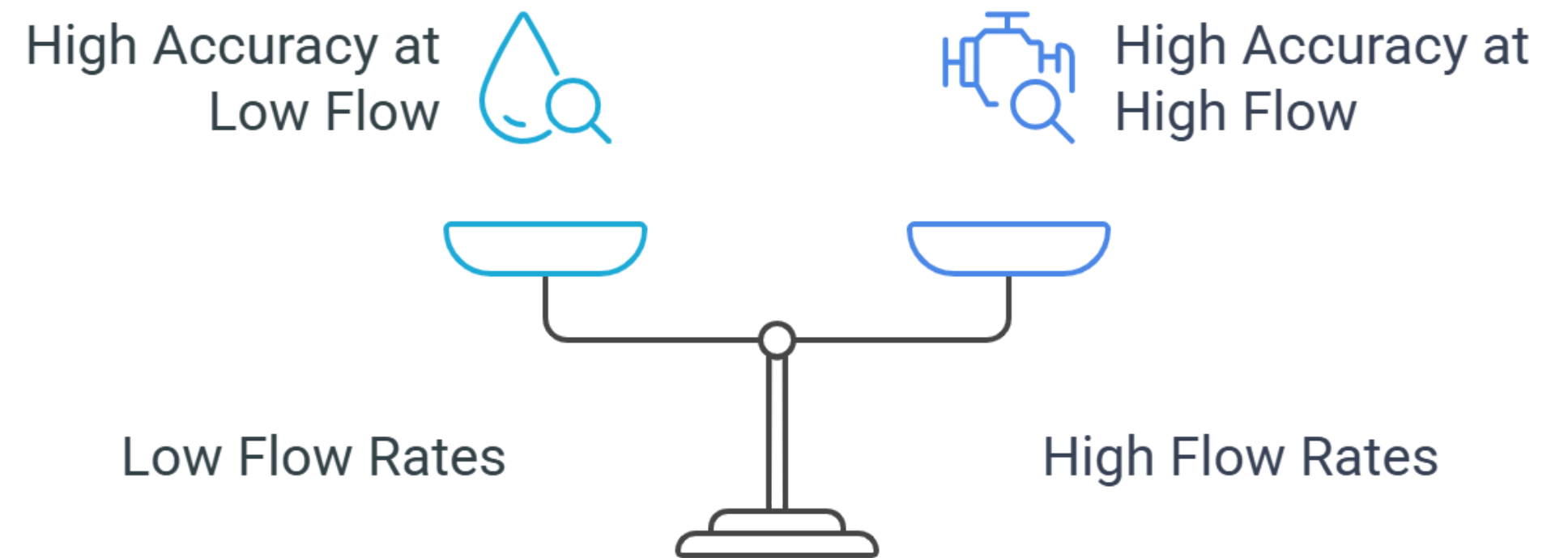


# What is the turndown ratio of ultrasonic flow meters?

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Typically **20:1 to 100:1**, depending on design.

This means they can accurately measure across a wide flow range, from very low to very high flow rates.



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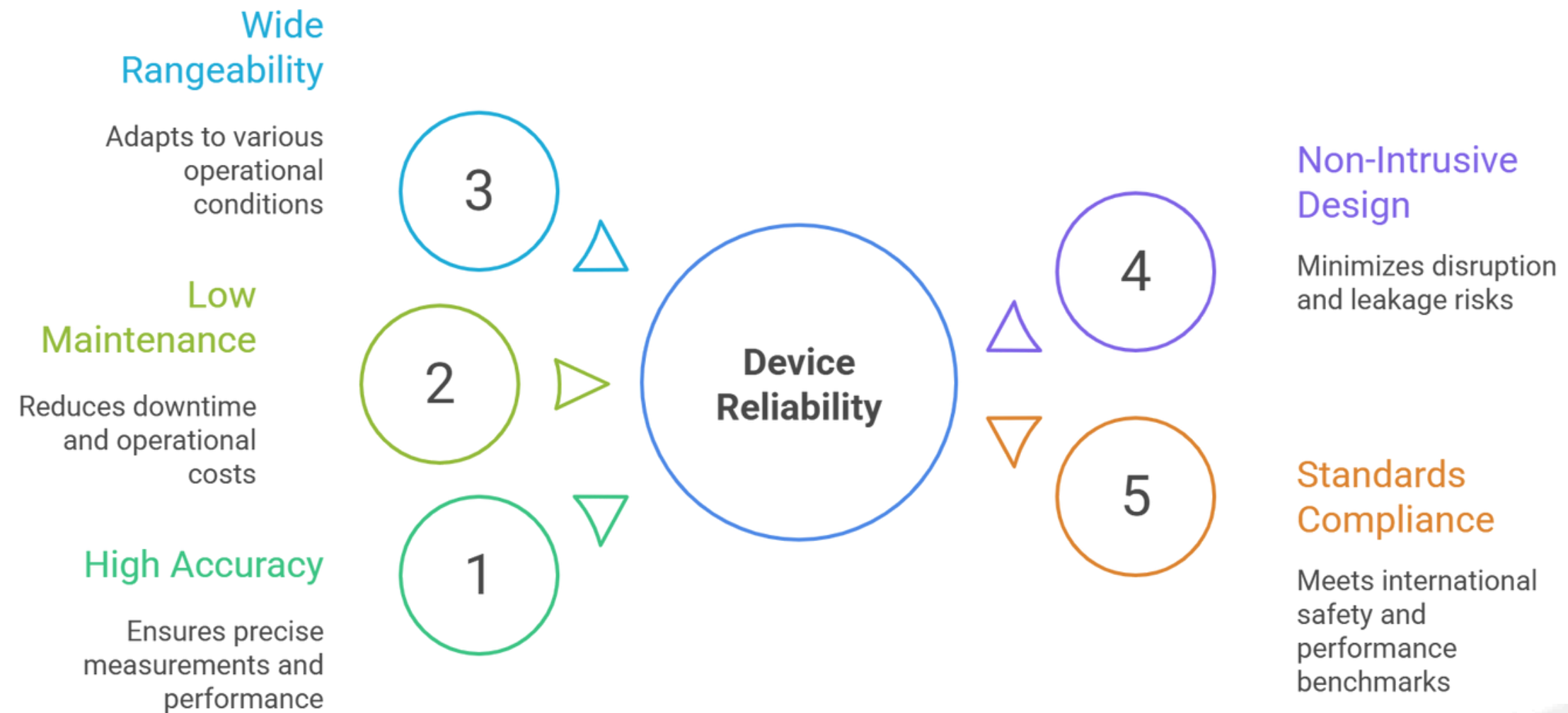
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# Why are ultrasonic flow meters preferred for custody transfer applications?

- High accuracy with multi-path design.
- No moving parts → low maintenance.
- Wide rangeability.
- Non-intrusive, reducing leakage risk.
- International standards compliance (e.g., AGA, ISO).



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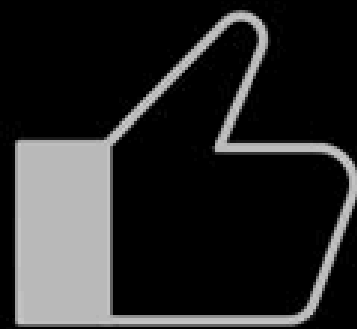
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