Optimizing ultrasonic flowmeter performance in biogas applications

Process instrumentation solutions for wet biogas measurement

Benefits at a glance

- Reliable wet gas measurement
- Accurate methane fraction analysis
- Optimized for multiphase flow conditions
- Flexible installation options
- Reduced maintenance downtime
- Enhanced thermal stability
- Ideal for anaerobic digester monitoring

Summary Biogas measurement presents unique challenges due to its saturated water vapor content and potential for free water. In anaerobic digesters, gas exits at temperatures between 95–102 °F, fully saturated with water vapor. If this gas cools before reaching the measurement point, condensation occurs, leading to free water formation and the onset of multiphase flow. These conditions can compromise the accuracy of flow and methane fraction measurements.

Endress+Hauser's Proline Prosonic Flow B 200 and Proline Prosonic Flow G 300/500 ultrasonic flowmeters are engineered to operate in wet gas environments. Their advanced transducer designs and signal processing capabilities allow for reliable measurement in saturated and semi-wet biogas streams. However, optimal performance depends on managing fluid dynamics and thermodynamics throughout the system.

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Challenge The core challenge in biogas measurement is maintaining the gas phase from the digester to the ultrasonic flowmeter. Several factors contribute to measurement complexity:

- **Condensation**: Saturated biogas condenses rapidly when exposed to cooler ambient conditions, especially in uninsulated or exposed piping.
- **Free water**: Animal waste digesters, such as plug flow pits and covered lagoons, often discharge gas with higher water content due to influent variability and outlet design.
- **Multiphase flow**: Once free water accumulates, the gas-liquid mixture becomes multiphase, disrupting ultrasonic signal paths and degrading flow accuracy.
- **Flow profile distortion**: Horizontal piping can lead to stratified flow, while vertical upward flow may cause cascading effects — both of which interfere with sound wave transmission.

Even in municipal digesters with more controlled conditions, the risk of condensation remains if thermal equilibrium is not maintained.

Solution Accurate biogas measurement using ultrasonic flowmeters requires a combination of robust instrumentation and strategic system design.

Instrumentation design

- Proline Prosonic Flow B 200 features metallic transducers with an acoustic matching layer. This layer vibrates at high frequency, repelling water droplets and maintaining a clean transducer surface.
- Proline Prosonic Flow G 300/500 uses all-metal transducers with a large gap between the socket and the transducer. Integrated drainage paths prevent acoustic coupling and allow condensate to escape, preserving signal clarity.

Proline Prosonic Flow B 200

Proline Prosonic Flow G 300/500

System-level countermeasures
To support the flowmeter's capabilities, the following practices are recommended:

- **Manage free water**: If free water cannot be controlled at the digester, install a knockout pot or water separator upstream of the ultrasonic flowmeter to remove bulk liquid.
- **Maintain thermal equilibrium**: Insulate all exposed piping between the digester and the flowmeter. In colder climates, heat tracing may be necessary to keep the gas temperature above its dew point.
- **Optimize installation orientation**: Horizontal installations are acceptable if free water is minimal and thermal conditions are stable. However, stratified flow may cause signal loss in the lower path. Vertical installations should favor downward flow, which aligns gas and liquid velocities and reduces cascading effects. Upward flow should be avoided due to the risk of water disrupting the measurement section.

Results When these best practices are implemented, ultrasonic flowmeters like the Proline Prosonic Flow B 200 and Proline Prosonic Flow G 300/500 deliver consistent and accurate performance in biogas applications:

- **Methane fraction** remains reliable even in partially flooded conditions, thanks to robust sound speed measurement.
- **Flow accuracy** is preserved in wet gas environments when free water is minimized and thermal equilibrium is maintained.
- **Operational stability** improves due to self-cleaning transducer designs and reduced maintenance needs.

By treating biogas as a dynamic fluid system and addressing both its thermal and physical behavior, operators can achieve high-quality data that supports process optimization, regulatory compliance and energy recovery.

Learn more about Endress+Hauser's ultrasonic flowmeters

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