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Engineering Insights: Conductivity Measurement

Part 3 of 4

Inductive Conductivity Sensors

Why Electrodeless Measurement Has Become the Industry Standard for CIP and Chemical Processes

How They Work

Inductive conductivity sensors, also known as **electrodeless** or **toroidal** sensors, measure conductivity without exposing electrodes to the process liquid.
Instead of passing electrical current directly through metal electrodes, the sensor contains two toroidal coils encapsulated within the sensor body.

The primary coil generates an alternating magnetic field, inducing an electrical current within the process liquid. This induced current creates its own magnetic field, which is detected by the secondary coil. The strength of this induced signal is directly proportional to the conductivity of the liquid.
Because there is no direct electrical contact between the measuring elements and the process media, the sensor is inherently resistant to contamination and corrosion.

Advantages

Inductive conductivity sensors offer significant operational advantages:

- No exposed electrodes.
- Minimal fouling effects.
- Excellent resistance to coating and scaling.
- Low maintenance requirements.
- Reliable operation in aggressive chemicals.
- Stable long-term measurement.
- Ideal for hygienic process environments.

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Limitations
Like every measuring technology, inductive conductivity sensors also have limitations.
They generally:

- Are less suitable for measuring extremely low conductivity values.
- Have a higher initial purchase cost.
- Are physically larger than conductive probes.
- Are optimised for medium to high conductivity applications rather than ultra-pure water measurement.

Typical Applications
Inductive conductivity sensors are widely used in:

- Clean-in-Place (CIP) systems.
- Food and beverage manufacturing.
- Breweries.
- Dairies.
- Pharmaceutical production.
- Chemical processing.
- Caustic and acid concentration control.
- Product-to-water interface detection.
- Product recovery systems.
- Hygienic process applications.

Engineering Takeaway
Inductive conductivity sensors are particularly suited to processes where fouling, aggressive media, hygiene and low maintenance make direct electrode contact a limitation.