Milk/Water Interface Detection

In dairy production, thorough and reliable cleaning of pipelines and process equipment is a critical factor in product quality, shelf life, and operational efficiency. Inadequate or poorly timed cleaning sequences can lead to product contamination, unnecessary product loss, and excessive wastewater generation.

A common cleaning scenario involves displacing milk from a filled pipeline using a pressurized water rinse. As the water front advances, it pushes the milk ahead of it and a milk/water interface forms at the boundary between the two media. Identifying this interface precisely and in real time is key to optimizing the process: divert too early and milk is lost to drain; divert too late and diluted product that is unsaleable and costly to treat enters the next stage.

THE LIMITATION OF TIME-BASED CONTROL

Many dairies rely on time-controlled switching to manage pipeline cleaning sequences. In this approach, the divert point is calculated from historical flow data and experience, with a generous safety margin applied to ensure no milk residues carry over.

While this provides a degree of reliability, it is inherently inefficient. Safety margins mean the switching point is either conservative, resulting in product loss to drain, or generous, overly diluted product to pass through to downstream processes. Variations in flow rate, pipeline length, or product viscosity between batches further undermine the accuracy of time-based approaches.

TURBIDITY-BASED INTERFACE DETECTION

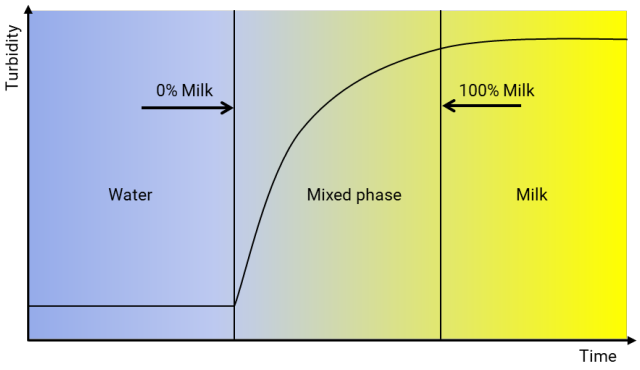
Inline turbidity monitors provide a direct, real-time measurement solution for milk/water interface detection. As the water front displaces the milk through the pipeline, the turbidity of the process stream falls sharply at the interface. This change in backscattered NIR signal is detected continuously and used to trigger the divert valve at the precise moment the interface passes the sensor.

Unlike time-based control, this approach is self-correcting. Regardless of batch-to-batch variation in flow conditions or product characteristics, the sensor responds to what is actually in the pipe. The switching point is determined by a measurable, reproducible physical parameter rather than an estimate.

HOW DETECTION WORKS

Backscatter turbidity sensors are optical devices. A beam of near-infrared (NIR) light is projected from the sensor into the process stream through a flush-mounted sapphire optical window. Suspended particles and droplets in the liquid — fat globules and proteins in the case of milk — scatter this light in all directions. A portion of that scattered light returns toward the sensor (backscatter) and is captured by a detector positioned adjacent to the light source. The intensity of this backscattered signal is directly related to the concentration of suspended material in the liquid and will be high when milk is present, low when clean water is present.

During the normal processing of milk, the signal from the sensor will be high. The backscatter signal drops sharply as the milk is displaced by clean water. This transition is detected in real time and used to trigger the pipeline divert valve at the optimum moment to maximize production and minimize waste.



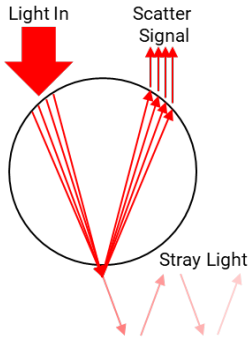
Turbidity signal transition from water to milk

THE EXSPECT 271 SENSOR

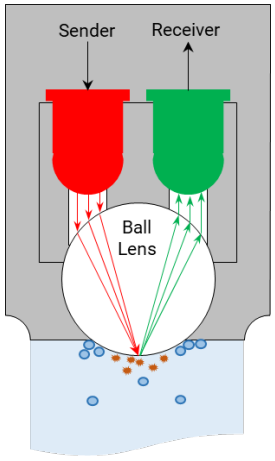
The EXspect 271 is a compact, high-precision NIR backscatter sensor designed for continuous in-line process monitoring and CIP/SIP regimes in the food and beverage industry. The sensor incorporates integrated signal analysis and a local display, enabling straightforward commissioning and ongoing monitoring without additional instrumentation. Key application areas include phase separation and interface detection, filter monitoring, product changeover detection, and concentration measurement across a wide range of process media.

A key design feature of the EXspect 271 is its spherical sapphire lens. Conventional flat windows present a planar interface to the process, which can act as a partial reflector. A portion of the emitted light is reflected at the internal surface and can re-enter the detector path as stray light, introducing bias, particularly at low turbidity levels where signal strength is limited. The spherical geometry reduces this effect. By altering the angle of incidence across the surface, internally reflected light is redirected away from the detector axis rather than back into it. This minimizes optical noise and improves sensitivity to true backscatter from the process fluid.

The curved surface also offers practical advantages in real-world operation. Flat windows tend to promote fouling and bubble adhesion, both of which degrade measurement stability over time. A convex surface is less conducive to buildup and is more effectively cleaned in situ, as process flow and CIP action generate higher local shear at the surface.



Limits the impact of pipe wall stray light



Sheds bubbles and self-cleans through flow shear action

In addition, the defined optical geometry greatly limits the impact of pipe reflections. Light interacting with the pipe wall is less likely to be returned directly to the detector, reducing susceptibility to installation effects.

The result is a sensor that delivers stable, repeatable measurements with reduced drift and interference—well suited to continuous dairy processing where consistency and uptime are critical.

- Reliable phase boundary detection
- Stable performance
- Low maintenance
- EHEDG/3A certified
- Selection of process connections

GET IN TOUCH

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