Application Note

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Leading Process Analytics

Greater Depth Filtration Performance

Through Turbidity and Pressure Monitoring

Depth filtration is an effective method in bioprocessing for removing particles from liquids using a permeable membrane. Turbidity serves as an important indicator of liquid quality, reflecting the concentration of suspended particles that could pose health risks or operational challenges. However, membrane clogging can hinder performance, highlighting the need for continuous turbidity and pressure monitoring to ensure optimal operation.

Background

Unlike surface filters, which capture particles only at the surface, depth filters trap particles throughout their entire thickness or depth. These filters are typically composed of fibrous or granular materials arranged in multiple layers. The materials create a complex pathway that captures particles of varying sizes [1].

Turbidity is a crucial metric for evaluating the clarity and quality of water and other fluids, indicating the concentration of suspended particles that can affect both appearance and functionality [2]. High turbidity levels may signal the presence of contaminants that could impact health and production processes. Depth filtration effectively reduces turbidity by efficiently trapping particles.

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Process

Depth filtration works like a multi-layered sieve, allowing fluid to pass through a thick medium that captures particles throughout its depth. As the fluid moves through the filtration system, it passes through several layers of porous materials.

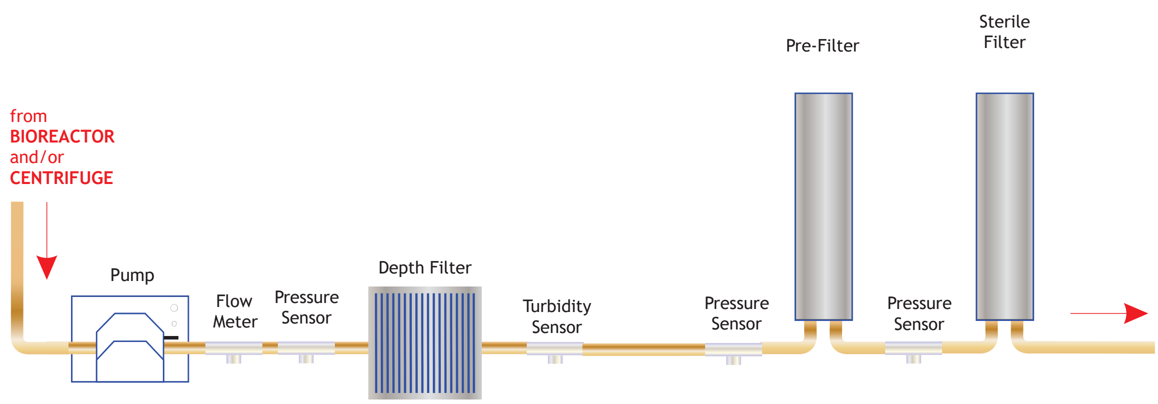
Different types of filtration material play a role in improving particle removal in depth filtration. Cellulose, for instance, provides a strong, fibrous structure for trapping particles; diatomaceous earth, made from fossilized diatoms, offers a high surface area for effective particle capture; and activated carbon is known for its ability to remove impurities and odors. These layers capture contaminants at various depths in the filter, with larger particles getting trapped in the outer layers and smaller ones going deeper into the medium [3].

Turbidity measurement after the filter is an important indicator of how well the depth filtration is working, as it reflects the presence of suspended particles. Measuring turbidity also allows operators to monitor filter efficiency and determine when maintenance is needed. This real-time measurement helps optimize filtration processes, improving product quality and safety. Depth filters are particularly effective for high-volume applications because they can handle a large number of particles before clogging.

Challenges

Clogging of depth filtration membranes presents a significant challenge that can reduce flow rates and filtration efficiency, resulting in increased maintenance costs and potential quality issues in the final product. Regular turbidity monitoring and effective management strategies are essential to mitigate clogging, ensuring optimal performance and compliance with quality standards, especially in critical industries. Failing to measure turbidity can lead to operational inefficiencies and health risks, underscoring the necessity for continuous monitoring.

Alongside turbidity, measuring pressure during depth filtration is equally important for several reasons. It ensures system integrity by confirming that the filtration system is operating within safe limits, thus preventing damage to the filter media and other components. Additionally, monitoring pressure aids in identifying the optimal time for filter replacement, as increased pressure before the filter may indicate that the filter is becoming clogged and less effective. Lastly, pressure measurement provides valuable data for performance monitoring, enabling informed decisions regarding maintenance and operational adjustments.



Mettler Toledo Pendotech's Solution

Single-Use Turbidity Flow Cells

METTLER TOLEDO Pendotech's Single-use Turbidity Flow Cells enable non-invasive turbidity measurements. A sample can be drawn and measured either off-line or through an on-line measurement unit like the Pendotech Turbidity System, which includes a photometer light source/detector, flow cells, fiber optic cables, a flow cell stand, and connections to a monitor or control system. Utilizing the Pendotech Single-use Flow Cell with this system eliminates the need for cleaning. These flow cells incorporate a specialized silica glass lens in the optical path, allowing for intensity measurements between the light source and detector without any direct contact with the fluid. The measured fluid flows through tubing connected to the flow cell's ports.

They come in several sizes, including a 3/4 inch sanitary flange with a 6.5 cm path length, a 1/2 inch hose barb with a 1 cm path length, a 1/4 inch hose barb with a 0.5 cm path length, and a 1/8 inch hose barb with a 2 mm path length. For best performance in turbidity measurements, larger path length flow cells are recommended. Testing with Formazin Turbidity standards indicates that the 6.5 cm flow cell is optimal for turbidity levels below 400 NTU, while the 1 cm flow cell is better suited for levels above 400 NTU, though fluid characteristics may influence results. The affordability of these flow cells makes them ideal for single-use applications. All polymeric materials in the fluid path meet USP Class VI standards, and the flow cells are manufactured in an ISO 9001-certified facility. Additionally, they are capable of withstanding gamma and x-ray irradiation up to 50 kGy.

Pressure Sensor

METTLER TOLEDO Pendotech's Single-Use Pressure Sensors provide accurate and cost-effective measurement of static and dynamic pressure for gases and liquids in biopharmaceutical applications. Designed for durability, these sensors are suitable for disposable use, serving as a reliable alternative to stainless steel pressure transducers. Equipped with High Accuracy Pressure (MEMS-HAP™) chips, they perform well in processes such as filtration, chromatography, and bioreactor monitoring while resisting sanitization in caustic-resistant polysulfone.

With a pressure rating of up to 75 psi, these sensors seamlessly integrate with METTLER TOLEDO Pendotech's PressureMAT monitor or other pre-qualified third-party devices, ensuring unobstructed flow paths and minimizing dead legs to reduce hold-up volume. They offer a pressure range of -11.5 to 75 psi (-0.79 to 5.2 bar) and accuracy specifications from -10 to 60 psi (-0.69 to 4.14 bar), making them an excellent choice for organizations looking to enhance their bioprocessing operations with advanced technology. They meet gamma irradiation and USP Class VI standards and require no calibration, having undergone stringent quality testing during production.

Conclusion

Depth filtration is an effective approach for removing particles from liquids. The filtration process utilizes multiple layers of fibrous or granular substances, forming a convoluted path that effectively entraps particles of different sizes, thereby enhancing filtration efficacy. However, issues such as clogging of the membranes in the filter can decrease performance, highlighting the need for routine turbidity checks and pressure monitoring to maintain optimal function. METTLER TOLEDO Pendotech's Single Use Turbidity Flow Cells and Pressure Sensors enable non-invasive assessments, improve process management, and lower maintenance expenses. These advancements help ensure adherence to industry regulations, enhance product quality, and reduce risks related to elevated turbidity and pressure changes.

References

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