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Real Time Turbid Liquid Fluorescence Sensing: Non-Invasive, Continuous Monitoring for Organ Perfusion and Beyond

A non-invasive continuous fluorescence detection system delivers real-time monitoring of biomarkers, contaminants, or quality markers in liquid streams without direct sampling. It employs a clamp-on turbidity sensor that corrects for and a multi-wavelength fluorescence detector, enabling accurate measurements even in highly turbid media such as organ perfusion circuits. The compact, low-maintenance design is ideal for clinical, bioprocessing, and industrial applications.

Keywords Turbidity correction, Fluorescence spectroscopy, Non-invasive sensing, Continuous monitoring, Organ perfusion, Clamp-on sensor

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Background Conventional fluorescence systems-microplate readers, spectrometers, or inline probes-require periodic sampling and direct liquid contact, raising contamination risks and limiting real-time insight. In turbid environments, scattering skews fluorescence signals, necessitating cumbersome calibration or batch analysis. Continuous monitoring of ex vivo organ perfusion, pharmaceutical production, or food safety demands a solution that remains accurate despite variable opacity, operates without interrupting flow, and requires minimal user intervention. Existing in-line sensors lack adaptive turbidity compensation and multiplexed wavelength capability, leaving a critical gap for reliable, real-time optical analysis.

Invention The system integrates two compact, clamp-on optical modules: a turbidity sensor that measures light attenuation across multiple wavelengths to quantify scattering via Mie theory, and a fluorescence detector that excites the sample with selectable LEDs while capturing emission through band pass filters. Real-time data fusion applies spectral fitting algorithms to correct fluorescence intensity for turbidity-induced losses, yielding accurate concentrations of target fluorophores. The design uses fiber optic coupling, low-power electronics, and software-driven calibration, allowing deployment on standard tubing or cannulas without altering flow dynamics. Prototype validation in liver perfusion models confirmed precise biomarker tracking under varying opacities.

Fields of Use Clinical organ perfusion monitoring, bioprocessing quality control, pharmaceutical manufacturing, food safety testing, environmental water analysis, and any continuous liquid process requiring real-time fluorescence measurement in turbid media.

Patent Status Patent Application filed

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