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Application of Fluorescence Microscopy for Quality Assessment in Industrial Biotechnology

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ABSTRACT

Fluorescence microscopy is widely employed in industrial biotechnology as a sensitive and reliable tool for quality control and bioprocess monitoring. In industrial production systems, microbial contamination and variations in cellular viability can significantly influence product quality, process efficiency, and regulatory compliance, creating a need for rapid and non-destructive analytical techniques. This work focuses on the application of fluorescence microscopy for detection of microbial contamination and assessment of bioprocess quality in industrial biotechnology. The approach is based on reported applications in which selective fluorescent dyes and probes are used to visualize microbial cells and evaluate cell viability and physiological status during bioprocessing. These fluorescence-based methods enable early and specific identification of bacterial or fungal contamination and provide visual confirmation of culture health and consistency during fermentation and related operations. Observations reported in the literature indicate that fluorescence microscopy supports reproducible analysis and improves reliability of quality assessment by allowing rapid interpretation of cellular behaviour and process-related changes. The significance of fluorescence microscopy lies in its ability to enhance quality control strategies through real-time monitoring, improved contamination detection, and support for informed decision-making in industrial workflows. Overall, the application of fluorescence microscopy contributes to maintaining product quality, strengthening quality assurance practices, and improving process reliability in industrial biotechnology.

Keywords: *Fluorescence microscopy, Industrial biotechnology, Bioprocess monitoring, Quality control, fluorescent dyes*

