Fraunhofer IPM

F-Fiber

Monitoring of cleaning-in-place processes in food production

Cleaning processes in the food industry are designed for worst-case fouling scenarios. F-Fiber makes it possible to control these processes and adapt them to the contamination level.

Fiber-optical probe for efficient detection of fouling

In the food processing industry, high hygiene requirements apply to ensure consistently high product quality. Deposits inside closed vessels are removed by regular cleaning routines, independent of the actual degree of fouling. F-Fiber, a fiber-optical fluorescence sensor developed by Fraunhofer IPM, enables assessing the cleanliness inside vessels and makes it possible to monitor cleaning processes in food production.

Enhancing CIP processes

In some food industries, such as the dairy industry, cleaning-in-place (CIP) processes are applied on a daily basis. As there is no reliable information on the amount of deposit present on the inside walls of a vessel or a pipeline, these processes are designed for worst-case contamination scenarios to make sure that the required hygienic standards are safely maintained.

This not only leads to delay in production, but also to a waste of energy, water, and cleaning agents. Adapting CIP processes to the actual surface coverage of contaminations therefore holds both, economic and ecological advantages for food processing processes.

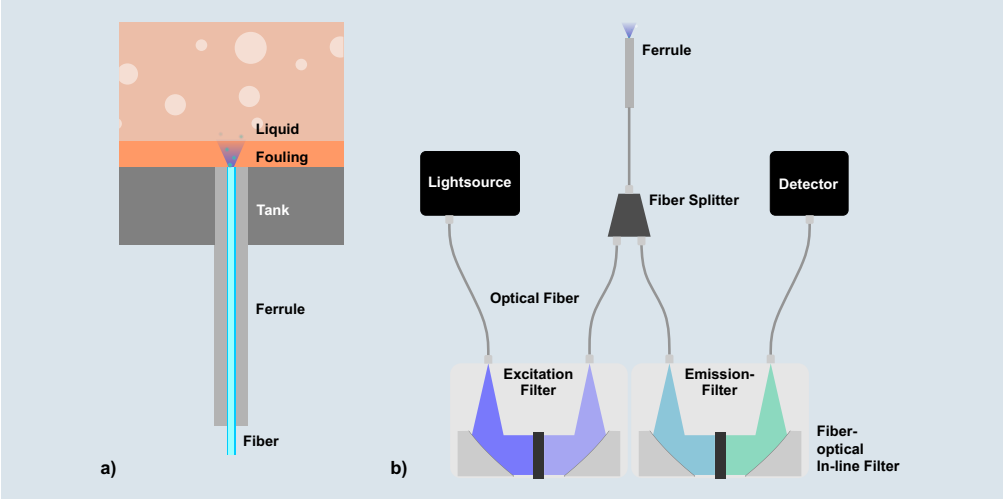
Fiber-optical sensor for minimally invasive inspection

F-Fiber lends itself to minimally invasive, highly versatile inspection of closed production systems. The fiber-optical sensor probes fouling inside vessels optically using fluorescence excitation and detection of the fouling deposit. It is suitable for detecting a large number of organic substances, in particular substances containing proteins and/or fat such as e. g. dairy products. Therefore, the sensor can be used in plants that process several different products.

In contrast to other measurement techniques, the sensor directly measures the fouling deposits instead of using indirect parameters such as

Advantages at a glance

- Targeted cleaning-in-process
- Real-time measurement of fouling
- Compact, versatile setup
- Economic use of water, processing agents, energy
- Integration into existing vessels and pipelines possible
- No perturbation of the fluidic system



a) F-Fiber installed in a production system. The fouled surface inside the vessel is excited by UV light.

b) The UV light source is coupled into the fiber system and spectrally filtered before it exits the control unit. The light excites the fouled surface and the emitted fluorescence travels back to the control unit. Here, the excitation wavelengths are filtered out and the signal is analyzed by a detector.

change of flowrate or thermal conductivity. F-Fiber uses an optical fiber tip with a diameter of one millimeter as a probe head. The sensor can be either mounted on various types of flanges with the possibility to measure at different locations within the production system or integrated permanently in the vessel, even at places difficult to access. All hardware components are located outside the production system and coupled into the optical fiber.

Real-time assessment of cleanliness

The fiber tip is embedded in a stainless-steel ferrule and integrated into the wall of the tank. Flush fitting and the choice of material, which is similar to the surrounding stainless-steel walls, guarantee that the sensor does not cause any perturbation of the fluidic system. Once integrated, the fiber tip is flushed by the product and fouling deposits accumulate on top of the sensor just as on the surrounding surfaces. These deposits are irradiated with ultraviolet (UV) light and the fluorescence emission is recorded with a sensitive detector. F-Fiber detects accumulation and degradation of deposits in real time, thus enabling cleaning processes to be triggered or adapted to the actual degree of fouling.

System setup

One end of the optical fiber is embedded in the ferrule whereas the other end is split to serve as waveguide for both the excitation and detection light. UV excitation light is emitted from the light source to the surface under investigation. The resulting fluorescence emission is guided back to the detector. The excitation light and the returned fluorescence light are collimated, spectrally filtered and coupled into the respective exit-fiber again. This fiber-based setup is alignment free and therefore robust against e.g. heavy vibrations common in food production plants. A high-power LED with a central wavelength of 405 nm is used to guarantee a distinct fluorescence signal.

Technical specifications

Size of fiber tip	1 mm in diameter
Size of fiber in ferrule	6.35 mm in diameter
Light source	High-power LED, 405 nm
Detector	Silicon photodiode
Measurement frequency	Up to 1 kHz
Detectable soils	Organic fouling and fouling containing proteins and/or fats, e. g. dairy products, mustard, yeast, and many more

All specifications and features are subject to modification without notice.

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