

## OPTICAL SENSORS FOR FERMENTATION PROCESSES

Walter Beyeler

Ingold Messtechnik AG  
Industrie Nord  
CH-8902 Urdorf/Switzerland

### 1. INTRODUCTION

In spite of the great effort of chemical engineers today the on-line measurement in fermentation processes is still limited to physical and chemical quantities. The most important biological parameters, such as biomass, substrate, product or metabolites are still not accessible to on-line measurements.

As a company strongly involved in the development and production of measurement equipment for bioprocesses, Ingold Messtechnik AG started a few years ago a research program directed to the development of on-line sensors for biological parameters. For the following reasons an approach using the optical measurement technology has been considered as the most promising one:

- The optical measurement technology has at least for laboratory use already reached a very high and sophisticated standard. The future developments of optical components such as semiconductor detectors or fiber optics will certainly increase the versatility of this technique.
- There are many compounds of biological origin which can be directly measured by optical methods (e.g. absorption, fluorescence attenuated total reflection).

- The combination of optical methods with chemical mediator substances would allow to measure also physical or chemical parameters such as pH or oxygen concentration. The use of enzymes and/or fluorescence labelled antibodies would allow to make this technique highly versatile.

## 2. IN-SITU FLUORESCENCE MEASUREMENT IN BIOPROCESSES

As a first result of the optical approach a process fluorometer for in-situ use in fermentation processes has successfully been developed. This instrument is dedicated to the measurement of the fluorescence observed with whole microorganisms or cells when illuminated with UV-light of about 360 nm. This fluorescence is mainly dependent on the intracellular NADH concentration. As NADH is a very important factor within the metabolic pathways of all living cells many important information can be obtained independent of the kind of cultivation by measuring this compound. On-line estimation of the viable biomass concentration, control of substrate and oxygen supply or the study of substrate uptake kinetics and regulation are just a few examples of the immense field of possible applications for this method.