

# Advantages of Using VisiFerm DO in Ethanologenic Fermentation

Improving efficiency and reliability of dissolved oxygen data during thermophilic bacterial fermentation

**Industry:** Biofuels

**Application:** Fermentation

**Hamilton product:** VisiFerm DO

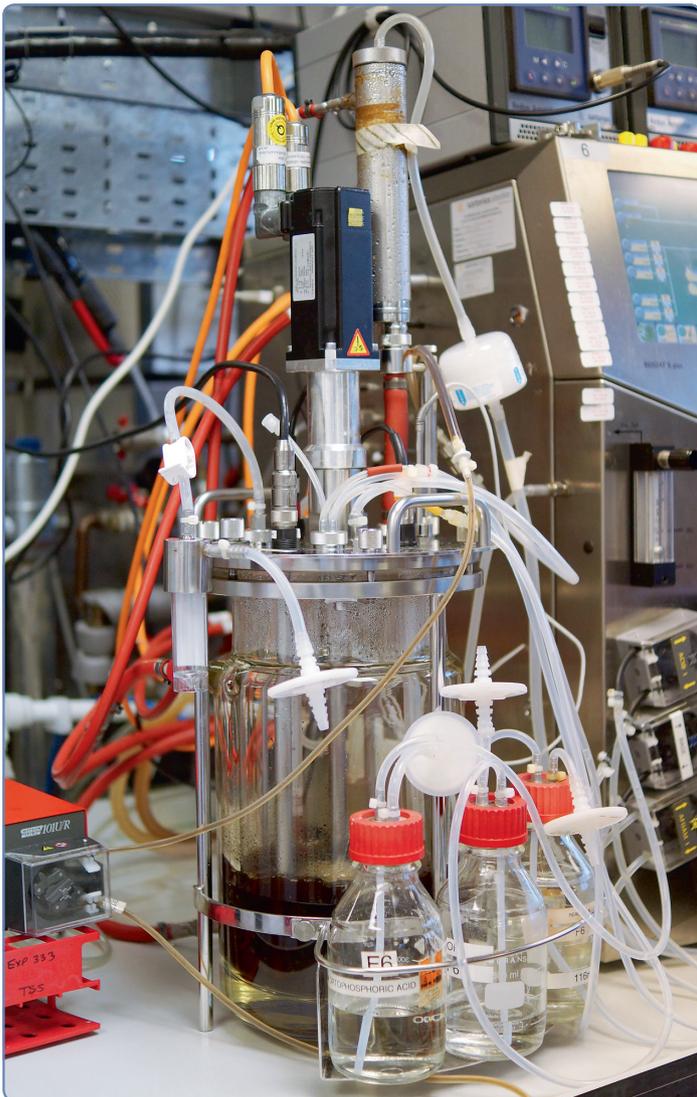


Figure 1: Fermentation of the pre-treated raw material.

## Benefits of the VisiFerm DO

- ▶ Increased reliability of DO measurement
- ▶ Less sensor down times
- ▶ Easy maintenance: No replacement electrolytes or cathodes
- ▶ No polarization
- ▶ Sensor status can be monitored easily

Bioethanol has become very popular over the last 10 years because it can be added to normal fuel to reduce the carbon footprint of driving cars. Common raw materials include corn, wheat, and other grains used in food production. As a result, demand for the raw materials has increased and so have their prices. To relieve some of the price restrictions, TMO Renewables Ltd. has developed an alternative method of producing bioethanol using low-value waste. The process enables fibrous cellulosic material to be broken down to a fermentable broth from which cellulosic ethanol is produced.

## The process

This process has been engineered around the thermophilic bacteria *Geobacillus*, conducted in bioreactors. The bacteria are the ideal workhorse for ethanol production, as they allow for effective control and monitoring of parameters that are key to microbial growth and metabolism, such as temperature, pH and the partial pressure of dissolved oxygen ( $pO_2$ ). The ability

to monitor  $pO_2$  throughout fermentation provides useful insight into which phase a fermentation is in, and how that fermentation is performing.

The first step of the fermentation is an aerobic phase to accumulate biomass. Once the biomass has accumulated to a predetermined concentration, agitation and aeration are reduced in order to induce a micro-aerophilic stage in which the production of ethanol occurs. Due to the nature of the microorganism, the fermentation occurs at 60 °C and varies from approximately 10 to 48 hours.

### Improvements due to the VisiFerm DO

Prior to switching to optical DO technology, TMO Renewables Ltd. used electrochemical Clark cells to monitor the dissolved oxygen (DO) content. After switching to the Hamilton optical VisiFerm sensor to measure DO, the reliability and dependability of the  $pO_2$  measurement improved greatly and sensor down times were reduced significantly. The handling of the VisiFerm DO is much easier because there is no electrolyte and cathode that have to be replaced, and no polarization time is needed. The VisiFerm DO is ready to use immediately. The ability to calibrate and determine the sensor status and history via the Hamilton Device Manager is another important benefit for the user.



Figure 2: Various kinds of raw material to produce bio-ethanol.



Figure 3: Stages of the process (left to right): dry raw material, steam cracked raw material, enzymatic hydrolyzed slurry, fermented slurry, distilled bio-ethanol.

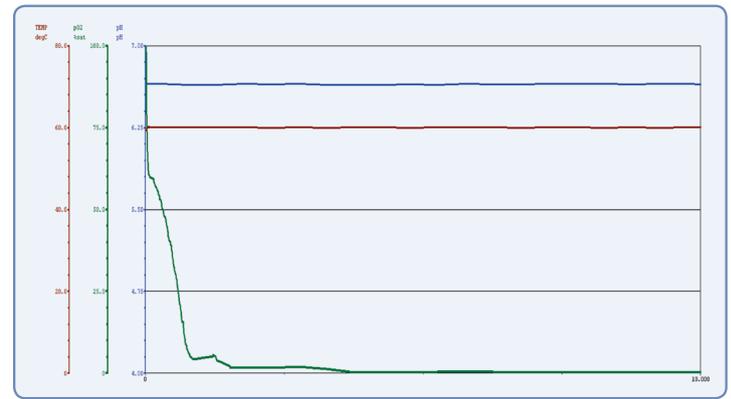


Figure 4: Hydrolysate Fermentation.

— pH.Value;Db 0.10 pH  
— pO2.Value;Db 1.0 sat  
— TEMP.Value;Db 0.20 degC

### VisiFerm DO Technical Data

Measuring range	4 ppb to 25 ppm (DO) or 0,1 to 600 mbar ( $pO_2$ )
Response time t98%	< 30 s at 25 °C, from air to nitrogen
Oxygen consumption	None
Required flow	None
Operating temperature	-10 to 130 °C; the sensor provides no DO reading above 85 °C
Pressure range	0 to 12 bar
Measurement principle	Oxygen dependent luminescence
Medium contacted materials	Stainless steel 316L/DIN 1.4435 FDA approved silicone and EPDM
Surface quality of steel	Ra < 0.4 $\mu$ m (N5)
Interface	Configurable 4-20 mA interface (DO or Temperature), digital RS485 Modbus RTU interface
CIP/SIP	Yes

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