Continuous Short-time BOD Measurement: Minimization of Product Losses and Wastewater Loads in Dairy Production

by
Dipl. Ing. Peter Kalte, Gross-Umstadt, Germany
and
J. Wimmer, Wasserburg, Germany

This is a translation of an article which appeared in "Deutsche Molkerei-Zeitung" in October, 1988.

While product losses in food processing can never be completely eliminated, Meggle Milchindustrie, a dairy plant in Wasserburg, Germany, processing 500,000 liters (132,000 gallons) of milk per day has taken a novel way to reduce their product losses and cut the cost of wastewater treatment.

In spring of 1987 Meggle Milchindustrie decided to install a system to monitor the wastewater discharged from their processing plant. The objective was to detect and eliminate major spills and to reduce the BOD load on the company's wastewater treatment plant. A project team studied the possibility of monitoring the plant's wastewater for relevant components and decided to install a continuous short-time BOD monitor, manufactured by Siepmann and Teutscher GmbH. In order to locate the origin of the spills, pH and conductivity measurements were integrated with the BOD monitor. The BOD monitor detects spills within minutes and triggers an alarm. The plant supervisor determines the reason and origin of the spill which can then be stopped immediately.
The system has resulted in a significant reduction of product losses and has drastically reduced BOD loads and electricity costs for the wastewater treatment plant. The system was installed in the summer of 1987 and paid the investment back within a few months. A continuous plant discharge control system for supervising the production process can generally improve profits in food processing industries.

The Task of Continuously Monitoring Wastewater from Dairy Production

All important components of dairy production, such as whey, cream, pasted whey and lactose can be measured by BOD. Spills can be detected within three minutes by a continuous short-time BOD monitor.
For further evaluation of cause and origin of the spills, pH and conductivity measurements were integrated in the BOD monitor's sampling system.

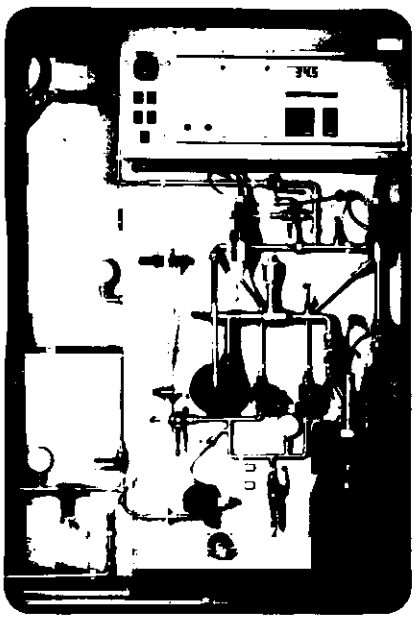
Measurement Parameters / Groups of Components	Conductivity	pH	Turbidity	Density	BOD(5)/BOD(M3)	COD
1. Acid (HCl, HNO3)	+	+	-	-	-	+
2. Caustic (NaOH)	+	+	-	-	-	-
3. Caustic (cleaning)	+	+	+	-	+	+
4. Whey (6%)	+	/	+	-	+	+
5. Cream	-	-	+	-	++	++
6. Pasted Whey (60%)	+	+	+	+	++	++
7. Lactose	-	-	-	-	+++	+++

+ measurable - not measurable

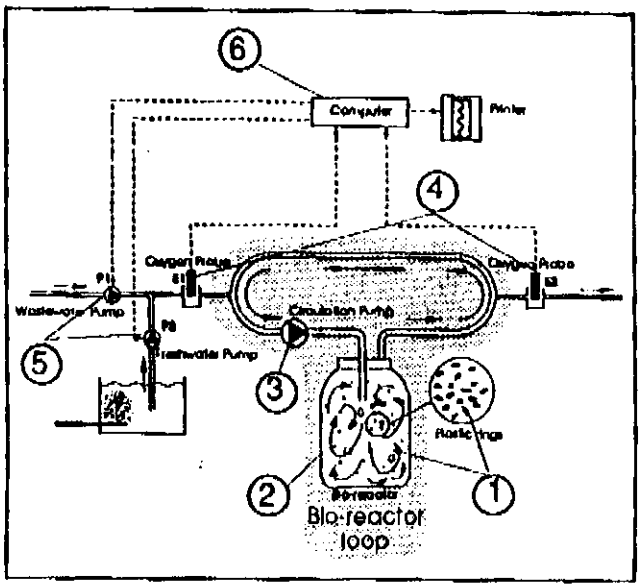
Table 1: Measurability of relevant component groups by different parameters

The BOD-M3 Monitor

The continuous short-time BOD-M3 monitor measures BOD concentrations continuously within a range of 2 - 10000 mg/l and makes results available on a digital display, print-out and electrical output signals. The instrument is shown in picture 1.
The measuring principle is shown in picture 2 schematically.
The heart of the system is a bio-reactor (2) containing a large number of small plastic rings (1). The plastic rings are kept in turbulent motion by a circulation pump (3) and serve as growth surfaces for microorganisms. The wastewater is diluted with potable water to a constant and low food concentration. This is achieved by metering pumps (5) in a control circuit, using the



Picture 1: Continuous short-time BOD Monitor: BIOX-1000



Picture 2: Principle of Operation of continuous short-time BOD measurement, BOD-M3

oxygen consumption (4) of the microorganisms as control parameter. The BOD is calculated by the instrument's computer based on the dilution ratio between wastewater and potable water.

The BOD-M3 instrument's rugged construction and robust sample system make it suitable for even extremely tough wastewater applications. Maintenance of the instrument is easy and very minimal.

Results are calibrated against BOD-5 but are 10 times more accurate than the standard method. Because of the dilution principle, the instrument is unaffected by toxic waste. Toxicity can be measured with an additional instrument, also operating on-line.

This measurement can be simply integrated with an effluent monitoring system.

The Installation of the Production Waste Monitoring System

The production waste monitoring system was installed in August 1987. The continuous short-time BOD instrument, together with the pH and conductivity probes were put into operation at the combined plant effluent. The instrument has freely programmable high/low/slope alarms. Simultaneously, a printer documents time and duration of the spills as well as accompanying pH and conductivity values.

Alarms are indicated at three different locations of the production area, at so called "acknowledgement boxes". These boxes comprise flash signals, 7 acknowledgement key switches - each one assigned to one specific person - a yes/no key and a location indicator.

If the BOD monitor detects a spill, it sends an alarm to these three boxes where the signals start to flash. Simultaneously, alarm is given in the operations center from where the shift supervisor is informed. He checks the alarm at the BOD monitor and the additional pH and conductivity values let him make an educated guess about the source of the spill. The final location of the spill is then determined by visual inspection of specific check points of the canal system. The spill is contained and the remedy is acknowledged at the "acknowledgement box". All activities are recorded in the operations center. The result is a completely documented history of problems, allowing operators to recognize susceptible areas and to improve their safety.

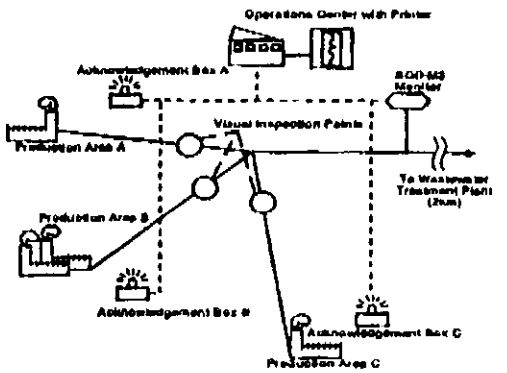


Table Picture 3: Schematic of Product Loss Monitoring System

The Success of the Production Waste Monitoring

The most significant successes of the continuous production waste monitoring system have been achieved precisely where intended:

A) Reduction of electricity in the wastewater treatment plant

B) Reduction of BOD loads to the wastewater treatment plant

C) Reduction of product losses

Directly measurable is the reduction in electricity, as shown in the following table:

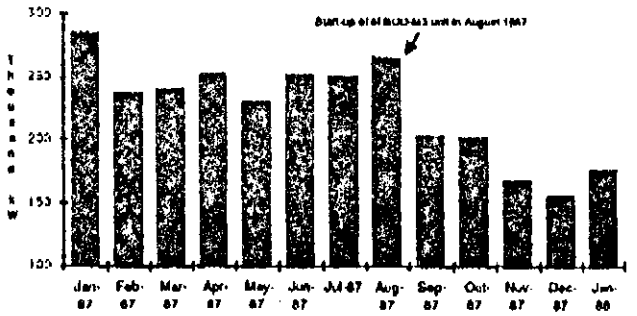


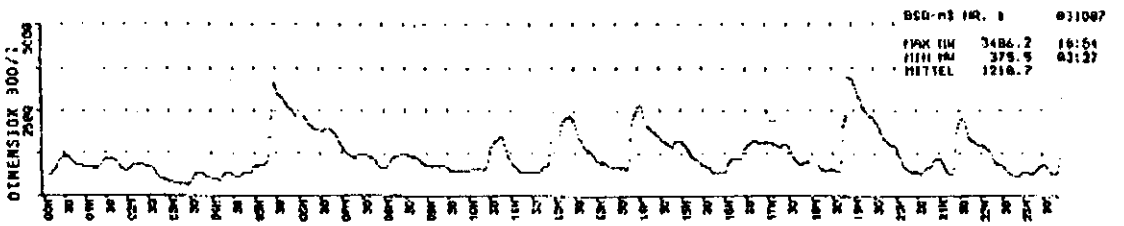
Table 2: Electricity Consumption in the wastewater treatment plant

The 30% reduction in electricity costs is clearly visible. Savings from this reduction in electricity alone are in the range of DM 10,000 (US $6,500) per month.

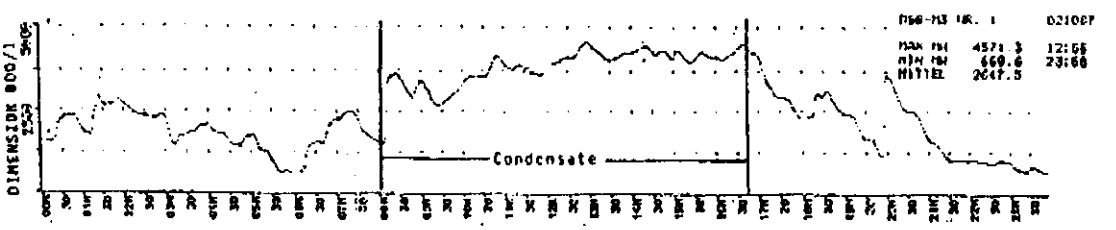
An additional advantage was to discover that the wastewater loads created by certain new products were extremely high. This is illustrated by the following printouts of the BOD-M3 monitor. (Pictures 4 and 5). Picture 4 shows a day with "normal" conditions. On October 10, 1987 a new product was started up, which resulted in extraordinarily high BOD concentrations in the wastewater. The high BOD concentrations were contained in the condensate of vacuum evaporators which are used to extract water from the product. The printout of the BOD-M3 monitor shown in Picture 5 accurately indicates start and duration of the evaporation process. The early recognition of such high wastewater loads allows operators to optimize the production process towards considerably lower BOD loads.

Final Observations

The production waste monitoring system by continuous short-time BOD measurement, complimented with pH and conductivity measurements, has been amortized at Meggle Milchindustrie within a few months. The significant reduction of production losses and savings in energy costs at Meggle show that food processing industries in general can improve their profits with such a system.



Picture 4: BOD Profile on a "normal" day



Picture 5: BOD Profile clearly showing start and duration of evaporation process, producing excessive BOD concentrations.

Literature:
1. G. Riegler:Die kontinuierliche Kurzzeit-BSB-Messung. "Korrespondenz Abwasser" 31(1984), S. 369-377.
2. M. Koehne, Siegen, F.W. Siepmann, Reinheim, D. te Heesen, Dinslaken:Der BSB-5 und der kontinuierliche Kurzzeit-BSB (BSB-M3 im Vergleich. "Korrespondenz Abwasser" 33(1986), S.
3. Operating Data of Meggle Milchindustrie, Wasserburg, Germany