

Lost Product Detection and Prevention Using TOC Monitoring of Wastewater

Problem

The international Dairy Industry accepts a "standard" Lost Product figure of 2-3% annually. Over time, this can translate into a significant amount of lost revenue.

Solution

The Dairy BioTector B7000i online TOC analyser was developed specifically for the Dairy Industry. Much of the global success of these analysers stems from the fact that they can overcome the obstacles faced in such harsh sampling and measurement conditions.

Benefit

Hach's reliable TOC monitoring delivers greater stability of wastewater loading, protection against overloading and optimisation of WWTP capacity. It also enables rapid response to product loss incidents, delivering process optimisation and cost reductions.

Background

Historically, many processing plants viewed production and wastewater treatment as two entirely separate functions. This is changing as raw material costs increase, margins tighten, the market changes, and competition becomes more intense. Therefore, cost management is more important than ever. Process wastewater is infamous for carrying valuable product away from the plant, and away from the bottom line.

International experts concur that approximately 2-3% of the total amount of milk purchased annually by Dairy Processors is lost during processing, some of this is an inevitable part of processing output but some of the loss could be avoided. As an extra commercial headache, pollutants generated by industry are very often these same losses in production. So, not only does Lost Product cost in terms of the wasted raw materials but it also costs to treat it at the WWTP (wastewater treatment plant). Production and treatment of each kilogram of BOD in a Dairy Processing Environment is expensive, particularly since the average plant will produce millions of kg of BOD each year.

Processing challenges for TOC measurement

Dairy Processing is a very challenging environment for an analyser due to the FOGS (Fats, Oils, Grease and Solid Waste), salts and particulates that are inevitably present in process streams. Many online TOC analysers fail under these harsh and challenging process and wastewater conditions.

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Figure 1: A BioTector analyser has been monitoring TOC on this dairy wastewater pond since 1997, with an Up-Time of >99.7%

Table 1: Correlation of TOC to BOD and to COD

| Factor for Wholemilk | TOC | BOD | COD |
|----------------------|------------|----------|-----------|
| Analysis cycle time | <7 minutes | 5-7 days | 2-3 hours |
| Accuracy | ±3% | ±20% | ±5% |
| TOC factor | 1 | ~2 | ~3 |

TOC correlation to BOD and COD

TOC analysis in a dairy plant determines the quantity of milk products present in wastewater discharge lines at a given point in time. TOC is a more reliable method of analysis than milk-water interface (turbidity) analysers and other optical measurement methods as these cannot correctly quantify the Lost Product and are subject to clogging and fouling.

Of all available measurement technologies, TOC is by far the most reliable method and it has the best relationship – much better than COD – versus the volume of the Lost Product. Besides this, TOC is also considered by many to be the most cost-effective, accurate and timely test with less interferences than alternative parameters, see table 1. Hach BioTector analysers can automatically correlate all TOC measurements, taken at intervals of ~6 minutes, to BOD and COD measurements.

Lost product detection

Table 2 details a “Typical Dairy Plant” model with processing volumes of 500 million litres per year, raw material (milk) prices averaged over a 5 year period and lost product levels of 2.5%. The model shows how this plant produces and

treats more than 1.3 million kg of BOD each year – each kg of BOD takes 9.26 litres of milk to produce, hence the actual Lost Product is 12.5 million litres of milk which equates to € 4,000,000 loss each year.

How does TOC monitoring reduce lost product levels?

Due to the reliability and accuracy of the BioTector analyser it is used as a management tool to make non questionable decisions, and to respond to incidents immediately and to optimise processes and process insight. Production teams are more informed and therefore more accountable, as are their maintenance departments.

WWTP teams can regulate and optimise their treatment processes, and process and WWTP teams work together more cohesively.

If a spill happens somewhere on the plant the analyser alarm alerts the team via the SCADA/DCS network and mobile phones, so management and operators are quickly supplied with accurate information and generally it takes a short time to get to the source of the problem.

Table 2: Outlining Lost Product Costs + Savings

Lost product savings

Model of a ‘typical dairy plant’

Working with our client base, our distributors and industry experts over two decades, we have developed a model of a ‘Typical Dairy Plant’. This model shows that, typically, Lost Product levels can be reduced by a conservative 15% using TOC monitoring. There is a direct correlation between levels of Lost Product and wastewater loading. Clients report 15-40% reduction to wastewater loading as a result of using TOC monitoring.

| Processing volumes: milk litres per annum (PA) | Kilogram of BOD produced and treated PA | Milk litres required to produce 1 kg of BOD ¹ | Lost litres to produce total BOD | Lost Product level | Farmgate price per litre ² | Cost of 2.5% lost product | Annual savings from ‘typical’ 15% reduction due to monitoring |
|--|---|--|----------------------------------|--------------------|--|---------------------------|---|
| 500,000,000 | 1,349,892 | 9,26 | 12,500,000 | 2.5% | € 0.32 | € 4,000,000 | € 600,000 |
| ¹ Each L produces 0.108 kg of BOD | | | | | ² Irish Food Board: average price 2007-2011 | | |

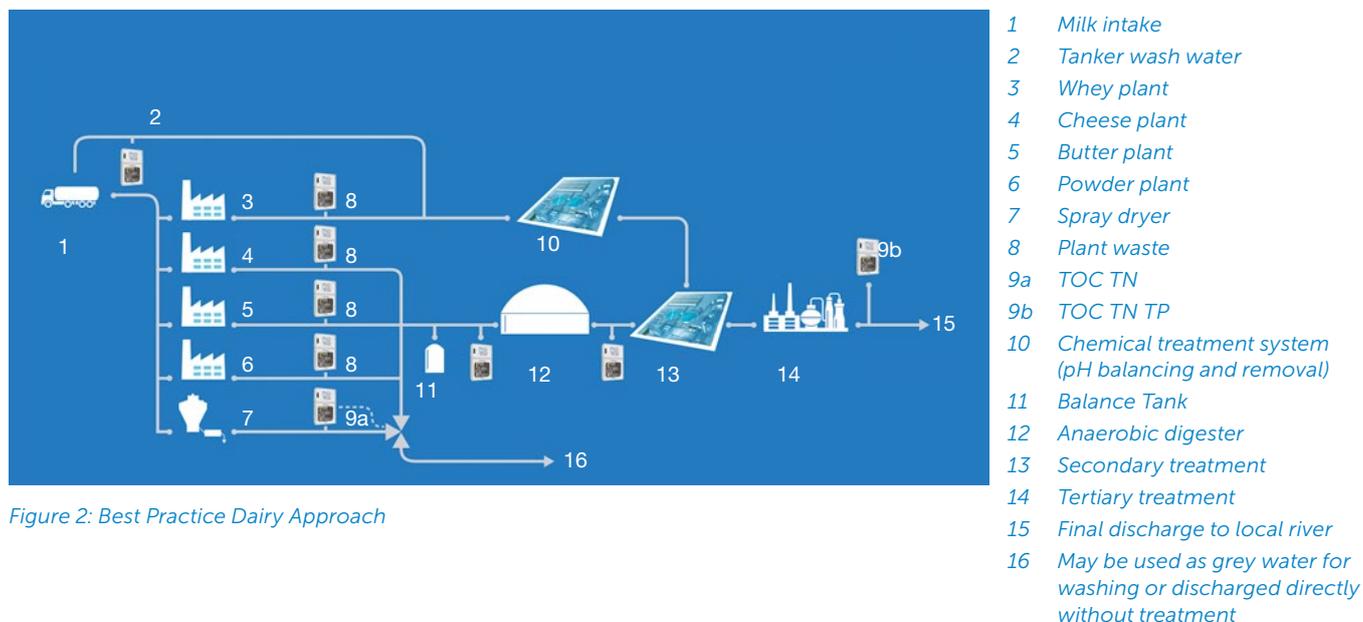


Figure 2: Best Practice Dairy Approach

A best practice approach is to locate analysers on process streams and use the TOC measurement information to detect and prevent sources of product loss, subsequently increasing plant yield (see figure 2).

Solution and Improvements

The Dairy BioTector B7000i TOC analyser was developed specifically for the Dairy Industry. Typically, Lost Product levels can be reduced by a conservative 15% using reliable TOC monitoring. There is a direct correlation between levels of Lost Product and wastewater loading. Clients regularly report greater than 15% reduction to wastewater loading as a result of using reliable TOC monitoring, with some clients achieving as much as a 40% reduction. Given this scenario, "Typical Dairy Plants" could save € 600,000 each year by reclaiming only 15% of product that was once lost in waste-

water. This figure relates solely to liquid milk costs and does not factor in additional processing costs (e.g. labour, energy, etc.) which could be even higher. Continuing with the "Typical Dairy Plant" model in table 3, TOC monitoring could directly save a plant up to € 105,000 each year in reduced treatment costs.

The unique BioTector TSAO (Two Stage Advanced Oxidation) technology gives consistent accuracy and reliability so that clients can have confidence in the TOC measurements. TSAO eliminates build up problems from salts (up to 30% w/w), calcium sludge (up to 12% w/w), particulates, sludge and FOGS that lead to analyser drift.

Typical industry sampling tube is ≤ 0.8 mm ID (inner diameter), whereas the BioTector B7000i sampling tubes are 3.2 mm ID. The powerful TSAO oxidation method allows particulates of up to 2 mm to be taken into the measurement for a more

Table 3: WWTP Cost Savings

| Wastewater treatment plant savings | | | | |
|--|--|------------------------------|--|---|
| Model of a 'typical dairy plant' | | | | |
| Kilogram of BOD being processed per annum (PA) | Annual WWTP running costs ¹ | Cost to treat each kg of BOD | Annual savings from 'typical' 15% wastewater loading reduction | 'Typical' estimate to produce and treat 1 kg of BOD |
| 1,349,892 | € 700,000 | € 0.52 | € 105,000 | € 3.48 |
| ¹ Industry supplied 'conservative' estimate including: energy, chemicals, labour, maintenance | | | | |

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representative sampling, and up to 1000 times bigger sample volumes to be used for reliable and representative sample measurement in comparison with conventional technologies. Hach BioTector analysers can also be modified to monitor TOC + TN, TOC + TN + TP, or even COD/ BOD.

A BioTector analyser automatically self-cleans all parts of the analyser, thus preventing clogging, sample contamination and inaccurate results. The Hach Dairy BioTector B7000i analyser only requires calibration and preventative maintenance at six-monthly intervals. These analysers have delivered consistently high performance in dairy applications, meeting MCERTs certified Up-Time of 99.86% and typical result accuracy and repeatability better than $\pm 3\%$ of reading.

Conclusion

There is much anticipation in the European Dairy Industry surrounding the on-farm milk volume expansion following the abolition of European milk quotas in 2015. Supplier surveys indicate that milk production will increase dramatically between 2015 and 2020. This will create many opportunities for the Dairy Industry and many new challenges in terms of sustainability, process efficiencies and WWTP capacity – challenges that Hach will continually work with the dairy industry to address with reliable and cost effective solutions.



Figure 3: BioTector B7000i Online TOC Analyser