

Pulling Back the Profits From Wastewater

Lost Product Detection and Prevention using TOC Monitoring of Wastewater: A Dairy Processing Study

Historically many processing plants viewed Production and Wastewater Treatment as two entirely separate functions. This is now changing as raw material costs increase, margins get tighter, market forces and competition becomes more intense. Cost management is more important than ever and process wastewater is known to carry valuable products away from the plant – and away from the bottom line.

“TOC is considered by many to be the most cost-effective, accurate and timely test with less interferences than alternative parameters.”

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. Production and treatment of each KG of BOD in a Dairy Processing Environment is expensive, particularly since the average plant will produce millions of KG of BOD each year.

BioTector manufacture Online TOC Analysers that offer real-time visibility and quantity of product in wastewater therefore providing more informed process control and incident response.

Across many industries with challenging processing environments particularly Dairy, PetroChemical, Pharmaceutical, Brewery & Soft Drinks, TOC analysers are recognised as a means to monitor and regulate loadings to the WWTP and to reduce Lost Product levels and waste treatment costs significantly. The patented TSAO technology from Biotector offers consistent accuracy and reliability so that clients can have confidence in the TOC measurements provided. This confidence is key to Lost Product detection and prevention.

Dairy Processing Challenges for TOC Measurement

Dairy Processing is a very challenging environment for an analyser due to the FOGS, salts and particulates that are inevitably present in process streams, see Figure 1. Many Online TOC analysers fail in these conditions.

There are however analysers available that are built to deal with these challenging environments. BioTector Online TOC analysers are an example of this as they were developed specifically for the Dairy Industry.

TOC Correlation to BOD & COD

TOC analysis in a dairy plant determines the quantity of milk products present in wastewater discharge lines at a given point in time. Product is lost in litres, gallons and kilograms not in terms of biological loading. TOC is

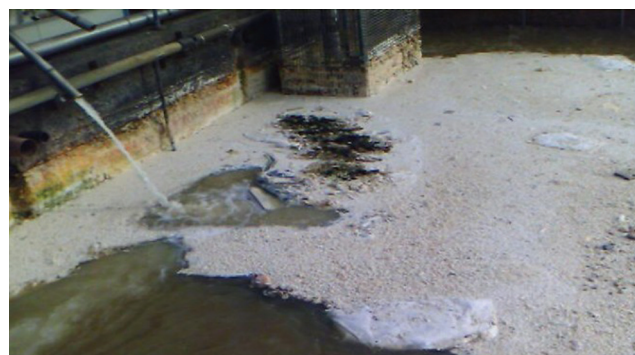


Figure 1: BioTector has been monitoring TOC on this Dairy Wastewater pond since 1997

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.

TOC is considered by many to be the most cost-effective, accurate and timely test with less interferences than alternative parameters, see Figure 2.

Lost Product Detection & Prevention

The international Dairy Industry accepts a “standard” Lost Product figure of 2-3% annually. As the Table in Figure 3 shows, even with a mid-way Lost Product figure of 2.5%, this loss can be very high in monetary terms. The cost of spilt milk is definitely worth shedding some tears...

Figure 3 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 1.3million KGs 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 lost each year. To look at it another way, this is the equivalent of 417 milk tankers carrying 30 tonnes each, pouring the milk directly into the drain!

This model shows that, typically, Lost Product levels can be reduced by a conservative 15% using reliable TOC monitoring. However, higher reductions have been reported and, in extreme cases, wastewater loading



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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

Figure 2: Correlation of TOC to BOD and to COD

reductions of 37% to 40%. BioTector distributors have also reported numerous occasions where a new installation has, within weeks, shown up processing problems that were previously unknown to the client.

Given this scenario, the "Typical Dairy Plant" could save c. €600,000 each year by reclaiming only 15% of product that was once lost in wastewater. This figure relates solely to liquid milk costs and does not factor in processing costs which could be higher. It is also assumed that total BOD loading will include contribution by surfactants and other types of waste, however these are relatively small in relation to the large volumes of milk.

How Does TOC Monitoring Reduce Lost Product Levels?

One analogy given occasionally by clients is that they consider BioTector as a Speed Camera – everyone trusts the information it gives, so behaviour will modify accordingly.

TOC measurements give visibility to the wastewater loading and processing insights. Because of the reliability and accuracy of the BioTector analyser it is used as a management tool to make decisions, respond to incidents and optimise processes. Production teams are more informed and therefore more accountable. WWTP teams can regulate and optimise their treatment processes. Both teams work together more cohesively.

If a spill happens somewhere on the plant, the analyser alarm for high loads rapidly alerts the team via the 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.

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 4.

WWTP Cost Savings & Capacity Optimisation

Reliable TOC monitoring also gives greater stability of wastewater loading and protection against WWTP overloading, it optimises WWTP capacity and, ultimately, protects the production process from any possible WWTP malfunction which could temporarily reduce or halt plant production.

Continuing with the "Typical Dairy Plant" model in the next Table, see Figure 5, TOC monitoring could directly save a plant c.€105,000 each year in reduced treatment costs.

3 Main Elements To Lost Product Detection & Prevention

- Measurement** – TOC measurements have been deemed the most cost-effective, continuous and timely test to identify and quantify milk products in wastewater streams. Analysers can correlate to BOD and COD automatically.
- Information Dissemination** – BioTector is interfaced with DCS networks including SCADA, together with pager and mobile phones. This information enables Production and WWTP personnel to work better together.
- Management Response** – when Management have confidence in TOC measurements the information is used for strategic decision making, general process control initiatives and incident responses.

2 Main Operational Advantages of Reliable TOC Monitoring

- Confidence:** TOC measurements (and automatic correlation to BOD and/or COD) are used by operators and management for process control. BioTector analyser measurements are used with confidence because they consistently provide high performance in this challenging environment with MCERT accredited uptime of 99.86% and typical accuracy and repeatability better than ±3% of reading.
- A Management Tool:** TOC information is used by both Production and WWTP personnel for decision making. The Production team will gain additional processing insights and the WWTP team can get close to the loading limit without going over it.

LOST PRODUCT SAVINGS MODEL OF A 'TYPICAL DAIRY PLANT'

Working with our distributors, our client base 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. End-users report 15-40% reduction to wastewater loading as a result of using TOC monitoring.

PROCESSING VOLUMES: MILK LITRES PER ANNUM (PA)	KG'S OF BOD PRODUCED & TREATED PA	MILK LITRES REQUIRED TO PRODUCE 1KG OF BOD*	LOST LITRES TO PRODUCE TOTAL BOD	LOST PRODUCT LEVEL	FARMGATE PRICE PER LITRE*	COST OF 2.5% LOST PRODUCT	ANNUAL SAVINGS FROM 'TYPICAL' 15% REDUCTION DUE TO TOC MONITORING
500,000,000	1,349,892	9.26	12,500,000	2.5%	€0.32	€4,000,000	€600,000

*Each L produces .108kg of BOD
*Irish Food Board: Average price 2007-2011

Figure 3: Table Outlining Lost Product Costs & Savings

BEST PRACTICE DAIRY APPROACH

TOC Measurement as a tool to reduce wastage in a Dairy Processing Plant: Lost Product, Energy & Water consumption, Treatment Costs

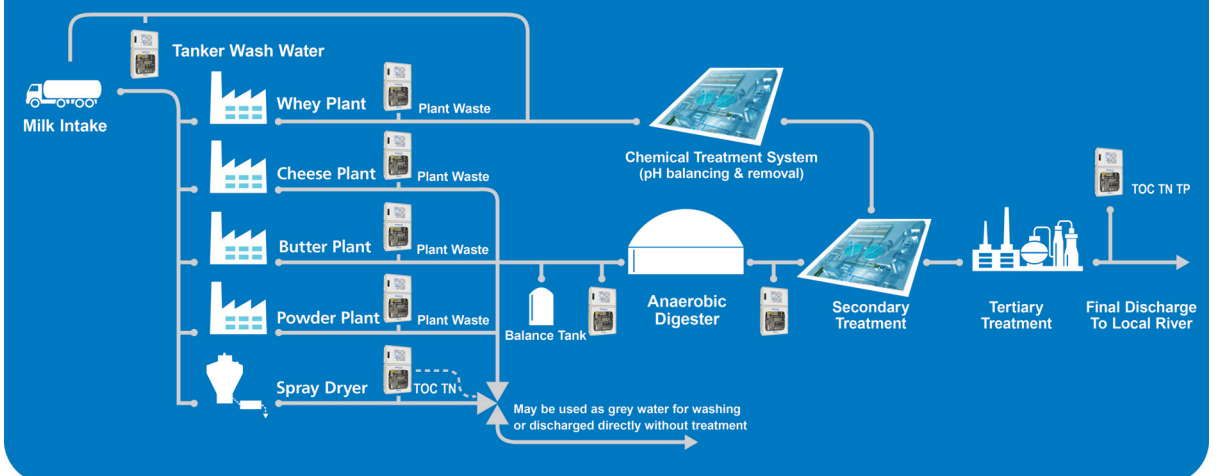


Figure 4: Best Practice Dairy Approach

WWTP SAVINGS MODEL OF A 'TYPICAL DAIRY PLANT'

Kg's of BOD being processed each year	Annual WWTP Running Costs*	Cost to Treat each Kg of BOD	Annual Savings from 'Typical' 15% Wastewater Loading Reduction	'TYPICAL' ESTIMATE TO PRODUCE & TREAT 1KG OF BOD
1,349,892	€700,000	€0.52	€105,000	€3.48

*Industry supplied 'conservative' estimate including: Energy, Chemicals, Labour, Maintenance

Figure 5: WWTP Cost Savings

The Future of Dairy Industry

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 2013 and 2020. This will create many opportunities for the Dairy Industry and many new challenges in terms of process efficiencies and WWTP capacity – challenges that BioTector will work with the industry to address.

About Us

BioTector Analytical Systems Ltd. (Ireland) is a privately owned company with more than 1,000 applications worldwide. BioTector won the 'Product Leadership USA 2012' award from Frost & Sullivan and is the market-leading TOC analyser in the USA.

Hach Company (Hach & Hach Lange), a leading manufacturer and distributor of analytical instruments partnered with BioTector in 2010 to become the exclusive distributor of the BioTector range of on-line liquid analysers in the United States, Canada, Mexico, Brazil and Europe. The BioTector B7000 has been a leading product in Hach's Industrial applications since that time.

Additional product information and distributor details can be found at www.biotector.com

Table 1: Glossary of Terms

BOD: Biological Oxygen Demand. Amount of dissolved oxygen

consumed by a biological community of organisms in a given body of water to break down organic content.

COD: Chemical Oxygen Demand. Laboratory test used to determine the amount of organic compounds in a given body of water by correlation to BOD.

DCS: Distributed Control System. A control system, usually of a manufacturing process or any kind of dynamic system.

FOGS: Fats, Oils, Grease (Solid Waste).

ID: Internal Diameter. The diameter of the inside of the sample tube.

PPM: Parts Per Million. Unit of measurement of the content of specific particles in a substance or mixture.

SCADA: Supervisory Control And Data Acquisition. Industrial performance computerised control system that monitors and regulates physical processes in multiple sites.

TOC: Total Organic Carbon. Total amount of Carbon content bound in organic compounds in a given solution.

TIC: Total Inorganic Carbon. Total amount of Carbon content bound through inorganic bonds in a given solution.

TN: Total Nitrogen. Total amount of all forms of Nitrogen molecules in a given solution.

TP (P): Total Phosphorous. Total amount of all forms of Phosphorous molecules in a given solution.

TSAO: Two Stage Oxidation Technology. The patented BioTector technology developed to overcome the usual challenges faced by TOC analysers in the Dairy Processing Industry.

WWTP: Waste Water Treatment Plant.