TOC Model 3S
On-line Total Organic Carbon Analyzer

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- General Introduction
  - TOC definition
  - Measurement principle
- Product Technical Features
- Applications

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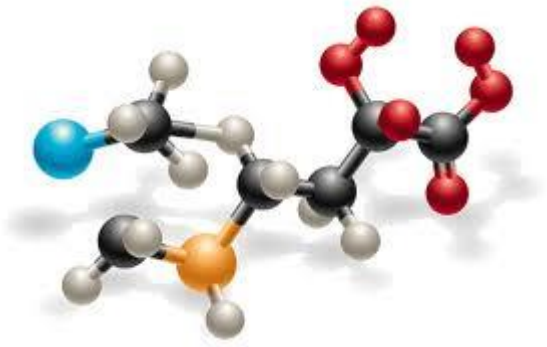
TOTAL ORGANIC CARBON – DEFINITION

Total Organic Carbon (TOC) is a commonly used measurement to determine the degree of organic contamination in water and is measured as carbon.

It is a sum measurement. Total Organic Carbon cannot be used to identify specific organic contaminants. It will, however, detect the presence of all carbon-bearing molecules, allowing for a determination of the concentration of organic contaminants in the sample stream, regardless of their molecular make-up.

CONTINUOUS MEASUREMENT - Continuous sample flow

Quick response time



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TOTAL ORGANIC CARBON – GENERAL PRINCIPLE

FUNDAMENTAL PRINCIPLES OF ALL TOC ANALYZERS

OXIDIZE ORGANIC COMPOUNDS TO CO_2

MEASURE THE CO_2 PRODUCED

What makes each TOC analyzer different is the method used to oxidize the organics in the water sample and the methods used to detect the resulting CO_2.

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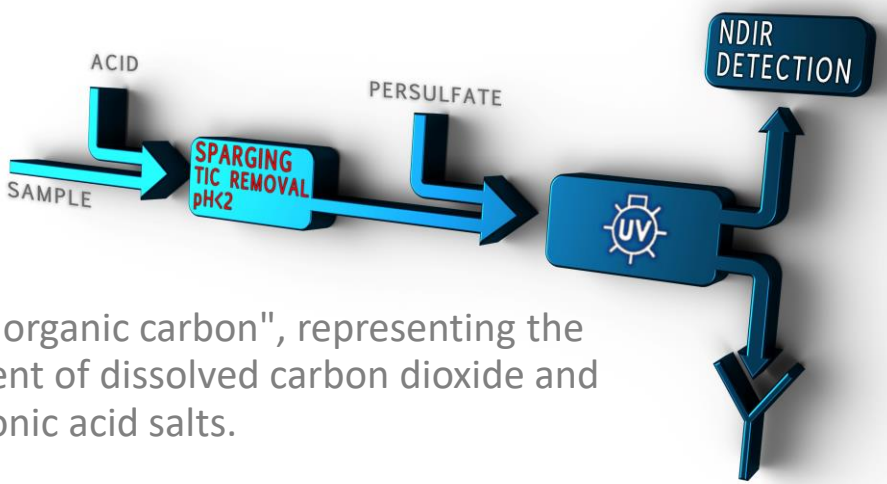
3 STEP PROCESS



IC "inorganic carbon", representing the content of dissolved carbon dioxide and carbonic acid salts.

2) Oxidation
The second stage is the oxidation of the carbon in the remaining sample in the form of carbon dioxide (CO_2).
UV light is the oxidizer but the oxidation power of the reaction is magnified by the addition of a chemical oxidizer, which is a persulfate compound.

3) Detection and Quantification
The CO2 developed through oxidation is then swept through an NDIR detector. The infrared light is adsorbed by the CO2 it passes through the detector.
The resulting measurement is directly correlated to concentration.

The analysis of TOC may be broken into three main stages:
1) Acidification
In the direct approach, inorganic carbon is first removed by acidification and sparging, and the remaining carbon is measured as TOC. Addition of acid and inert-gas sparging allows all bicarbonate and carbonate ions to be converted to carbon dioxide, and this IC product vented along with any POC that was present. Sparging also removes purgeable organic carbon. However, POC generally represents 1% or less of total carbon in a sample, it can be considered negligible compared to the overall TOC concentration. It is more accurate to call the measurement non-purgeable organic carbon (NPOC).

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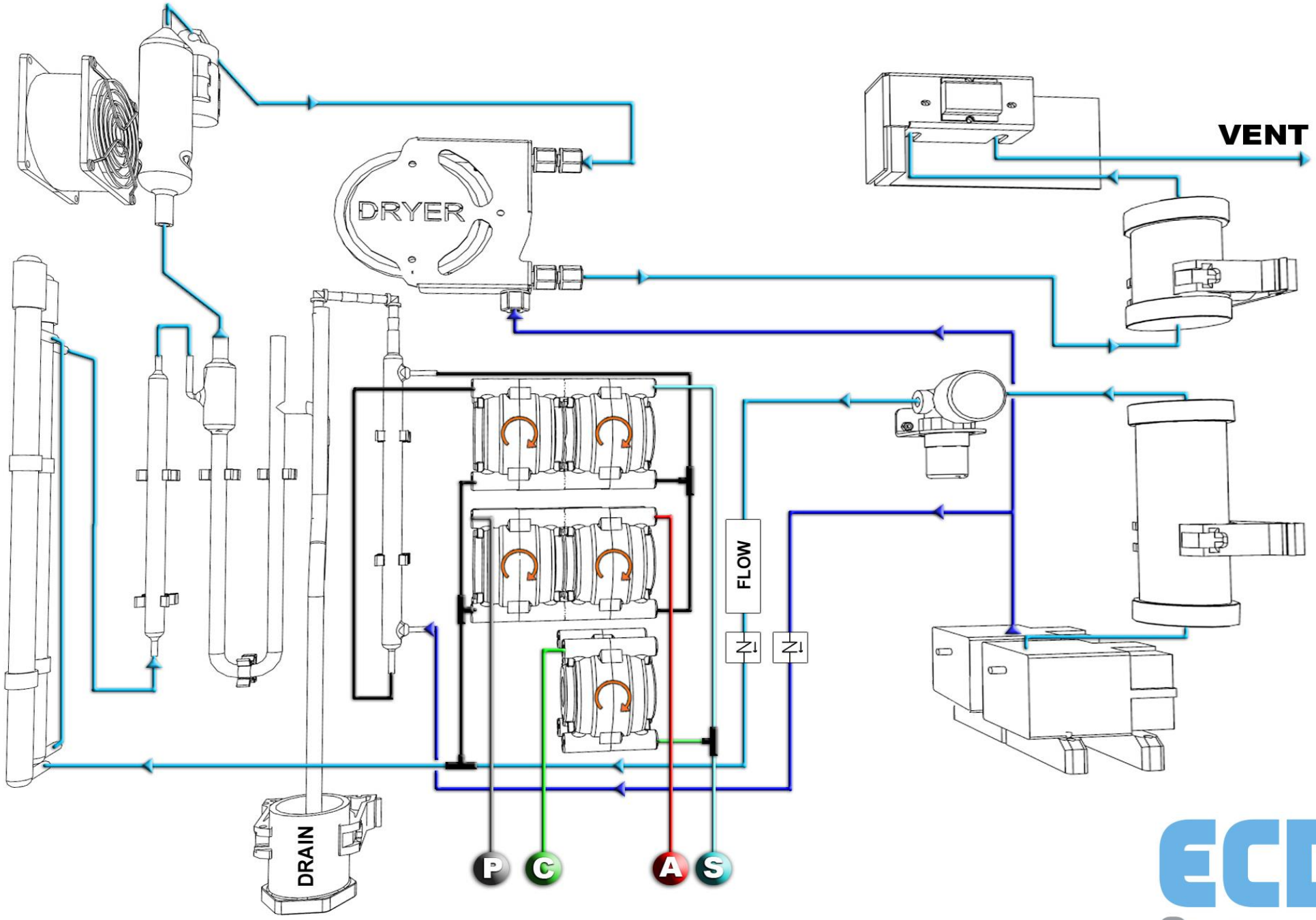
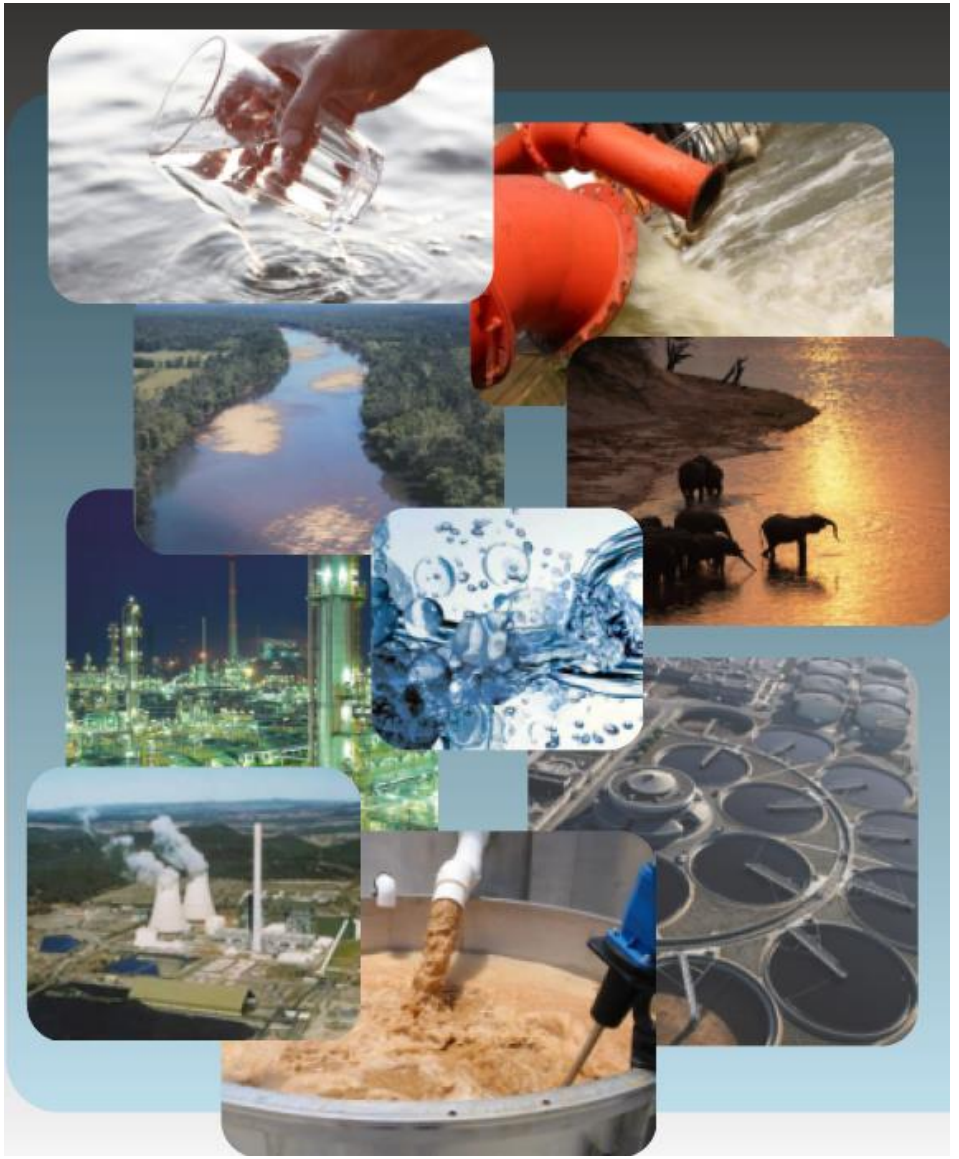

DRYER
VENT
FLOW
DRAIN
P
C
A
S

Applications

TOC or Total Organic Carbon detection is an important measurement because of the effects it may have on the environment, human health, and manufacturing processes. TOC is a highly sensitive, non-specific measurement of all organics present in a sample. It can be used to regulate the organic chemical discharge to the environment in a manufacturing plant and for process control. In addition, low TOC can confirm the absence of potentially harmful organic chemicals in water used to manufacture pharmaceutical products.
TOC is also of interest in the field of potable water purification due to disinfection of byproducts.



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TECHNICAL FEATURES

DUAL COMPARTMENT ENCLOSURE
VALVE FREE SAMPLE LINE
DIGITAL FLOWMETER
INTEGRATED CARRIER GAS
AUTOMATIC CHECK OF ZERO GAS
TOUCHSCREEN INTERFACE
MATERIALS USED IN THE ANALYZER
COMPLETE SEPARATION OF STRIPPING LINE AND CARRIER GAS LINE
FAST LOOP RESERVOIR (loss of sample / dilution water alarm)
AUTOCLEAN / AUTOCALIBRATION / AUTOVALIDATION
EASY INSTALLATION AND MAINTENANCE

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Typical applications for TOC

- WASTE WATER – INDUSTRIAL & MUNICIPAL WWTP
- DRINKING WATER
- SURFACE WATER
- PRODUCT CONTROL AND MONITORING
- BOILER CONDENSATE RETURN
- COOLING WATER
- DE-ICING RUNOFF IN AIRPORT
- STORMWATER / RUNOFF

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WASTE WATER

Direct discharge – surface / body water
Indirect discharge to a public WWTP – feed water limit
Process control

Reliable and continuous measurements.
Compliance with statutory limit levels.
Control and monitoring of the treatment process with continuous measurement data.
Process optimization.
Reduce operational cost.

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WASTE WATER - Example industries

Chemicals
Pharma
Food & Beverage
Automotive
Oil & Gas
Power & Energy
Petrochemical
Pulp & Paper

Case Study – Industrial Waste Water

Introduction

A Major UK Soft Drinks manufacturer has instantly seen the benefits of moving to on-line technology. The customer approached our UK distributor, after their effluent plant (containing an aerobic treatment facility), was overloaded with COD (organic load) over a two day period. The consequences of such an incident were severe. Too high COD load leads to shock and death of the bacteria. The effluent plant had to be closed down whilst the reactors were re-seeded with aerobic bacteria. But whilst the effluent plant was shut, the plant needed to continue production of soft drinks. This meant that effluent was tankered off site until the effluent plant came back on-line. Re-seeding and tankering waste came at a cost of over $0.65 million dollars (£0.5 million pounds) to the plant.

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The Problem

The effluent plant was monitoring load with twice daily spot samples using the standard COD lab method. Not only is the test method hazardous with the use of potassium dichromate, it is a time consuming and slow analysis. This particular incident also highlights how spot sampling is not an effective means to monitor or control a process, as significant events can be missed leading to monetary losses and/or out of consent discharges.

Real-time Solution

Our solution was to monitor and control the daily load to their effluent treatment plant by using continuous TOC analyzer. COD is essentially an indirect measure of Organic load (TOC). TOC can be used to measure COD levels with a correlation factor and it is this method that has become the industry standard for continuous COD monitoring and control.

It was established that in soft drink manufacturing the main contribution to COD was sugars, which would give a consistent chemistry going to the effluent plant and would ensure a consistent, stable correlation between COD and TOC.

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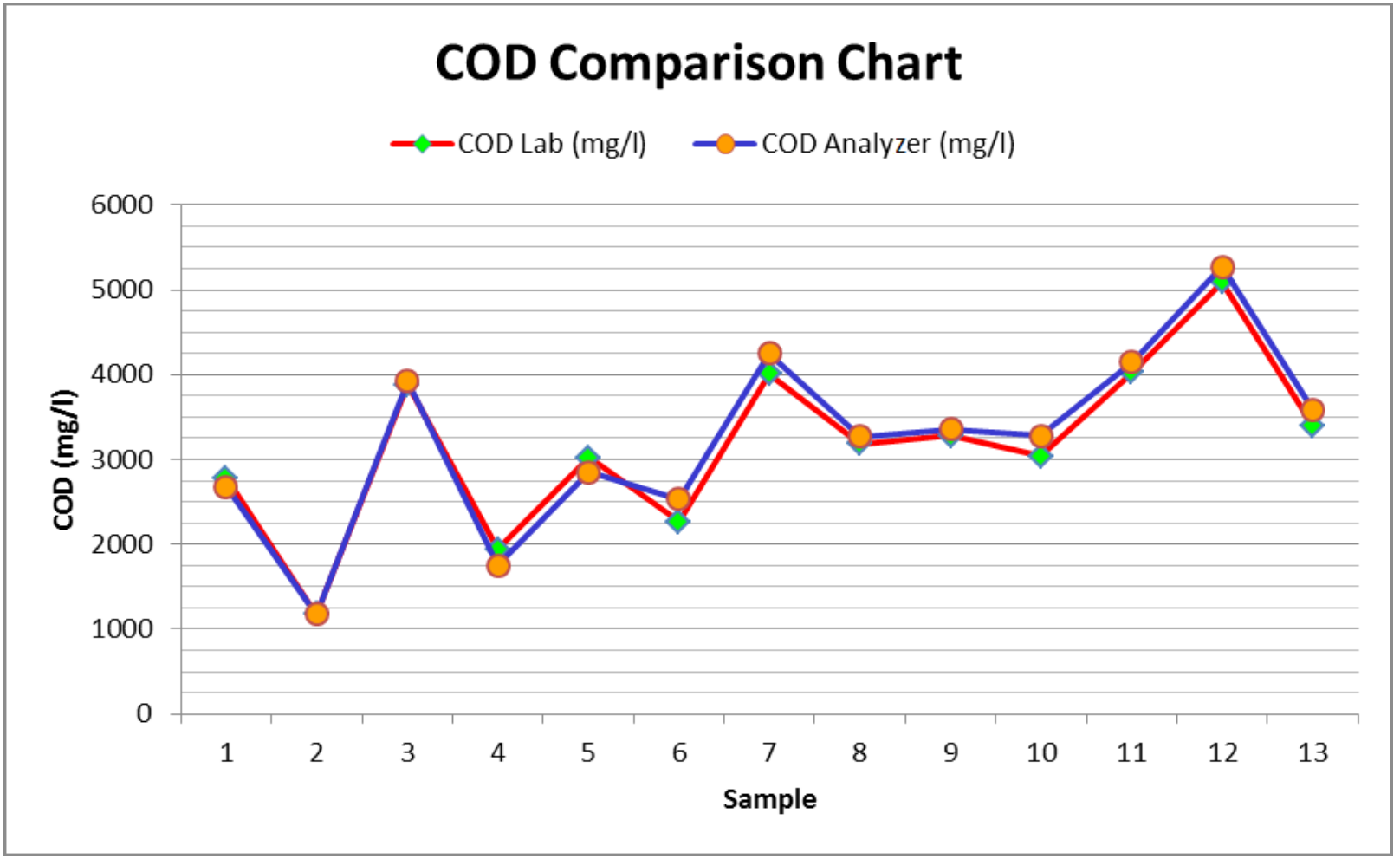
Results

A two month trial period using the TOC analyzer was carried out where the company measured lab COD samples alongside the TOC results.

Indeed a very consistent and reliable correlation was established between COD and TOC which turned out to be a correlation ratio between 2.7-2.9. Validation of the ratio using a factor of 2.9 showed the TOC analyzer gave highly accurate COD results (for example a TOC value of 1000mg/L would mean a COD of 2900 mg/L).



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Robustness to Suspended Solids

Furthermore the customer was very satisfied that the analyzer could cope with the quality of the effluent with a 100% up-time in the face of high levels of suspended solids and bug growth in the sampling lines. This gave them confidence in the robust design of the analyzer with wide bore tubing and no-internal valves proving the system to be rugged. The simplified layout and use of easily obtainable and inexpensive parts meant the analyzer was easy to operate and maintain, whilst giving accurate and reliable COD results continuously.

Instant Return on Investment

The company saw instant benefits when continuously monitoring COD. They were able to understand when peak COD loads were hitting the effluent plant. Also due to the continuous logging of COD they were able to calculate the daily COD loading to the plant and efficiently dose nutrients and save energy costs on aeration to the plant to maintain the correct balance for an efficient treatment. In doing so it has been calculated that the cost of the analyzer was paid back within 6 months from chemical savings alone.

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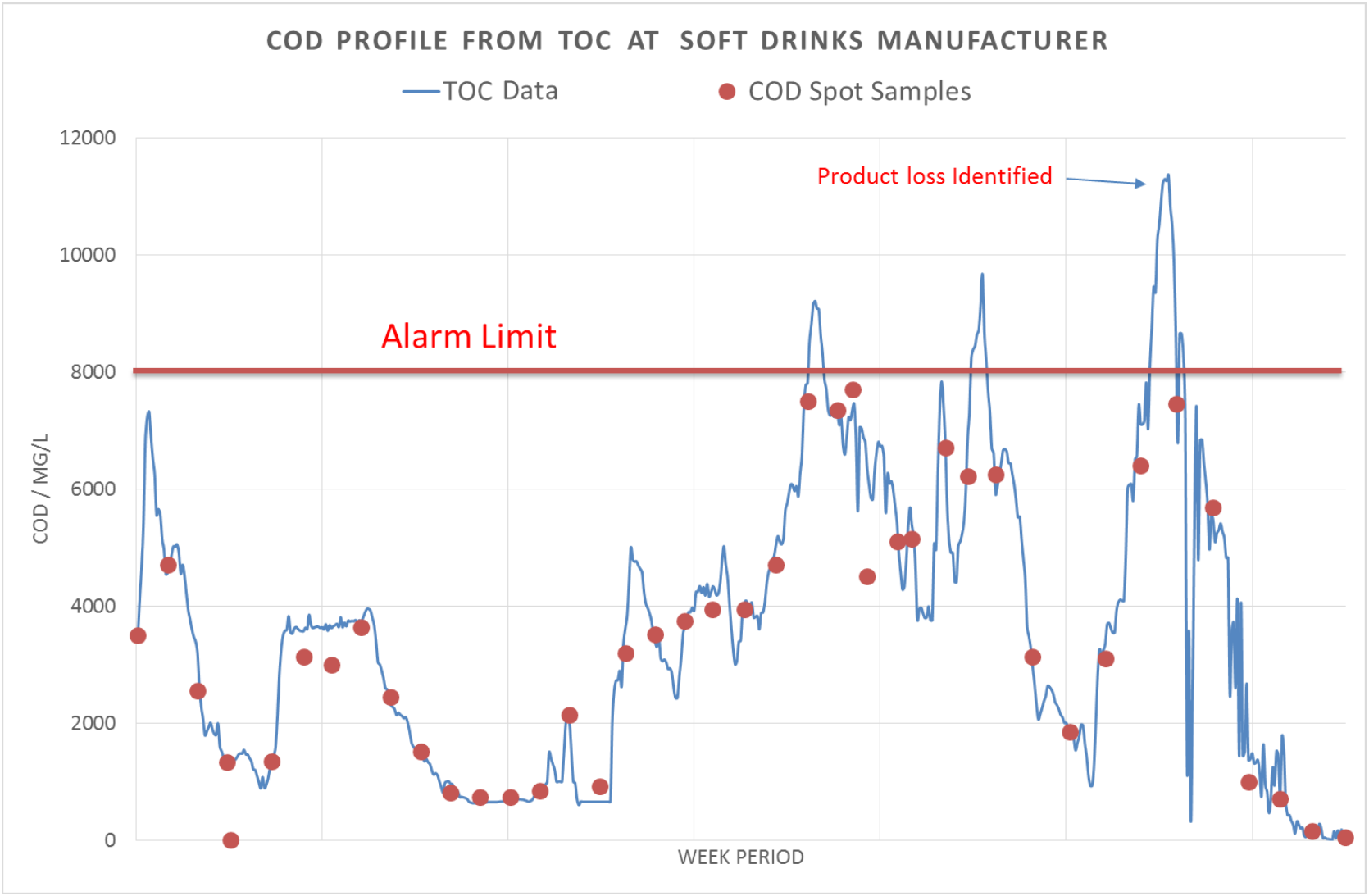
Up-Stream Process Understanding

It quickly became apparent that the plant was often being overloaded at systematic times during the week. The operators were able to manage the loading coming into the plant by instructing when the bottling plant had to stop discharge to the effluent plant in order to manage the correct loading and prevent another costly ‘COD shock’.



Additional Cost Savings

An additional benefit since the TOC analyzer was installed was that it identified a major product loss when a syrup pipe leaked. This was identified by a sudden high level COD spike. The plant was informed; the leak was identified and fixed before more costly losses were incurred (calculated loss before leak being found was twice the cost of the analyzer).

Summary of Benefits

Good Correlation between predicted and Lab COD tests.
COD Spot sampling identified peak COD events would have been missed.
Real time TOC results meant out of consent effluent was identified and contained.
Upstream information was gained, such as peak loads due to product losses (leaking pipe).
Protecting aerobic effluent plant, ensuring effluent compliance and reducing product losses.
Reducing manual testing, reagent and analysis costs. – RAPID PAYBACK

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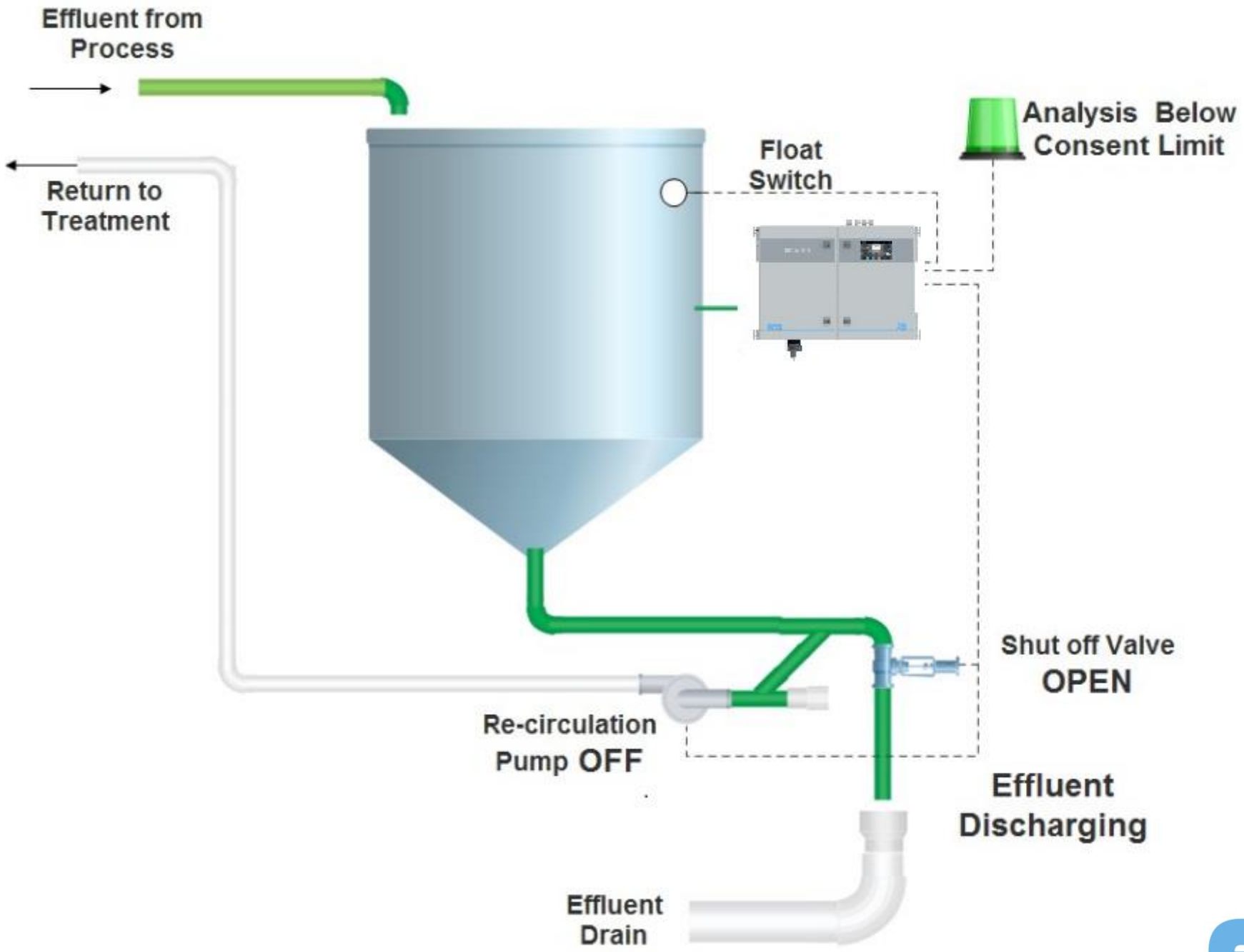
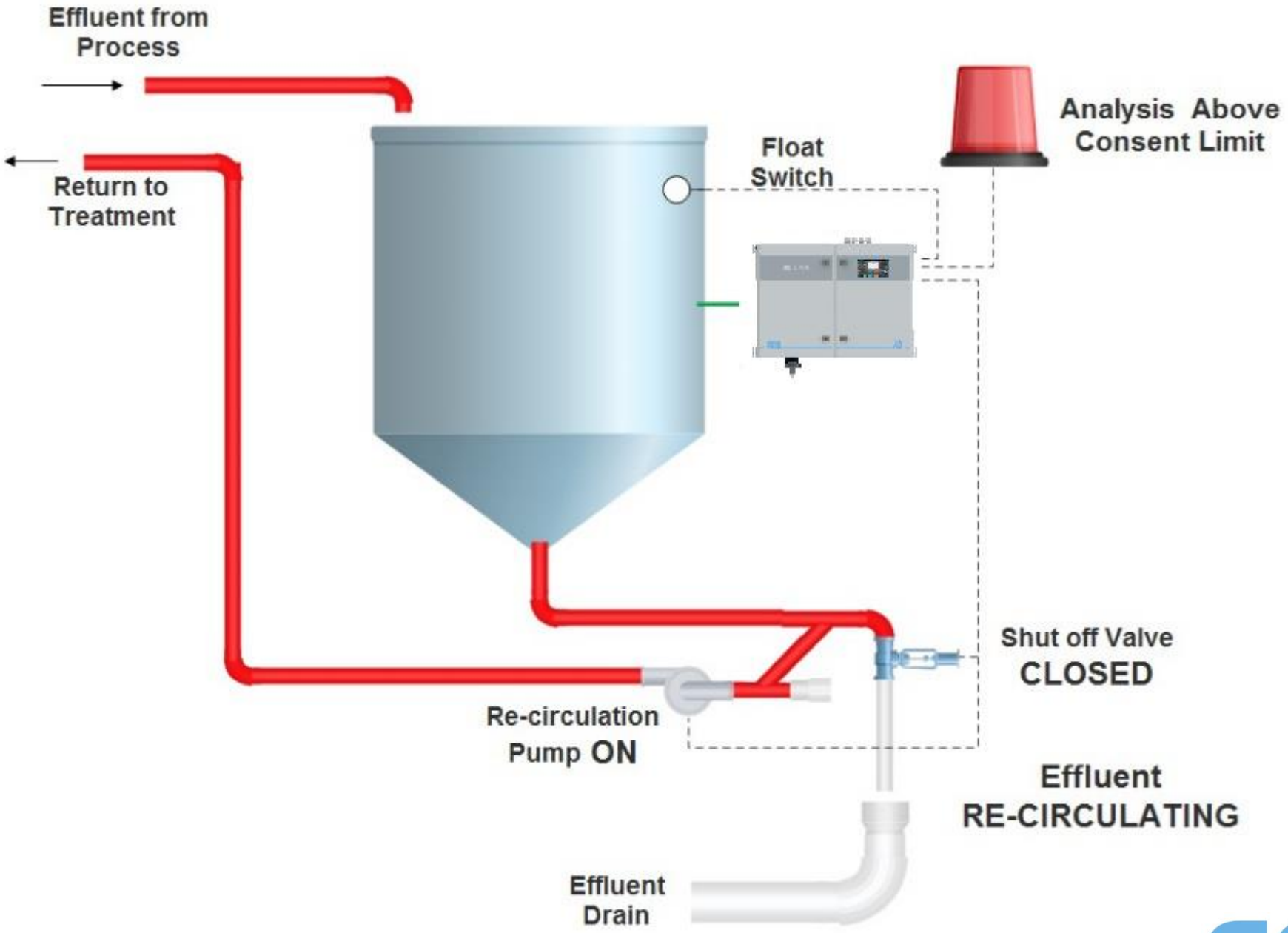

Effluent from Process
Return to Treatment
Float Switch
Analysis Below Consent Limit
Shut off Valve OPEN
Re-circulation Pump OFF
Effluent Discharging
Effluent Drain


Effluent from Process
Return to Treatment
Float Switch
Analysis Above Consent Limit
Shut off Valve CLOSED
Re-circulation Pump ON
Effluent RE-CIRCULATING
Effluent Drain

Safeguarding drinking water supplies with monitoring of water sources for Total Organic Carbon

Monitoring the Total Organic Carbon (TOC) content of the incoming source water will detect early pollution events and prompt action to be taken to divert or close the raw water intake before the treatment plant is contaminated. Moreover TOC is used to determine the quantity of the naturally occurring organic matter (NOM) in source water .

Monitoring of TOC content in the finished water prior to distribution is also required in some countries to control disinfection by-products such as trihalomethanes (THMs) and haloacetic acids (HAAs), which have been linked to cancer.

TOC is also an important parameter for optimizing and thereby reducing costs associated with a treatment process, and is an indicator of the health and safety of source water and distribution system water quality.

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Case Study – Drinking Water
River Monitoring Station

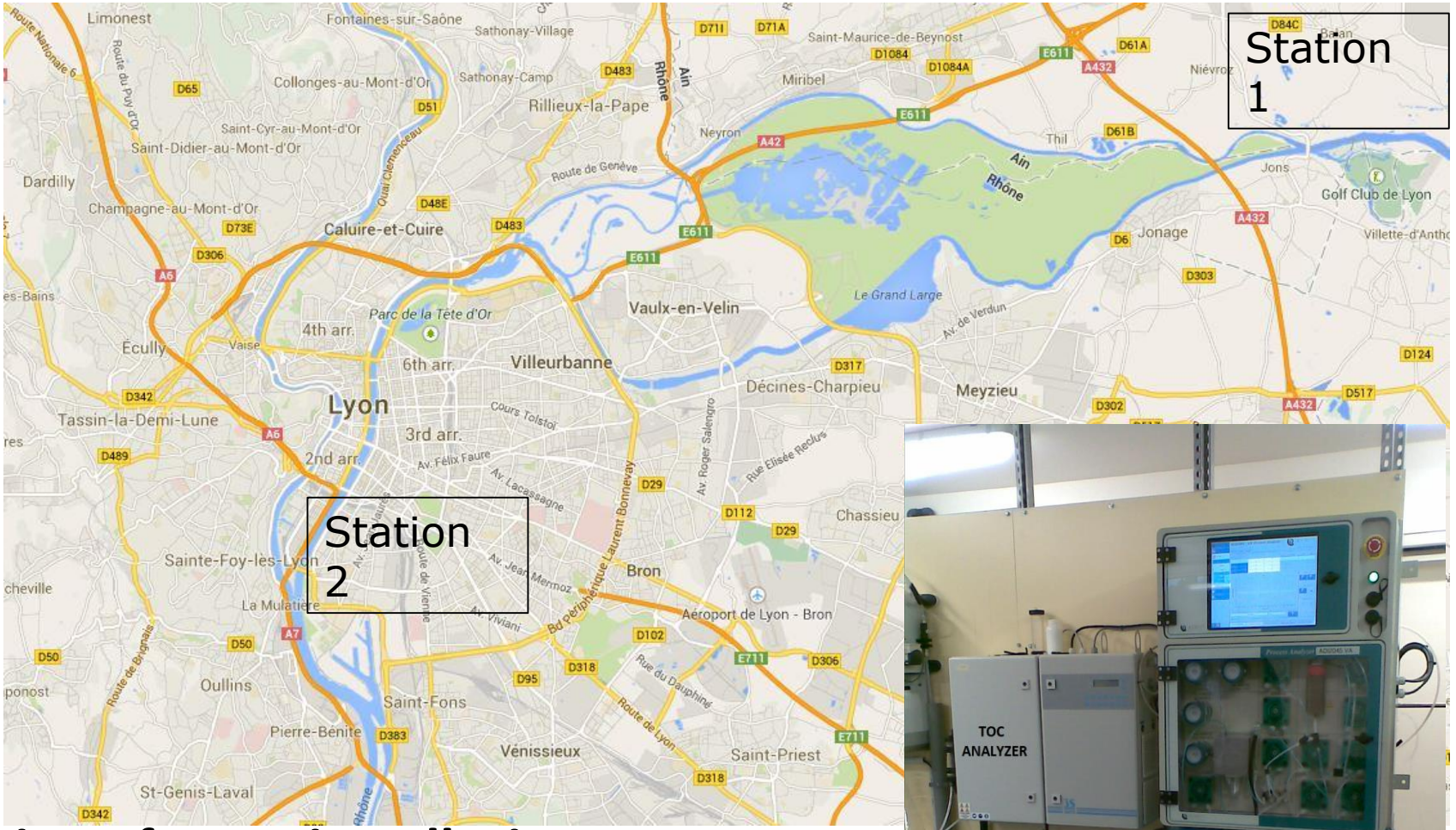
Water monitoring station, used for quality control of the river water.
The task of the station is the continuous monitoring of water quality at the inlet of the drinking water treatment plant.

Veolia France installations
VEOLIA LYON Station de Jons close to LYON 2 x TOCMETER
VEOLIA Annet S Marne (Paris area) 1 x TOCMETER
VEOLIA at Rennes 1 x TOCMETER
VEOLIA Plouasne (close to Brest) 1 x TOCMETER
VEOLIA at Nice 1 x TOCMETER

Other parameters monitored: OIW, turbidity.

CASE STUDY VEOLIA WATER – Lyon, France

VEOLIA EAU



Early warning of organic pollution

First station 5 miles (8 km) upstream of inlet

Second station at inlet

First station gives early warning

Second station confirms inlet water quality

Case Study - Surface Water Quality Monitoring for De-Icing Fluid Events at Heathrow Airport

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UK's busiest airport. Heathrow has purchased 10 TOC Analyzers for the whole surface water catchment of the Airport runways and aprons. Heathrow has a vast catchment area with its multiple runways and taxi network, means surface water can easily become contaminated and run off into the nearby watercourses has to be controlled and regulated.

Heathrow has 2 main treatment areas with multiple monitoring and decision making parts of the process. These different parts of the process have TOC levels ranging from a few ppm up to several hundred ppm in winter times where de-icing is very high.

Surface water leaving the catchment needs to be analyzed and diverted to the treatment process if it exceeds 20 ppm. Throughout the process TOC is monitored at multiple locations to ensure the process is operating correctly and to calculate dosing of nutrients to the aerobic treatment process followed by ensuring effluent water is within the consent level and returned to the water course safely.

Heathrow are not unfamiliar with on-line analyzers and TOC, with aging assets and difficulty in maintaining spare parts of their previous systems meant new units were sought.

Heathrow invited our company along with 4 other top TOC manufacturers to 3 months concurrent evaluation to see which analyzer would come out on top for robustness, accuracy, ease of use and maintenance.

After the rigorous evaluation our TOC analyzer was selected as the most reliable and accurate unit with lowest running costs and ease of use.

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Case Study: Cooling water extraction. Using TOC to monitor the return to the environment.

In several developed countries cooling water extracted from the natural environment accounts for over 50% of national water withdrawals. Much of this water is used in power generation plants producing electricity for domestic and industrial consumption. Many industrial processes also produce a lot of heat. Cooling towers or heat exchangers are used to dissipate the heat produced. These require a plentiful supply of water. Often this cooling water is extracted from a natural water body such as a lake or river and returned to the source after use. Licenses to extract water are controlled by government agencies or local authorities. They are issued with strict conditions that the water is not contaminated during use and is returned to its source in as close to the same quality as it was when extracted. This is to ensure there is no environmental impact, thermal, biological or chemical. Failure to do so can result in prosecution. Continuous on-line monitoring of the surface water intake and the outlet can ensure legal requirements are met and costly fines are avoided. One parameter that can be used as a primary indicator of water is TOC. By monitoring TOC, pollution events can be quickly identified and alarms sent to a control room where corrective actions can be rapidly instigated.