Water Technologies & Solutions
case study

food and beverage manufacturer increases efficiency and quality control with total organic carbon analysis of cleaning cycles

challenge

Food and beverage (F&B) manufacturers face numerous challenges related to the quality, efficiency, and environmental effects of their manufacturing processes. Some of the challenges in the industry today include:

1. Demand for increased efficiency
2. Compliance to the Food Safety Modernization Act (FSMA) to ensure consumer safety
3. Pressure to reduce water and resource usage
4. Effect of product recalls on productivity and consumer safety

The FSMA, whose final rules and provisions were released in late 2015, requires F&B companies to improve control over product safety and quality by enacting prevention-based controls, rather than reactive, in their manufacturing processes. Cleaning and sterilization of manufacturing equipment is one process where F&B companies can be more proactive to prevent quality problems. For example, minimizing carryover from product to product on shared equipment trains is extremely important for safety and quality, especially for foods known to contain allergens.

Before any sterilization (or sanitization) activities begin, soils and residual product must be completely removed from manufacturing equipment to ensure proper sterilization. Any attempts to sterilize dirty equipment are not only a waste of time and money, but can also jeopardize the quality of the next product manufactured on the equipment.

A California F&B company that manufactures over 350 individual products per year sought to implement new process tools to improve product quality and safety. In addition, the company aimed to increase efficiency and reduce water usage in environmentally-conscious California. Although the company was using ATP swab tests to check for microbial contamination, it experienced recurring quality issues leading to product loss. The company recognized the importance of verifying equipment cleanliness and wanted to identify a fast, easy, and reliable solution to improve quality control of its cleaning process.

solution

This company successfully implemented Total Organic Carbon (TOC) analysis with a Sievers* M9 TOC Analyzer in Turbo Mode to monitor rinse samples after clean-in-place (CIP) cycles to verify the cleanliness of its manufacturing equipment. The cleaning process was updated to add TOC analysis prior to any sterilization processes so that time was not wasted attempting to sterilize dirty equipment. While there are techniques available to test for microbial contamination on equipment (such as ATP swabs), these tests lack the necessary accuracy and selectivity for residual soils and are prone to false positives. Adding TOC analysis to the cleaning verification process provides a more comprehensive understanding of equipment cleanliness from residual soils.

TOC analysis of rinse and swab cleaning samples has been a widely-used method for the past 15+ years in the pharmaceutical and biotechnology industries to validate the complete removal of active drug compounds, excipients, and detergents from manufacturing equipment. Because F&B products are organic in nature or have organic components (flavors, dyes, etc.), TOC analysis of rinse samples is also a highly effective tool in F&B manufacturing to determine the cleanliness of equipment. Any residual products or cleaning agents that remain on equipment during the final rinse will be detected by measuring TOC.

results

Table 1 shows TOC measurements for grab samples from the California facility taken during the last minute of the CIP final rinse. The data shown are for two different products being manufactured on the same equipment after cleaning with tap water.

Table 1: TOC measurements of rinse samples demonstrate equipment is not clean following the CIP cycle for Product B.

Product	Sample	TOC Measurement	Outcome from ATP Test
Product A	Tap Water Background	0.52 ppm TOC **Clean**	
	Final Rinse	0.53 ppm TOC **Clean**	Clean
Product B	Tap Water Background	0.61 ppm TOC **Clean**	
	Final Rinse	1.13 ppm TOC **Dirty**	Clean

ATP swab testing performed on the same equipment indicated that the equipment was clean of microbial contamination after the CIP cycles for both Product A and B, but TOC results clearly showed that the equipment was still dirty from organic or product residues after the CIP cycle for Product B. Following visual inspection, operators confirmed that the manufacturing equipment was still dirty and would require additional cleaning to ensure product quality and safety.

Prior to implementing TOC analysis, this company would have used only ATP swab data to make decisions to proceed to sterilization. This would have led to manufacturing subsequent batches of product on dirty equipment, resulting in loss of product. As TOC results provide information about the organic residues still remaining on equipment, TOC analysis is an attractive analytical method for F&B manufacturers to ensure the product quality and safety for their customers. Additionally, monitoring TOC data trends over time on equipment allows companies to proactively address cleaning or maintenance concerns before they fail or lead to unsterile product.

water reduction and savings

Population growth, drought, and global environmental concerns have encouraged industries to be more conservative with water use. Within F&B manufacturing, the cleaning process is one of the first places companies are assessing to decrease water usage. By implementing TOC analysis to verify equipment cleanliness, manufacturers can potentially shorten CIP cycles without sacrificing quality. For example, the analytical data provided in TOC measurements can help companies optimize CIP cycles and confirm that a shortened cleaning cycle is sufficient to remove all soils from the equipment. Shortening CIP cycles, even if only by several seconds, can result in significant cost savings over time from reduced water usage.

Another concern in F&B cleaning processes is confirming equipment cleanliness following idle time. This California facility estimated that they would save upwards of $10,000 per month in water, labor, and chemical costs by reducing the number of times they needed to clean equipment that had been sitting idle for longer than the allotted hold time. Soon, it is going to use TOC analysis on rinse samples to determine if the equipment is still clean to eliminate unnecessary CIP cycles.

troubleshooting production equipment

While using a Sievers M9 TOC Analyzer in grab mode at various points throughout the facility, the California F&B manufacturer discovered a piece of production equipment was not rinsing properly during the CIP cycle. It sampled several ports on the final rinse both upstream and downstream of the production vessel and used TOC results to locate the failure (**Figure 1**). By identifying the issues, future flow changes during the CIP cycle and engineering changes can be implemented.

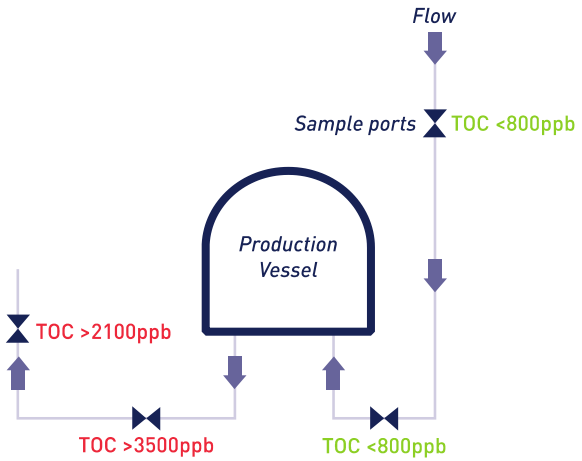

Figure 1: TOC analysis of grab samples upstream and downstream of a production vessel reveals the location of failure.

return on investment

At this California facility, up to 50 batches of product are run in a 36-hour production session. Any issue during a production session that causes loss of product costs a minimum of $200,000. Because measuring TOC is more accurate than other tools in determining equipment cleanliness prior to sterilization, risk of product loss is minimized. Thus, the return on investment to implement TOC analysis in this facility's manufacturing process is many times the cost of the analyzer, and payback can be achieved in a single session.

Furthermore, it generally takes three to seven days following a production session to confirm that the product can be sold. During that time, production does not stop and often two or three more sessions are occurring. Any issues in the first session that are not corrected can easily lead to over $600,000 in losses as costs multiply before the defect is realized. TOC analysis is an easy way to ensure any problems in cleaning cycles are detected in near real-time, before resulting in catastrophic loss of product and money.

The added benefit of using TOC analysis to improve production efficiency by streamlining CIP cycles and reducing water can save tens of thousands of dollars per month in labor, water, and chemical costs.

Sievers M9 TOC Analyzer

For this application, it is important to use a TOC Analyzer with a wide dynamic range, the ability to analyze a tap water matrix (since many F&B manufacturers clean with tap water), and the ability to provide fast and reliable data for quick decision-making. This California facility selected the Sievers M9 TOC Analyzer, which can analyze samples from 0.03 ppb to 50 ppm TOC, uses a method that is approved by both the EPA and Standard Methods for municipal tap water, only needs to be calibrated once per year, and requires no carrier gases. Furthermore, the ability of the Sievers M9 to run both online and grab samples allows it to be used at numerous sampling locations and rinse streams throughout a facility.

Online analysis from a CIP rinse using the Sievers M9 in Turbo Mode allows operators to view the rinse-down process of equipment in real-time. In addition, grab samples can be taken at various points throughout the rinse cycle, at different sample locations on a single piece of equipment, or on multiple pieces of equipment. A combination of online analysis and grab (at-line) analysis gives a detailed view of the efficacy of the cleaning process and provides an early indication of problems with the CIP cycle or the equipment itself.

conclusion

Implementation of TOC analysis with the Sievers M9 TOC Analyzer allowed a California F&B manufacturer to improve efficiency and quality control in its cleaning processes. TOC analysis proved to be more accurate than other methods to determine cleanliness, thus providing greater confidence in decision making and prevention of product loss. Additional benefits of TOC analysis in F&B manufacturing can be realized through optimization of CIP cycles and troubleshooting of production processes.

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