

Green Pharmaceutical Manufacturing With Water-efficient TOC Monitoring

Issues around water scarcity are set to increase. Water is used in almost every production process, and industries, including pharmaceuticals manufacturing, require vast quantities of it. The costs of producing pure water and of discharging it are substantial. So methods of reducing water use are growing in importance. Total organic carbon (TOC) analyzers, essential in the pharmaceutical industry, can consume large quantities of pure water. New, water-efficient TOC analyzers reduce water use – lowering costs and increasing green manufacturing.

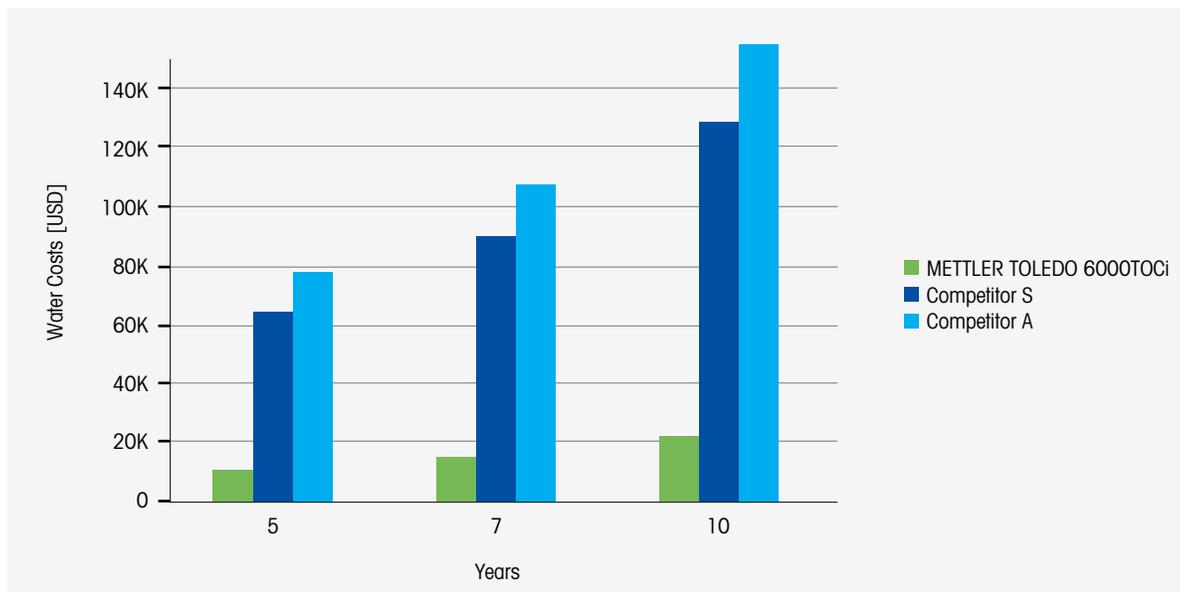
Growth in biologic drugs has increased demand for water

Eight of the top ten blockbuster drugs on the market today are biologics. Names like Humira® are now commonplace, and the need for more biologic drugs is increasing substantially. With this growing need for biologics, which must be grown in cellular systems, comes a requirement for bioproduction and, hence, water. Larger and larger bioprocess facilities are being created to meet the demand for these blockbuster drugs, and production of high purity water and its analysis are costly.

Therefore, the ability to use less water to analyze for essential attributes such as TOC, is a growing need in the biopharmaceutical arena.¹ Additionally, some manufacturing plants are now installing their own wastewater treatment plants to help ease the burden on municipal water systems. This not only provides the manufacturers with water, it also helps them to comply with evolving, integrated pollution prevention laws that are being enacted in Europe.²



Water use can be further reduced with analytics designed with water efficiency in mind. The METTLER TOLEDO 6000TOCi Total Organic Carbon sensor operates at a flow rate of only 8.5 mL/min, minimizing the amount of expensive, high quality water used for this key measurement. This water-efficient sensor's optimized flow rate can deliver significant cost and water savings over the sensor's lifetime. The 6000TOCi's low water use means there is less water to discharge in the pharma manufacturing space.



Water consumption costs over 10 years, comparing the METTLER TOLEDO 6000TOCi with two competitive analyzers.

Critical factors in green manufacturing

Like climate change and the impact of carbon emissions, many countries and organizations are thinking about their water use. In this regard, there are several initiatives to understand and several reasons why green (low water usage) TOC systems are important.

Corporate initiatives to be green

Many companies now have initiatives in place to become greener. These include lower carbon dioxide emissions, lower waste generated and lower water use. Labs and process analytical technologies (PAT) for manufacturing pose a unique challenge to sustainability. It is not as easy as installing smart thermostats or smart lighting, as can be done in an office space. An excellent example of corporate initiatives to go green comes from one of the world's largest biotechs. In 2015, they initiated a program to fight waste, recycle and reduce water consumption and lower carbon dioxide emissions by decreasing transportation activities.³ In particular, water consumption by manufacturing processes was highlighted as the largest contributor to total water use.

Cost of water is continuing to increase

The cost of discharge/sewer water can be ten times greater than the incoming price of water. Certain parts

of the world (e.g., Germany) charge considerably more for discarding wastewater, which leads to substantial costs for an organization. These rates are an incentive to conserve water and save money. Therefore, many companies have instituted a reuse/recycle plan for assets such as water cooling towers, implemented gray-water systems for irrigation of landscaping, or added more drought-tolerant plants to their landscaping. In the case of pharmaceutical water systems, reuse of wastewaters back into the RO system (or other purification system) is becoming more popular, significantly cutting wastewater discharge. Several cosmetics companies have also been early adopters of water loop factories in some countries, and have realized tens of millions of dollars in savings.⁴

Energy cost of water systems

Heating Water for Injection (WFI) above ambient temperatures is costly. In the case of Hot WFI, not only does an organization pay for the water, it also pays for the energy to heat the water. One estimate showed that the cost of heating water from 20 to 80 °C over a year in a PAT system typical of a pharma water system, could cost as much as \$100/TOC unit per year if the installed TOC analyzer was running at 60 mL/min.⁵ This is compared to just \$13/TOC unit per year for running the 6000TOCi at 8.5 mL/min.

The environmental impact of water usage in a hot WFI system is compounded by the energy required to heat the water. The heating process is probably a significant source of carbon dioxide emissions. Therefore, switching to ambient WFI can profoundly affect energy costs and reduce the release of greenhouse gases.

Environmental impact

Green TOC systems are good for the planet. For all the discussion on cost savings for water and energy, the fact remains that the Earth does not have enough fresh water, and conservation is required to maintain the delicate balance between the ecosystems we rely on. The World Health Organization (WHO) estimates that by 2025, half of the world's population will be living in water-stressed areas.⁶

Water efficiency in TOC measurement

Lowering the amount of wasted water during manufacturing is important for any pharma/biotech plant. Analysis of water quality is also a necessity in the manufacturing of all biologic drugs and vaccines today. However, the amount of water used to test key parameters such as TOC, is often overlooked.

Many previous generation TOC monitoring systems use membrane-based batch methods that do not provide truly continuous data, and consume considerable amounts of water to perform their analysis. As they operate at a flow rate of 50-60 mL/min, this can lead to more than 600 L of water lost to drain every week and, as they are batch methods, the potential for missed TOC excursions. In comparison, the 6000TOCi sensor delivers real-time, continuous TOC monitoring to improve process control, and operates at a flow rate of only 8.5 mL/min. Only 84 L of water is discharged each week for this water-efficient sensor.

This reduced water consumption results in significantly less waste over the sensor's lifetime, and significant water cost savings for manufacturers. In a batch-controlled system, an entire batch of water (several cubic meters) might be wasted if an excursion happened and was not acted on in time. Additionally, when installed on hot WFI systems, there are added savings when you consider the additional cost of heating the wasted water.

Conclusion

Issues around water use are growing in importance, and that trend is set to continue. In places where water scarcity is becoming a serious concern, such as the Western United States and Taiwan, lower water consumption is becoming a requirement for organizations as sufficient water is not available.

METTLER TOLEDO 6000TOCi		
Competitor S		
Competitor A		

Flow rate comparison between the METTLER TOLEDO 6000TOCi and two competitive analyzers.

The METTLER TOLEDO 6000TOCi sensor consumes as little as a sixth of the water needed by batch-based analyzers, to help organizations reduce water costs and fulfill the need to be more environmentally responsible. An organization wishing to implement a greener TOC-analysis process can therefore install this low-flow sensor and realize the reduced costs of less wasted water.

References

- 1 - <https://www.pharmtech.com/view/water-water-everywhere>
- 2 - <https://www.pharmtech.com/view/considering-water-use-pharma-manufacturing>
- 3 - https://www.gene.com/assets/frontend/pdf/content/good/sustainability/Genentech_Environmental-Sustainability_Factsheet_2020.pdf
- 4 - https://cdn.cdp.net/cdp-production/cms/reports/documents/000/005/577/original/CDP_Water_analysis_report_2020.pdf?1617987510
- 5 - <https://www.energy.gov/eere/femp/energy-cost-calculator-electric-and-gas-water-heaters#output>
- 6 - <https://www.who.int/en/news-room/fact-sheets/detail/drinking-water>



Optimized flow rate

of 8.5 mL/min minimizes the amount of high-quality water used for water-efficient TOC monitoring

True continuous measurement

captures any increase in TOC levels, ensuring no excursions are missed

Stable and reliable analysis

is achieved by using proven UV oxidation technology and the highest accuracy conductivity sensors

Verifiable system performance

Dynamic Lifetime Indicator (DLI) tool monitors remaining UV lamp life so maintenance can be planned before problems occur

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For more information

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Subject to technical changes

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