Addressing BOD_5 Limitations through Total Organic Carbon Correlations: A Five Facility International Investigation

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Dedicated in memory of Paul Lagassé, P.Eng., ITA Board Director/ Wastewater Engineer, City of Winnipeg, Manitoba, Canada

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Instrumentation Testing Association

The Instrumentation Testing Association is an international nonprofit technical and educational organization dedicated to promoting the understanding, selection, improvement, and cost-effective use of instrumentation and automation applications for monitoring and controlling water, wastewater, and industrial systems. Since 1984, ITA has provided educational and technical services to environmental specialists, including civil, mechanical, electrical, and environmental engineers; scientists; local, state, and government officials; treatment plant operators, technicians, and collection systems personnel; laboratory personnel; chemists; industrial technologists; students; academics; and equipment manufacturers and distributors.

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DEDICATION

This research report is dedicated to ***Paul Lagassé, P.Eng***., Wastewater Engineer for the City of Winnipeg, Manitoba, Canada. Paul Lagassé was a volunteer Board member for ITA and actively served on ITA's Board from 2002 until his passing in late 2010. Paul was actively involved in ITA's TOC Research project as an advisor and Board member and was significant in helping ITA launch the TOC research project in early 2010. In dedication to Paul Lagassé, we will miss your enthusiasm for learning and teaching; your passion to protect the environment; and your vision for embracing and utilizing available technology now and for a better future.

ITA's RESEARCH & DEVELOPMENT

The Instrumentation Testing Association (ITA) was established in 1984 at a United States Environmental Protection Agency (U.S. EPA) meeting held in Chicago, Illinois to address the need for obtaining unbiased and objective research regarding the performance and reliability of online instruments used in the water and wastewater treatment industry. ITA was formed as a 501(c)(3) non-profit technical and education organization to conduct charitable, educational, and scientific testing for public safety. ITA's mission: *to advance the theory and practice of instrumentation and automation for water and wastewater treatment and other public works facilities by promoting the reliable performance of environmental instrumentation and automation technologies*: was developed by its volunteer Board of Directors representative of public and private, water and wastewater treatment utilities, throughout the U.S. and Canada. ITA's mission is designed to advance treatment that will result in providing better public water service and enhancing public health. ITA carries out its mission by developing and disseminating information on instrumentation and automation technologies and conducting educational programs in the field of instrumentation and automation.

ITA's research and development reports are intended to provide innovative information through a review of technical practices and detailed procedures that research and experience have shown to be functional and practical. ITA's cooperative research process provides a unique perspective in the openness of protocol development. All participating stakeholders assist with the development of the test protocol and procedures. In addition, all stakeholders participate in review and final publication of research results to ensure unbiased and technically accurate analyses.

ABSTRACT

This research report presents site-specific correlations between the 5-day biochemical oxygen demand (BOD_5) and total organic carbon (TOC) for wastewater treatment plants (WWTPs) representative of various flows, treatment technologies and watershed ecosystems. Full-scale long-term wastewater quality data including BOD_5 and TOC for three City of Winnipeg WWTPs, the Town of Quispamsis WWTP, and the City of San Francisco Oceanside Water Pollution Control Plant (WPCP) were provided for the operating period of 2011 and analyzed to determine if there was a statistically significant correlation between BOD_5 and TOC. Although the focus of this study was the correlation between BOD_5 and TOC, for the Oceanside WPCP, the correlation between BOD_5 and COD was also reviewed. A summary of the treatment technology, sample preservation method used for the TOC analysis, and data analysis for each plant is presented.

Chapter 1 presents BOD_5 limitations and addresses the need for an alternative approach. Chapter 2 presents current practices of using TOC analysis as an alternative to BOD_5. Chapter 3 presents correlation data and analysis between BOD_5 and TOC for five facilities of various flows, treatment levels and climates. Chapter 4 presents a comparative analysis and report summary and Chapter 5 provides wastewater treatment plants with an implementation protocol for developing a site-specific BOD_5:TOC correlation study to allow a TOC limit to be substituted for a BOD_5 limit in permits.

EXECUTIVE SUMMARY

Wastewater treatment plants (WWTPs) are challenged with the objective of treating wastewater to a level that is acceptable for discharge into receiving waters (lakes, streams, rivers, estuaries, bays, etc.). Regulatory agencies require that WWTPs routinely measure and report by permit, the biochemical oxygen demand (BOD) of raw and treated wastewater to determine the strength and wastewater loadings to and from WWTPs (USEPA, 2000).

Although the BOD_5 test is still a widely accepted parameter by regulators for characterizing water and wastewater quality, it is inaccurate, unreliable, not effective at low concentrations, and it cannot be used for process control or real-time monitoring due to the time it takes to receive test results, at least five days (Constable, 1979). Wastewater treatment plants can discharge treated effluent that may not meet permit limitations for up to five days before a compliance issue can be identified by the BOD_5 test.

The wastewater industry has expressed a need for an analytical test to replace BOD_5 that can provide quantifiable, precise and timely measurements of receiving stream wastewater loadings and plant removal efficiencies, in addition to providing monitoring and process control capabilities. Total organic carbon (TOC) and/or chemical oxygen demand (COD) have been commonly accepted and used in industrial wastewater treatment as key parameters for process monitoring and control. Global regulations allow COD or TOC to be substituted for BOD_5 when a long-term BOD_5:COD or BOD_5:TOC correlation can be demonstrated.

Wastewater treatment professionals are very eager to make a change from the BOD_5 regulatory reporting requirements. TOC as an alternative to the BOD_5 analysis will save WWTPs in analytical costs and potentially could reduce chemical and energy costs if used for process control purposes. TOC as a BOD_5 alternative will also increase plant operations efficiency and response time to waste loading upsets.

Although there have been many studies that examine the correlation of BOD_5 to TOC; research is needed to demonstrate that TOC can be reasonably used to monitor plant performance as an alternative to BOD_5 measurements for permitting purposes. This research report presents the correlation of BOD_5:TOC for five facilities of various flows, treatment levels and climates and present site-specific equations for each site. The correlations and the statistical significance of each are also summarized.

A statistically significant BOD_5:TOC correlation was demonstrated when all BOD_5 data sets throughout the treatment process including raw sewage, primary effluent, and final effluent were plotted against their respective TOC data sets. Using all BOD_5 data sets throughout the treatment process (from influent to effluent), is what is required to demonstrate a site-specific BOD_5:TOC correlation to allow a TOC limit to be substituted for a BOD_5 limit in permits.

When considering the final effluent data set independently (where low BOD_5 concentrations are present), a statistically significant BOD_5:TOC correlation was difficult to be demonstrated due to the inherent inaccuracies of and ineffectiveness the BOD_5 measurement at low BOD_5 concentrations.

In addition, to guide wastewater treatment plants in developing a site-specific TOC:BOD_5 correlation that could be used to allow a TOC limit to be substituted for a BOD_5 limit in permits, an implementation protocol is presented.

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Project Advisory Panel:

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