Rapid Bacteriological Quantification Using Florescent Enzymatic Activity in Municipal Wastewater e

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Rapid quantification of bacteria in municipal wastewater has the potential to change how municipal wastewater treatment plants (WWTP) operate by providing operators microbiological assessment in near-real time. Conventional quantification methods, specifically membrane filtration (MF) or most probable number (MPN), do not provide sufficient response time to modify treatment or assess the impact of discharge on environmental and human health. Furthermore, current methods lack sufficient dynamic range to reliably quantify bacteria in wastewater. Due to the lack of a robust method, communities discharge wastewater above pathogenic regulatory limits, resulting in fines, human and environmental risk, and loss of discharge permits. The relevance of near-real time data is more pertinent in naturalized systems, where the ability to change treatment parameters are slower in comparison to chemical or UV disinfection.

A rural WWTP in South Eastern Ontario was selected as a representative model of small-community treatment systems across Canada. The site consists of conventional primary and secondary treatment, grit chamber and aeration settling basin respectively, followed by waste stabilization ponds (WSP) and a constructed wetland. Many rural and remote communities rely on naturalized systems for the removal of pathogens through naturally occurring biological, chemical and physical processes, due to their ease of operation and low energy requirements. The examined system treats primarily municipal wastewater with little industrial specialization in the area.

The researched method uses a diode array florescent spectrophotometer and fluorophore-bound defined-substrate growth medium for the detection and quantification of bacteria in aqueous samples; this method is well defined in drinking water and faster than traditional methods. However, the significantly greater variation in chemical levels, bacterial species, and bacteria quantities in wastewater compared to drinking water currently invalidates this method. Data was collected weekly over a 4-month spring-summer period, where changes in the naturalized system are most magnified by seasonal variability.

Preliminary signal analysis of fluorescent spectroscopy data reveals chemical and physical parameters in wastewater impact the correct quantification of bacteria. Water chemistry parameters, namely pH, chlorophyll, total organic carbon (TOC), lipids, dissolved oxygen (DO), and chemical oxygen demand (COD), were monitored. Less processed wastewater, specifically activated sludge, was found to contain more interferents at higher concentrations. Multivariate statistics between water-quality parameters were determined and used as general indicators of dependence. These statistics identified preliminary, strong and weak correlations, and isolate interfering parameters, providing more robust quantification algorithms specific to municipal wastewater.

The technology, water parameters correlations, and signal isolation methods resulting from this research contribute to the continued operational improvement of WWTPs and provides practical knowledge for operators of both conventional and naturalized treatment systems.