

## **Comparison of Microbial Removal Performance MBR and Conventional Wastewater Treatment Plants with Disinfection**

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### **ABSTRACT:**

Wastewater treatment plants in Ohio and elsewhere in the U.S. operating with MBR systems are required to disinfect permeate. This requirement results in an increased cost to both capital and O&M, and with chlorination there is a potential increase in the formation of disinfection byproducts. Disinfection following MBR treatment may not be needed if the MBR process alone removes microorganisms as well as or better than conventional technologies with disinfection. The overall goal of this study was to sample at multiple municipal wastewater treatment plants to determine if disinfection following MBR treatment is needed to provide the same level of public health protection from microorganisms as that found for conventional systems that use disinfection after secondary treatment.

This study began in 2007, and included the participation from many different entities such as environmental regulators, funding agencies, municipalities, government research agencies, manufacturers, and engineering consultants. The study had three major objectives: first to compare the reductions of enteric viruses in MBR systems to the reductions found for conventional secondary treatment before disinfection; second to compare the additional reduction of enteric viruses achieved by disinfection of secondary wastewaters at conventional plants with those achieved by disinfection of MBR treated wastewaters and lastly, to compare reductions of indicator bacteria and indicator viruses (coliphage) in MBR and conventional systems, and identify which indicator(s) best represent the removal of enteric viruses.

Sampling was performed at five (5) different wastewater treatment plants in Ohio; three (3) MBR facilities and two (2) conventional facilities. The sampling began in 2008 and was completed in October of 2010. The samples were collected at the following locations:

- Before conventional or MBR secondary treatment (Raw)
- After conventional or MBR secondary treatment (Post-Secondary)
- If applicable, after secondary, but before tertiary treatment (Pre-Tertiary)
- After disinfection (Post-Disinfection)

Criteria for the plant selected for use in the study include:

- Plants located in Ohio (Example Plant Schematic Attached)
- Existing conventional facilities with discharge limitations not greater than 10 BOD/12 TSS/1 NH<sub>4</sub> that use chlorine or ultraviolet (UV) disinfection.
- MBR plants have been in operation for at least one year.
- Facilities and processes within the plants are well-defined.

Detention times were calculated and sampling was staged to collect theoretically the same slug of water as it moves through the plant. Samples were analyzed for bacterial indicators (E.coli, fecal coliforms, enterococi), somatic and F-specific coliphage, enteric viruses by qPCR (enteroviruses, noroviruses, and adenoviruses), and culturable viruses. All of these microorganisms can be typically found in municipal wastewater.

Conclusion: After three years of field sampling, development of new standard methods for analysis and evaluation of the comparative results, the findings show that the permeate after MBR activated sludge and before disinfection is similar or of higher quality than the effluent from a convention activated sludge process after disinfection. The results show that disinfection after MBR activated sludge provides no addition treatment to the wastewater. (Example result exhibit attached – Fecal). Furthermore, wastewater treatment with MBR activated sludge and no disinfection allows for significant capital and O&M cost associated with disinfection to be

reassigned to unit processes providing treatment for a more sustainable and green environment.

(Example O&M results graph attached)

*Project Status:* All field work and analytical work has been completed. Three journal articles are being published. The first paper presenting the standard methods developed to satisfactorily analyze the wastewater was published in October 2011 as Scientific Investigations Report 2011 - 5150 by USGS and is titled, “Quantifying Viruses and Bacteria in Wastewater – Results, Interpretations Methods, and Quality Control” by Francy and others. The second article was published in May 2012 in Water Research and is titled “Comparative Effectiveness of Membrane Bioreactors, Conventional Secondary Treatment, and Chlorine and UV Disinfection to Remove n Microorganisms from Municipal Wastewaters” by Francy and others.

The third article applies the results of the study to the wastewater industry with impacts to capital and O&M cost, the environment and treatment processes. This articles is titled “Comparison of Microbial Removal Performance MBR and Conventional Wastewater Treatment Plants with Disinfection”, by Gellner and others. This paper is being peer reviewed and will be ready for publication in late 2012 or early 2013.

*Consequences to the Industry:* The study shows that disinfection after MBR activated sludge provides no to little additional treatment through the unit process. The capital and O&M cost associated with disinfection are noted and are significant. The use of MBR activated sludge without disinfection allows for the reallocation of disinfection facility monies to processes that provide needed and noticeable treatment while maintaining a sustainable environment.

**KEYWORDS:**

Disinfection, Membrane BioReactor, MBR, Activated Sludge, Viruses, E-coli, Fecal