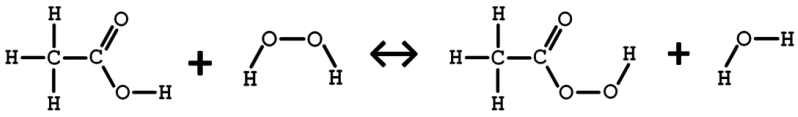
VIGOROX® WWT II WASTEWATER DISINFECTION TECHNOLOGY AND VIRUSES

VigorOx® WWT II Wastewater Disinfection Technology

Disinfection Forum
No 9, August 2015

VIGOROX® WWT II is an equilibrium peracetic acid solution that contains 15% peracetic acid (PAA) by weight at full concentration. The solution exists as an equilibrium of PAA, hydrogen peroxide, acetic acid and water as per:



Peracetic acid has been used as a low temperature biocide for the past thirty years in many industries, including medical device disinfection and sterilization, food and food processing sanitization and aseptic bottle packaging. It has proven effective on bacteria, viruses, yeasts and spores1, depending upon its usage rate and available contact time. While the underlying mechanism of action is not well known, PAA acts as an oxidant; denaturing proteins, disrupting cell wall permeability, and oxidizing sulfhydryl and sulfur bonds in proteins, enzymes and other metabolites.

REDUCTION OF VIRUSES IN WASTEWATER

Currently, there are no federal or state requirements for virus reduction in municipal wastewater effluents. Recently, the U.S. EPA stated that they are considering development of guidelines for the reduction of viruses in wastewaters but have not published draft guidance at this time. It is anticipated that the U.S. EPA will be publishing draft guidance on the analytical measurement of viruses in 2016, with potential, non--risk based, draft guidelines on the control of viruses, using MS2 bacteriophage as a surrogate model, sometime in 2017, based on comments by U.S. EPA at several recent technical conferences. A period of public commentary will then follow the release of the draft guidance, and as a result, finalization of any federal regulation regarding the control of viruses in wastewater may not take effect until at least potentially 2020, in PeroxyChem's estimation.

Regulation on virus reduction in wastewater will have a great impact on the municipal wastewater industry, as all wastewater disinfection technologies will need to demonstrate the ability to meet the potential new viral limits. This includes all currently established disinfection technologies that are being used for the control of bacterial pathogens. Disinfection technologies that are currently emplaced for the control of bacteria will need to be tested to meet new viral standards: chlorination will need to be demonstrated effective at given treatment plants where ammonia, if present, may convert the chlorine to chloramines; UV systems may need to be resized to meet new target organisms. This will be true for peracetic acid disinfection systems as well.

VIGOROX® WWT II PERACETIC ACID AND ITS USE TO MEET POTENTIAL NEW VIRUS STANDARDS

VIGOROX® WWT II PAA has been shown to be economically cost--effective for the treatment of bacteria, such as coliforms, E. coli and Enterococcus, in municipal wastewater streams. Typically, when evaluating VIGOROX® WWT II for use at a treatment plant, jar testing or pilot reactor trialing is used to determine the optimal PAA dosage to achieve effective kill under economically viable conditions.

With respect to virus kill, there are peer reviewed literature articles demonstrating that peracetic acid can reduce viral loading in wastewaters. This is shown in Table 1.

Table 1
Viral Inactivation with PAA

Matrix	Organism	Inactivation	Dose [mg/l]	Contact Time[min.]	Reference
Enhanced primary effluent (1)	Indigenous MS2	1 log	1.5--3.0	60	Gehr et al. 2003
Secondary effluent	MS2	3.5 log	5	120	Lazarova et al., 1998
Secondary effluent (2)	Indigenous F+ coliphages	0.6 log	1.5	20	Zanetti et al., 2007
Seeded wastewater	RNA Phage	2 log	25	5	Rajala-Mustonen et al., 1997
Tertiary effluent	MS2	0.35 log	5	30	WateReuse Foundation, 2012
Peptone water	MS2	1.3 log	15	10	Koivunen and Heinonen-Tanski, 2005
Demineralized water	MS2	>4 log	15	5	Baldry et al., 1991
Lab water (pH 5.0)	MS2 (dispersed virus)	4 log	40	30	Mattle et al., 2011
Lab water (pH 3.6)	MS2 (aggregated virus)	4 log	40	60	Mattle et al., 2011
Secondary effluent	coliphages	1--2 log	5	30	Freese et al., 2002
Secondary effluent	Φx174	7.5 log	10	120	Lazarova et al., 1998
Seeded wastewater	DNA Phage	5 log	25	5	Rajala-Mustonen et al., 1997
Demineralized water	Φx174	>4 log	30	5	Baldry et al., 1991
Secondary effluent (2)	Indigenous Somatic coliphages	0.6 log	1.5	20	Zanetti et al., 2007

(1) Enhanced physicochemical processes (ferric and/or alum coagulation) for suspended solids and phosphorus removal. COD 123-240 mg/l, TSS 16-45 mg/l, and turbidity 16-31 NTU.

(2) Secondary effluent characteristics: pH 6.7-6.8, COD 26-28 mg/l, and TSS 6.1-17 mg/l.

In general for peracetic acid, the "concentration times contact time" factor (C*t) needed to achieve viral reduction will be greater than that for bacteria. However, as with bacteria, the required C*t will be dependent upon the wastewater matrix and the target reduction goals for each treatment plant, requiring jar testing or pilot trialing to ascertain the optimal dosing based on a viral kill efficacy and economics. Similar differences in treatment intensity between viruses and bacteria are typically observed with most disinfection technologies. Note currently, VIGOROX® WWT II is not labeled for treatment of viruses.

As there are no current viral reduction requirements in North America, the cost effective rate of application for hypochlorite (or chlorine chemistry) in actual wastewater is not well known either. Recent laboratory work performed for the Ministry of the Environment, Ontario Province, Canada demonstrated that VIGOROX® WWT II PAA was able to achieve statistically equivalent reductions on Coxsackievirus B6 as compared to hypochlorite in actual wastewater from a local treatment plant (PeroxyChem, 2014). The conditions of the test compared VIGOROX® WWT II concentrations as low as 1.5 ppm to hypochlorite at 1.6 ppm as Cl2 with contact time of 30 minutes.

CONSIDERATION OF VIGOROX® WWT II DISINFECTION

When considering the use of VIGOROX® WWT II disinfection technology at a wastewater treatment plant in view of the potential U.S. EPA draft guidance on virus reduction, several factors should be considered:

- It will be several years before any potential virus reduction requirements on the federal level are set.
- All current wastewater disinfection technologies will require viral efficacy testing and possible redesign of current disinfection systems.
- Implementation of VIGOROX® WWT II disinfection technology is simple (it only requires installation of storage tanks, chemical feed pumps and associated controls) and, contrary to other disinfection systems such as UV, does not require significant capital investment since equipment is typically leased to the plant's owner. If other disinfection technologies were to prove more cost--effective to meet pathogen limits in the future, plant owners would not face large sunk or conversion costs to switch to alternative technologies.

As a result, potential future regulatory guidelines should not impact the selection of VIGOROX® WWT II to meet today's permit requirements.

REFERENCES

(1) CDC "Guideline for Disinfection and Sterilization in Healthcare Facilities", 2008.

(2) Baldry, M.G.C., French, M.S., Slater, D., 1991. The activity of peracetic acid on sewage indicator bacteria and viruses. Water Sci. Technol. 24 (2), 353– 357.

(3) Freese, S.D., Nozaic, D.J., Bailey, I., Trollip, D.L., 2002. Alternative Disinfectants for Wastewater Effluents: Viable or Prohibitively Expensive? Biennial Conference of the Water Institute of Southern Africa, Durban South Africa, May 2002.

(4) Gehr, R., Wagner, M., Veerasubramanian, P., Payment, P., 2003. Disinfection efficiency of peracetic acid, UV and ozone after enhanced primary treatment of municipal wastewater. Water Res. 37, 4573–4586.

(5) Koivunen, J., Heinonen--Tanski, H., 2005. Inactivation of enteric microorganisms with chemical disinfectants, UV irradiation and combined chemical/UV treatments. Water Res. 39, 1519–1526.

(6) Koivunen, J., Heinonen--Tanski, H., 2005a. Peracetic acid (PAA) disinfection of primary, secondary and tertiary treated municipal wastewaters. Water Research. 39 (18), 4445--4453.

(7) Lazarova, V., Janex, M., Fiksdal, L., Oberg, C., Barcina, I., Pommepuy, M., 1998. Advanced wastewater disinfection technologies: short and long term efficiency. Water Sci. Technol. 38 (12), 109–117.

(8) Mattle, M., Crouzy, B., Brennecke, M., Wigginton, K., Perona, P., Kohn, T., 2011. Impact of virus aggregation on inactivation by peracetic acid and implications for other disinfectants. Environmental Science and Technology. 45 (18), 7710--7717.

(9) Rajala--Mustonen, R.L., Toivola, P.S., Heinonen--Tanski, H., 1997. Effects of peracetic acid and UV irradiation on the inactivation of coliphages in wastewater. Water Sci. Technol. 35 (11–12), 237–241.

(10) WateReuse Foundation, 2012. Study of Innovative Treatments for Reclaimed Water. WateReuse Foundation. WRF--02--009.

(11) Zanetti, F., De Luca, G., Sacchetti, R., Stampi, S., 2007. Disinfection Efficiency of Peracetic Acid (PAA): Inactivation of Coliphages and Bacterial Indicators in a Municipal Wastewater Plant. Environmental Technology. 28 (11), 1265--1271.

(12) PeroxyChem. Determination of Performance Equivalency Between Chlorine and VigorOx WWT II in Disinfection of Wastewater. Report to Ontario MOE, 2014.

PeroxyChem LLC
2005 Market Street,
Suite 3200,
Philadelphia, PA 19103
United States

+1 267 422 2400
www.active-oxygens.com