AVOIDING THE FORMATION OF DISINFECTION BY-PRODUCTS IN WASTEWATER WITH THE USE OF VIGOROX® WWT II PERACETIC ACID

VigorOx® WWT II Wastewater Disinfection Technology

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This edition of Disinfection Digest discusses the benefit of using VIGOROX® WWT II for wastewater disinfection to address concerns or compliance issues with regards to disinfectant by-products (DBPs) and the implications to wastewater utilities.

THE DISCOVERY OF CHLORINATED DBPS AND THEIR IMPACT TO WASTEWATER UTILITIES

While the chlorination process is the most commonly used disinfection technology for municipal wastewater in the US, formation of harmful chlorinated DBPs has become a concern, and is one of the major drivers for wastewater utilities to consider alternative disinfection technologies. Studies in 1970s found that trihalomethanes (THMs), which include chloroform, dichlorobromomethane, dibromochloromethane and bromoform, can be formed from chlorinated disinfection processes[1]. Since that, numerous and even more toxic DBPs have been identified as the result of the wastewater chlorination process. These include, for example nitrosamines[2] and cyanide3 & 4. Some of these DBPs have been identified as human carcinogens or probable human carcinogens. They could also be toxic to aquatic organisms. Once these DBPs are formed, adding dechlorination process will not remove them.

Depending on site specific conditions, utilities may have discharge limits on DBPs in their National Pollutant Discharge Elimination System (NPDES) permits. A few examples of these limits are shown in Table 1. For comparison purpose, the corresponding maximum contaminant levels (MCLs) in accordance to the primary drinking water standard in US are also included in the table. Similar to other water quality parameters, the limit values of DBPs in NPDES permits vary from plant to plant, depending primarily on the dilution factor of the wastewater effluent discharging into the receiving stream, the target sensitive aquatic organisms to be protected, and the use designation of the receiving stream. Of interest to note is that the limit values in NPDES permits could be lower or much lower than drinking water MCLs. For example, the MCL of THMs in drinking water is 80 ppb, while some wastewater utilities have limit values for individual THM species ranging from about 1 to 20 ppb in their NPDES permits. When these limits are promulgated, it is almost impossible for wastewater utilities to continue use chlorine as their disinfection technology.

VIGOROX® WWT II PROVED A COST EFFECTIVE SOLUTION TO ADDRESS DBPS

VIGOROX® WWT II is a non-chlorine, peracetic acid based disinfectant. As a result, adding VIGOROX® WWT II to wastewater does not form chlorinated DBPs or other harmful DBPs, such as nitrosamine or cyanide. It is a cost effective alternative for wastewater utilities to replace the chlorination process as a means to eliminate on the potential to form DBPs. Several case studies are described below.

Table 1

DBP Limits in NPDES Permit

Wastewater Plant	DBPs	Limit Value in NPDES Permit	US Drinking Water Maximum Contaminant Levels (MCLs)
Plant A (CA)	Dibromochloromethane	0.81 ppb	Total THMs 80 ppb[a]
	Dibromochloromethane	1.1 ppb	
Plant B (OK)	Dibromochloromethane	17.7. ppb	
Plant C (CA)	Dibromochloromethane	3.4 ppb	
	Dibromochloromethane	2.2 ppb	
	N-Nitrosodimethylamine (NDMA)[b]	1.40 ng/L	No standard in US[c]
Plant D (CA)	Cyanide	4.3 ppb	200 ppb
Plant E (FL)	Cyanide	1.0 ppb	200 ppb

a: Sum of four THM species (chloroform, dichlorobromomethane, dibromochloromethane and bromoform).

b: NDMA is one species of nitrosamines and is often considered as an indicator for the whole group of nitrosamines.

c: World Health Organization recommends a guidance value of 100 ng/L in recent Drinking Water Guideline5. Health Canada recommends a maximum acceptable concentration of 40 ng/L6.

1. CITY OF ST. AUGUSTINE, FL

This is the first municipal wastewater plant in the US to fully implement VIGOROX® WWT II as the disinfectant. After a comprehensive study with bench scale testing, full scale trialing including cost comparison among different disinfection alternatives (including ozone and UV light disinfection), VIGOROX® WWT II was found to be the most cost effective alternative to replace their chlorination/dechlorination system to eliminate THM formation and distribution into the environment. Results of the formation of DBPs during the full scale trial, comparing VIGOROX® WWT II and chlorine / dechlorination are shown in Table 2. As can be seen from the table, adding VIGOROX® WWT II to the wastewater does not form any THMs, whereas the addition of chlorine yields an increase in the concentration of THMs.

Table 2

DBP Monitored Results during Full Scale Trial for City of St. Augustine[7]

DBPs	Before Disinfection	After Chlorination	After VIGOROX® WWT II
Dibromochloromethane	0.6	56.9	0.6
Dibromochloromethane	0.6	72.7	0.6
Chloroform (ppb)	0.8	21.6	0.8
Bromoform (ppb)	0.6	19.6	0.6

a: The average dose of VIGOROX® WWT II during the trial is 1.5 mg/L (as PAA). The average dose of chlorine is 7.0 mg/L (as Cl2) which provides similar disinfection efficiency as VIGOROX® WWT II against fecal coliform and enterococci.

2. WWTP FACILITY IN FL

Additional trials are currently being conducted to assess the use of VigroOx WWT II as a replacement to the chlorination process in an effort to address compliance issues with chlorinated DBPs. An example, shown below, in which bench scale testing was performed for a utility and indicated that a VIGOROX® WWT II dose of 2 mg/L (as PAA) with a contact time of 30 minutes can achieve the disinfection goal for this utility, while eliminating compliance issues associated with THMs. The utility is planning for full scale implementation in 2015. Results of DBP analysis from the bench scale test are shown in Table 3, demonstrating the benefit of using VIGOROX® WWT II to address DBP formation.

Table 3

DBP Results during Bench Scale Test (contact time 30 minutes)

DBPs	Un-treated Samples	PAA-Treated Sample			Chlorine Treated Sample[a]	
		2 mg/L	3 mg/L	5 mg/L	5 mg/L	10 mg/L
Bromoform (ppb) [b]	<10	<10	<10	<10	30	70
Dibromo-chloro-methane (ppb) [b]	<5	<5	<5	<5	8.8	21

a: These chlorine doses provided similar disinfection efficiency as that of 2 mg/L (PAA) and 3 mg/L (PAA) against fecal coliform and enterococci for the wastewater sample

b: Permit limits are 360 ppb for bromoform and 34 ppb for dibromochloromethane.

CONCLUSIONS

The formation of chlorinated DBPs, such as THMs, nitrosamines and cyanide, poses a challenge to wastewater utilities using the chlorination process as their disinfection technology, even when a de-chlorination step is added. VIGOROX® WWT II has been demonstrated to be a cost effective disinfection alternative for those wastewater plants to eliminate concerns or compliance issues associated with DBPs. As a non-chlorine disinfection technology, VIGOROX® WWT II does not generate chlorinated DBPs.

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