

VIGOROX® WWT II PERACETIC ACID FOR WASTEWATER DISINFECTION: PROPERTIES AND CHARACTERISTICS

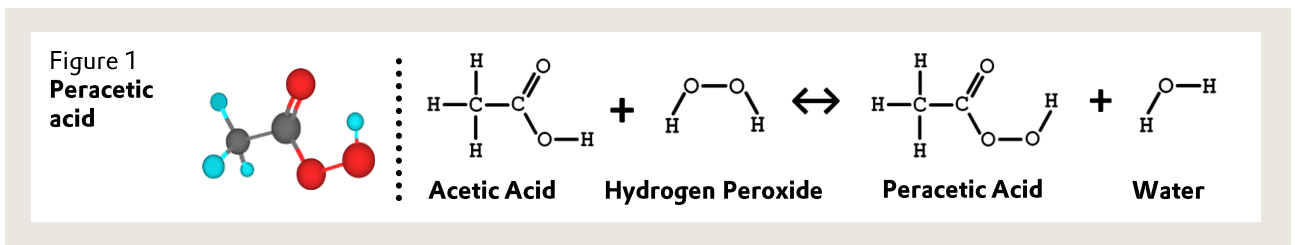
VigorOx® WWT II
Wastewater Disinfection Technology

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In this second edition of Disinfection Digest, we will cover the physio-chemical properties of VigorOx WWT II peracetic acid.

COMPOSITION, STABILITY AND PHYSICAL PROPERTIES

VIGOROX® WWT II exists as an equilibrium solution containing all four compounds:



with the following equilibrium concentrations:

Table 1
Peracetic acid equilibrium concentrations

Component	Weight percent (%)
Peracetic Acid	15
Hydrogen Peroxide	23
Acetic Acid	16
Water	>45
Catalyst	<1

VigorOx WWT II is formulated to maintain its equilibrium for more than one year under proper storage conditions, which include maintaining the product contaminant free and at temperatures below 84 °F (29 °C). There is a natural decomposition for both the peracetic acid and hydrogen peroxide components of the formulation, whose kinetics are driven by temperature. From measurements in the PeroxyChem laboratories, the decomposition kinetics for VigorOx WWT II follows the Arrhenius rate equation:

It follows the Arrhenius rate equation:

$$k(\text{day}^{-1}) = Ae^{-E/RT}$$

- Where A is the pre-exponential factor
- E = Activation energy
- R = Universal gas constant
- T = Temperature in °K

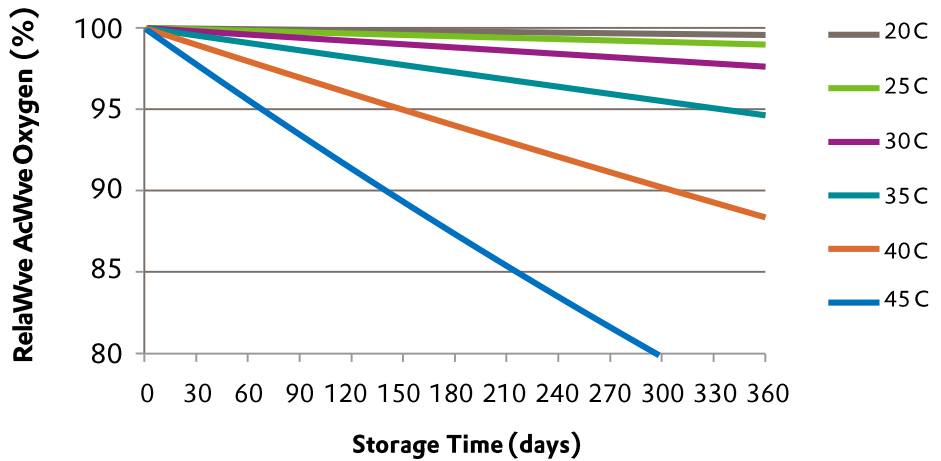
The loss of active oxygen, which is the combination of peracetic acid and hydrogen peroxide is given as:

$$[AO]_f = [AO]_i e^{-kt} \text{ where } t \text{ is time in days}$$

and can then be plotted out as a function of storage time and temperature as shown in Figure 1.

Figure 1

Stability of VigorOx WWT II as a Function of Temperature



Based on the above data, the shelf life of VigorOx WWT II for it to maintain its initial assay of 15% peracetic acid is as follows

Temperature Condition	Shelf life
T < 86°F (30°C)	1 year
T < 100°F (37.8°C)	4 months
T < 110°F (43.3°C)	1 month

Table 2
Shelf life of VIGOROX® WWT II

The product has the following physical and chemical properties:

Property	Value
Appearance	Clear, colorless, liquid
Physical state	Liquid
Odor	Pungent, stinging, vinegar-like
pH (of neat solution)	<1
Freezing point	-56°F (-49°C)
Boiling point	226 °F (108 °C)
Flash point	154 °F (68 °C) closed cup
Flammable properties	Substance does not burn, but will support combustion
Oxidizing properties	Strong oxidizer
Vapor Pressure	20 mm Hg at 25 °C
Density	1.15 g/mL at °C
Water solubility	Completely soluble

Table 3
Physical and chemical of VIGOROX® WWT II

VigorOx WWT II is completely soluble in water with a density slightly heavier than that for water. The low freezing point of --56 °F allows VigorOx WWT II to be used in cold weather climates without the need for heat tracing piping. In comparison, the freezing point of a 12% sodium hypochlorite solution is --20 °F with a corresponding freezing point of +45 °F for a 40% sodium bisulfite solution, required for dechlorination.

The product is shipped in totes or delivered in bulk to a tank. It is classified for shipping purposes as a 5.2 organic peroxide. Safety and handling characteristics will be addressed in a future Disinfection Digest.

ANTIMICROBIAL MODE OF ACTION

The mode of action of peracetic acid on the microbial inactivation has been postulated to occur via two mechanisms¹⁻⁻⁴. The first is due to the release of "active oxygen", which disrupts the sulfhydryl (--SH) and sulfur (S--S) bonds within enzymes and proteins in the cell membrane. This in turn affects the transport processes across the cell membrane. The second method is the generation of hydroxyl radicals by the peracetic acid, which react with the microbes, leading to rapid inactivation. Because of the disruption of the chemiosmotic function of the cell membrane as well as interference through the cell walls, microbes do not build up resistance to peracetic acid disinfection.

DOSING PARAMETERS

The target VigorOx WWT II peracetic acid concentration within the contact chamber will be dependent on a number of factors. These include:

1. Type and concentration of incoming bacterial load and target log kill reduction
2. Contact time within the disinfection zone
3. Wastewater oxidant demand
4. Allowable residual peracetic acid at the outflow

For most bacteria, VigorOx WWT II can achieve one to five log reduction of incoming bacteria concentration within fifteen to thirty minutes contact time at peracetic acid concentrations between one and five ppm. Within this range, the ability to meet the permitted log reductions may be greatly impacted by the quality of the incoming wastewater, which can exert a demand upon the oxidant. Typically, the demand upon the peracetic acid by the wastewater is kinetically rapid, with most of the demand being satisfied within the first couple of minutes of contact. The peracetic acid demand may be a function of several water quality parameters, and as a result will be dependent upon the particular wastewater facility and may have a temporal component as well (time of day, time of year, etc).

$$\text{PAA demand} = f(\text{COD, BOD, TOC, TSS, UVT, color, ...})$$

Where COD is chemical oxidant demand, BOD is biological oxidant demand, TOC is total organic carbon, TSS is total suspended solids, and UVT is UV transmittance. Once the demand is met, the achievable bacterial kill will be mostly a function of concentration x contact time. Demand and bacterial log reduction can be determined for a fixed time point with a typical "jar test" procedure, and investigated more dynamically using a side--stream pilot test program.

Finally, VigorOx WWT II dosing concentration may be dependent upon the allowable peracetic acid residual at the outflow under the specific site permit. As an example, a typical allowable peracetic acid residual at the outflow is one ppm. As a result, the peracetic acid dosing may need to be adjusted to insure outflow concentrations do not exceed this allowable maximum.

FIELD APPLICATIONS

VigorOx WWT II is typically applied to the disinfection contact chamber without the need for pre-dilution through metering pumps. The following equation can be used to determine the peracetic acid dose rate as a function of target peracetic acid concentration within the wastewater stream:

$$\text{VigorOx Application Rate} \left(\frac{\text{gal}}{\text{day}} \right) = \frac{PAA_{\text{Target}} * MGC * 100}{1.16 * 24 * PAA_{\text{Assay}}}$$

Where

- PAA_{target} = target peracetic concentration in the wastewater (example 1.5 ppm, PAA_{target} 1.5)
- MGD = wastewater flow rate (example 30 MGD plant, MGD = 30)
- PAA_{assay} = PAA concentration in VIGOROX® WWT II (example, 15.1% assay on VIGOROX®, PAA_{assay} = 15.1)
- 1.16 = specific gravity of VIGOROX® WWT II

SUMMARY

VigorOx WWT II peracetic acid is an economical, highly effective disinfection technology for wastewater treatment systems. Its low freezing point, storage stable formulation makes it a simple-to-apply solution as an alternative disinfection choice for your wastewater disinfection needs.

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