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Solutions for a clean environment

TECHNICAL BULLETIN
MUNICIPAL

DRINKING WATER TREATMENT - HYDROGEN PEROXIDE PRE-OXIDANT APPLICATION

Introduction

The use of hydrogen peroxide (H_2O_2) as a pre-oxidant in municipal water treatment is well documented and has been practiced for over 15 years. Historical applications of H_2O_2 in drinking water have been for taste and odor control, hydrogen sulfide removal, iron removal and ozone enhancement/destruction. With the EPA Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) coming into effect, more recent emphasis has been on the reduction of the formation of total trihalomethanes (TTHM) and haloacetic acids (HAA5).

Features

- **TTHM and HAA5 Reduction**
  - Recent water plant applications have demonstrated positive results in reducing TTHM and HAA5
  - The use of H_2O_2 for TTHM and HAA5 reduction does not require expensive capital projects
- **Taste and Odor Control**
  - H_2O_2 is equally or more effective than $KMnO_4$ for the removal of various taste and odor compounds
- **Hydrogen Sulfide Removal**
  - H_2O_2 can effectively oxidize H_2S to remove the taste and odor, as well as corrosion associated with sulfides
  - H_2O_2 is more economical than potassium permanganate ($KMnO_4$) or chlorine and has no harmful by-products
- **Ozone Applications**
  - H_2O_2 may be used for ozone enhancement and residual ozone quenching
- **Iron Removal**
  - H_2O_2 is very effective in the oxidation and precipitation of iron

H_2O_2 provided for this application by USP Technologies (USP) is certified under the ANSI/NSF Standard 60: Drinking Water Treatment Chemicals – Health Effects for use in the treatment of drinking water. The required dose rates will vary depending on the application and the individual characteristics of the municipal water plant.

TTHM and HAA5 Reduction

Stage 2 DBPR is put into effect to reduce potential cancer, reproductive and developmental health risks from disinfection byproducts (DBPs) in drinking water. Research on the use of H_2O_2 for this application is documented as early as the 1970s, with actual implementation in North American municipalities over the past several years. Recent water plant applications have demonstrated positive results in reducing TTHM and HAA5, as well as improving TOC reduction. In addition, some water plants have recently documented significant reductions in TTHM and HAA5 by the use of H_2O_2 in doses as low as 0.5 mg/L. Other benefits such as algae control and taste and odor improvement have also been documented.

The use of H_2O_2 for TTHM and HAA5 reduction does not require expensive capital projects so it can be easily integrated into existing water plant operations. This allows H_2O_2 to be full-scale pilot tested so that its benefits can be documented under a plant's specific conditions. This is a critical step since all source water varies in organics make-up, therefore individual plant results with the use of H_2O_2 may vary at each plant.

Taste and Odor Control

Surface waters often contain objectionable taste and odor compounds. Many of these can be treated with H_2O_2. In a study conducted in the late 1980s*, H_2O_2 was equally or more effective than $KMnO_4$ for the removal of various taste and odor compounds. While H_2O_2 is successful in treating many taste and odor occurrences, in some instances it cannot control higher levels of geosmin and MIB. In these cases, an advanced oxidation process that involves the generation of hydroxyl radicals such as UV/H_2O_2 or Ozone/H_2O_2 is the recommended alternative.

Ozone Applications

H_2O_2 can be used to enhance the performance of ozone systems for organic oxidation such as taste and odor compounds and THM precursors, or for quenching of ozone residuals near the end of the contactors.

Hydrogen Sulfide Removal

Hydrogen sulfide (H_2S) is a common taste and odor compound found in underground potable water sources characterized by a rotten egg odor and metallic taste. H_2O_2 can effectively oxidize H_2S to remove the taste and odor as well as corrosion associated with sulfides. The oxidation reaction can be controlled under alkaline conditions to produce soluble sulfate and a minimal amount of colloidal sulfur; hence, turbidity is minimized. For this application H_2O_2 is more economical than $KMnO_4$ or chlorine and has no harmful by-products.

Iron Removal

The removal of iron from potable water sources is aesthetically advantageous, since iron can discolor the water, spot laundry and stain plumbing fixtures. In addition, the growth of iron-oxidizing bacteria can result in abnormal taste and odor as well as contribute to biofouling in water distribution systems. H_2O_2 is very effective in the oxidation and precipitation of iron as it rapidly oxidizes iron to a ferric state to form dense, easily settled solids, which are then removed through conventional flocculation/precipitation/filtration systems. H_2O_2 has a fast reaction rate and is also more economical for this application than $KMnO_4$ or chlorine.

Safety

H_2O_2 stored and handled in a safe manner can be integrated into almost any environment, including raw water lift stations at water plant intakes or in the water plant itself. Compared to other chemicals typically used in water plants, H_2O_2 has a lower oxidizer class rating making it easy to integrate into existing and new plants.

NFPA Hazard Code of Common Chemicals

Chemical	Health	Flammability	Reactivity
Ozone	4	0	3
Chlorine	4	0	2
Sodium Hypochlorite (12-15%)	2	0	1
Potassium Permanganate	3	0	2
Hydrogen Peroxide (35% & 50%)	3	0	1

Formulas

Hydrogen Sulfide Removal

$$H_2S + 4\ H_2O_2 \rightarrow SO_4^{2-} + 4\ H_2O + 2\ H^+ \quad \text{(for pH > 8)}$$

Ozone Enhancement & Residual Ozone Quenching

$$H_2O_2 + O_3 \rightarrow 2 \cdot OH + {}^3/_2\ O_2 \rightarrow H_2O + 2\ O_2$$

Iron Removal

$$2\ Fe^{2+} + H_2O_2 + 2\ H^+ \rightarrow 2\ Fe{+}3 + H_2O\text{-}$$

Treatment Benefits

USP treatment provides benefits over other oxidative technologies:

- Economical
- Fast reaction rate
- Easily settled solids
- Minimal equipment requirements

* "Evaluating Oxidants for the Removal of Model Taste and Odor Compounds from a Municipal Water Supply",W.H. Glaze, R. Shep, W. Chauncey, E.C. Ruth, J.J. Zarnoch, E.M. Aieta, C.H. Tate, and M.J. McGuire, Journal of AWWA, May 1990.

About USP Technologies

USP Technologies is the leading supplier of peroxygen-based technologies and services for environmental applications. We have been serving the water, wastewater and remediation markets for over 20 years and have offices and field service locations throughout North America. Our consultative approach to problem solving includes application assessment, technology selection and development of a tailored treatment approach. Our full service programs successfully integrate storage and dosing equipment systems, chemical supply, inventory and logistics management, and ongoing field and technical support. This approach provides cost-effective, "hands-off" solutions to our customers. USP Technologies also can provide access to experienced application partners for a turn-key program encompassing engineering, site characterization and technology selection, program implementation, execution and report generation.

Getting Started

We look forward to supporting your treatment needs, whatever the scale of your requirements. To obtain a streamlined treatment solution tailored to your specific project, give us a call at (877) 346-4262.

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