



Standard Guide for Use of Advanced Oxidation Process for the Mitigation of Chemical Spills¹

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1. Scope

1.1 This guide covers the considerations for advanced oxidation processes (AOPs) in the mitigation of spilled chemicals and hydrocarbons dissolved into ground and surface waters.

1.2 This guide addresses the application of advanced oxidation alone or in conjunction with other technologies.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* In addition, it is the responsibility of the user to ensure that such activity takes place under the control and direction of a qualified person with full knowledge of any potential safety and health protocols.

2. Terminology

2.1 Definitions of Terms Specific to This Standard:

2.1.1 *advanced oxidation processes (AOPs)*—ambient temperature processes that involve the generation of highly reactive radical species and lead to the oxidation of waterborne contaminants (usually organic) in surface and ground waters.

2.1.2 *inorganic foulants*—compounds, such as iron, calcium and manganese, that precipitate throughout a treatment unit and cause reduced efficiency by fouling the quartz sleeve that protects the lamp in photolytic oxidation AOP systems or the fibreglass mesh that is coated with TiO₂ in photocatalytic AOP systems.

2.1.3 *mineralization*—the complete oxidation of an organic compound to carbon dioxide, water, and acid compounds, that is, hydrochloric acid if the compound is chlorinated.

2.1.4 *photoreactor*—the core of the photoreactor is a UV lamp that emits light in the broad range of 200 to 400 nm wavelength range.

2.1.5 *radical species*—a powerful oxidizing agent, principally the hydroxyl radical, that reacts rapidly with virtually all organic compounds to oxidize and eventually lead to their complete mineralization.

2.1.6 *scavengers*—a term used for substances that react

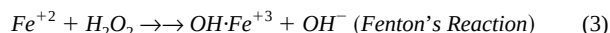
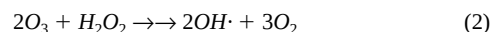
with hydroxyl radicals that do not yield species that propagate the chain reaction for contaminant destruction. Scavengers can be either organic or inorganic compounds.

3. Significance and Use

3.1 *General*—This guide contains information regarding the use of AOPs to oxidize and eventually mineralize hazardous materials that have entered surface and groundwater as the result of a spill. Since much of this technology development is still at the benchscale level, these guidelines will only refer to those units that are currently applied at a field scale level.

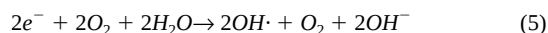
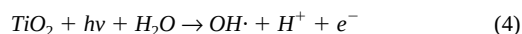
3.2 Oxidizing Agents:

3.2.1 *Hydroxyl Radical (OH)*—The OH radical is the most common oxidizing agent employed by this technology due to its powerful oxidizing ability. When compared to other oxidants such as molecular ozone, hydrogen peroxide, or hypochlorite, its rate of attack is commonly much faster. In fact, it is typically one million (10⁶) to one billion (10⁹) times faster than the corresponding attack with molecular ozone (**1**).² The three most common methods for generating the hydroxyl radical are described in the following equations:



3.2.1.1 Hydrogen peroxide is the preferred oxidant for photolytic oxidation systems since ozone will encourage the air stripping of solutions containing volatile organics (**2**). Capital and operating costs are also taken into account when a decision on the choice of oxidant is made.

3.2.1.2 Advanced oxidation technology has also been developed based on the anatase form of titanium dioxide. This method by which the photocatalytic process generates hydroxyl radicals is described in the following equations:



3.2.2 *Photolysis*—Destruction pathways, besides the hydroxyl radical attack, are very important for the more refractory compounds such as chloroform, carbon tetrachloride,

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² The boldface numbers in parentheses refer to the list of references at the end of this standard.