Advanced oxidation reactions

Advanced oxidation processes (AOP) include chemical procedures designed to remove organic and some inorganic materials in water and waste water by means of oxidation. In the treatment of water and waste water AOP employ ozone, hydrogen peroxide and ultraviolet light (UV). Hydroxyl (-OH) radicals may be generated by various methods inter alia radiation, chemical, sono- and photo-chemical methods.

Principle of disinfection

AOP reactions depend on the hydroxyl radicals, which readily oxidise compounds in water by breaking them down and converting them into tiny inorganic molecules. AOP thus rely on the generation of hydroxyl radicals from ozone or hydrogen peroxide with UV or other catalysts acting as an energy source.

AOP reactions using Hydrogen peroxide use UV light to photo-chemically dissociate the compound into two radicals:

\[
\text{H}_2\text{O}_2 + \text{UV} \rightarrow 2\cdot\text{OH}
\]

The two free hydroxyl radicals combine with contaminants, dichloromethane for example:

\[
\cdot\text{OH} + \text{CH}_2\text{Cl}_2 \rightarrow \text{H}_2\text{O} + \cdot\text{CHCl}_2
\]

\[
\cdot\text{CHCl}_2 + \text{O}_2 /\text{H}^- \rightarrow \text{CO}_2 + 2\text{HCl}
\]

The contaminant is thus reduced to mineral salts, water, and carbon dioxide.

AOP reactions using ozone remove contaminants in a similar manner:

\[
2\text{O}_2 + \text{H}_2\text{O}_2 \rightarrow 2\cdot\text{OH} + 3\text{O}_2
\]

Applications of advanced oxidation disinfection processes

AOP are particularly well suited for disinfecting biologically toxic or organic non-degradable compounds and harmful chemicals such as pesticides and petroleum in waste water. These otherwise harmful compounds are converted into water, carbon dioxide, and salts. The use of advanced oxidation in waste water permits the re-use of the cleaned waste water in streams and sewage treatment.

AOP have been gaining widespread popularity over the last several decades as an efficient water and waste-water treatment process; their efficiency and
effectiveness is further augmented when combined with ultraviolet disinfection.

**Characteristics of advanced oxidation processes**

AOP are attractive due to the use of relatively cheap and readily available chemicals, materials, and ease of operation. A slight limitation of AOP is its dependence on the pH of the water and production of sludge when used with iron to produce hydroxyl radicals.