OZONE AND AOP METHODS

One of the most important aspects of water treatment is the removal of organic substances of autochthonic and human origin. These are low mass organics that have toxic properties. Present existing technologies are found to be in sufficient as rarely the oxidation proceeds to complete mineralization. This has led to growing interests in advanced oxidation processes, commonly known as AOP.

Hydroxyl radicals have very high oxidative reductive potential (EOP), 2.8 V that is only second to Fluorine. OH radicals are non–selective on organics and fast acting and are not susceptible to radical scavengers such as carbonates and humus substance present in water.

OH radicals can be created using: hydrogen peroxide and UV 254 Nm, hydrogen peroxide and ozone, UV and ozone, catalysts such as TiO2, Fenton, and manganese with ozone. By using AOP method a chain of oxidative and degradation reactions are initiated leading at the end, to formation of carbon dioxide, water and inorganic compounds – total mineralization not seen with other technologies.

Chemical oxidation is used mainly to remove both natural organic substances and micro–pollutants present in water. It also used to make algae and other forms of biological life harmless, improve the coagulation process, improve removal efficiency of complex iron and manganese compounds, improve taste and smell of water and in water disinfection. However refractory substances like humic acids, phenols, pesticides chlorinated organic substances require very strong oxidants for its removal. Many of these compounds have toxic, mutagenic and carcinogenic properties of water and need to be totally removed for making the water safe.

H_2O_2/O_3: H_2O_2 is a very stable compound and highly soluble in water. It is an effective source of hydroxyl radicals and simple to implement. Hence it is the most favorable combination with ozone. With use of O3/H2O2 combination, and by increasing the ratio of H2O2/O3 and ozone dose there are chances of removal of around 60% COD when it is only around 25%–30% with ozone alone. TOC content has also been observed to be considerably reduced. However since ozone has a cost, it always prudent to use ozone only for the tertiary stage after routine classical treatments. Incorporation of single stage/double stage biology, can enhance the reduction and bring about 70–80% reduction of COD/TOC, but usually the cost can over weigh the benefits. Reaction time of over 20 minutes is ideal for this process. The ozone/h2O2 ration should be minimum 1:0.3 (30% H_2O_2).

UV/O3: UV at 180 nM has been used successfully to remove small amounts of organics. Using UV 250 nM with ozone is another method to reduce the amount of ozone required and reduction of the reaction time. It has been noted that the ozone dose is halved when UV is combined with ozone. However the disadvantages of this method are due to the fact that the formation of OH radicals is slow and the water must be pre–treated to ensure high UV penetration. UV is also power intensive and using ozone and UV could mean high operation costs. The commercially UV lamp sizes are available in the market also restricts its use only in small flow capacities.

Disadvantage of Ozone: High Capital Costs Coupled With High Power Requirement

However the combination of UV and also restricting the use of ozone to final polishing stages could negate these high costs. The AOP with ozone and UV are normally carried out at alkaline pH, and hence it may be required to adjust this pH to meet drinking water standards.

TiO_2 is also used in combination with Fe^{++}, Fe^{+++}, UV and also ozone. TiO_2/Fe combination requires acidic pH, and pH adjustments need be made. Apart from this there could be an increase in salt concentration in water and sediment formation.

TiO2 and UV have relatively quick actions due to the large surface area of TiO_2. Enrichment of TiO_2 with platinum and Cu^{++} could enhance the reactions. Sometime UV is replaced by sunshine. This process is not so often used since the process is not fully known, and the requirement of microfiltration to remove Tio_2 from water. Sometimes to avoid micro–filtration, glass/Teflon coated with TiO_2 is used as reactors.

Other combinations of H_2O_2 and UV have also been proven to be very effective.

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