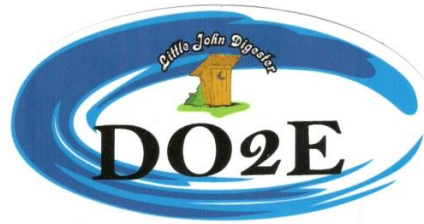


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Municipal & Industrial  
Wastewater Treatment  
Equipment & Solutions



**“Solving the World’s Water Problems”**

March 22, 2012

## **ADVANCED OXIDATION PROCESSES**

### ***A.O.P.***

**Advanced Oxidation Processing** is the generation and implementation of hydroxyl radicals ( $\text{HO}^+$ ) to oxidize contaminants in air and water. It is considered one of the most powerful oxidants readily available and it produces *NO* harmful by-products.

Hydroxyl Radicals are generated by 2 means. 1) By breaking down hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) by irradiating the water with germicidal U.V. or 2) *combining ozone and water in the presence of germicidal U.V. (254 nanometers).*

The A.O.P. we will be working with will be the 2<sup>nd</sup> process of generating Hydroxyl radicals in the presence of germicidal U.V. This type of system is compact and produces a very concentrated and much more effective oxidation process when applied using DO<sub>2</sub>E Waste Water Technology.

## Ozone Chemistry

Ozone is a form of energetic oxygen that contains three oxygen atoms ( $O_3$ ) rather than the normal two atoms ( $O_2$ ) commonly thought of. Ozone naturally occurs in the atmosphere after a lightning storm and is one of Mother Nature's most powerful disinfectant and oxidants which are readily available. Ozone does not produce harmful by-products and can be generated on-site.

Oxygen =  $O_2$

Ozone =  $O_3$

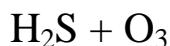
## Oxidation

When ozone reacts with B.O.D., C.O.D., F.O.G., and combined halogens it reduces contaminates to inert compounds or carbon dioxide and water. Inert materials maybe saline, silicon dioxide, and various other degraded composites.

Ozone removes; most heavy metals such as iron, manganese, zinc, and copper etc. through advanced oxidation processing. It breaks down pharmaceuticals, kills bacteria (E-coli) and viruses such as the three forms of hepatitis. Ozone also oxidizes hydrogen-sulfides ( $H_2S$ ) to:

1) *sulfur dioxide*,  $SO_2$ , 2) *sulfite*,  $SO_3$ , 3) *sulfate*,  $SO_4$

Advanced Oxidation Process for  $H_2S$ :



= (1) Sulfur Dioxide  $SO_2$

= (2) Sulfite  $SO_3$

= (3) Sulfate  $SO_4$

This is why A.O.P. is so effective for air quality and odor control. A.O.P. or Ozone combined with hydroxyl radicals, are 100 to 200 times more effective when properly injected directly into the water column where the hydrogen sulfide is produced. This hybrid ozone carries a half- life of up to 15 minutes.

Most Ozone is applied as a fogging agent which does not reach the source of the hydrogen sulfide. *This method of fogging ozone is ineffective at destroying the source of the problem, and often creating a much more severe corrosion problem.* This fogging approach only reacts with H<sub>2</sub>S gas as it is released from the water column. To effectively eliminate H<sub>2</sub>S, you must properly inject the ozone directly into the water column where the H<sub>2</sub>S is originating from.

The most efficient and effective means of injecting ozone or concentrated oxygen into a fluid column requires a unique combination of course and fine bubble diffusion, released in a confined space or vessel under minimal pressure, (>2.5 p.s.i.) Air under pressure generates heat, and heat can reduce oxygen transfer by as much as 80%. This can be easily achieved using a low pressure high volume regenerative air blower.

### ***Ozone and Advanced Oxidation Combined***

Ozone generated by vacuum Ultraviolet or Corona Discharge ozone generators is exposed to ultraviolet light creating hydroxyl radicals (OH).

Hydroxyl radicals are an even more potent and powerful oxidizer than ozone alone. The combination of ozone and hydroxyl radicals provides one of the most powerful oxidation products which will substantially reduce organic loading and microorganisms in waste water.

This patented hybrid ozone allows us to;

- 1) Reduce the amount of ozone normally required.
- 2) Improves the reaction time tremendously (200X).
- 3) Address many more complicated applications especially in very large commercial, industrial and municipal waste water cleanup projects.

***A.O.P. combined with the patented DO<sub>2</sub>E delivery technology, can now be used on a varying scale to address a wide variety of difficult and previously impossible cleanup applications as it applies to waste water treatment and environmental issues.***

## *Patented Hybrid Ozone Technology*

Unlike regular UV lamps for ozone generation, this patented UV Hybrid lamp is combined with a high energy electromagnetic field. These tubes are typically good for 15 – 20,000 operating hours and can be changed out easily.

This hybrid ozone technology uses a modified VUV ozone tube as a corona electrode. This is accomplished by placing a high voltage helical around the tube to generate a high energy electromagnetic field. The results are an ozone generator which produces ozone using corona discharge technology and high energy light.

This unique combination produces pure ozone in addition to catalyzing Advanced Oxidation Processes, (A.O.P.), which add another level of effectiveness in terms of oxidation, disinfection, and sanitation.

This patented hybrid ozone system produces pure ozone with NO TOXIC NITROUS COMPOUNDS as found in other standard corona discharge ozone generators. The output is constant and is NOT negatively affected by temperature or humidity as in standard corona discharge technology.