

# OZONE V/S CHLORINE AND UV IN PRODUCT WATER TREATMENT IN PHARMACEUTICALS

Pharmaceutical product water treatment has been adopting classical disinfection technologies such as chlorine and UV for years together. Each of this technology has its advantages and disadvantages. Ozone technology has been present for more than decades now. With greater awareness and more user experience, ozone technology is close to becoming a priority in pharma water treatment.

Attributes	Chlorine	Ozone	Remarks
Oxidation Potential	1.36 Volts	2.07 volts	Ozone more reactive than chlorine
Disinfection: Bacteria	Moderate	Excellent	
Disinfection: Virus	Moderate	Excellent	
Environmental Friendly	No. forms by products	Friendly	Ozone forms, no compounds
Color removal	Good	Excellent	Far reactive than chlorine
Odor removal	Fair	Excellent	Far reactive than chlorine
Carcinogen Formation	Very likely	Unlikely	Safer than chlorine
Bromate Formation	No	Yes, if not careful	Needs precaution
Organics Oxidation	Moderate	Excellent	Far reactive than chlorine
Micro Flocculation	Nil	Excellent	Advantage in ETP
pH Effect	Yes. Acidic pH Required	No. of action not dependant on pH	Advantage Ozone
Water Half Life	2-3 hours	20 minutes	Advantage Chlorine
Operation Hazards: Skin Toxicity & Inhalation Toxicity	Yes	No skin toxicity, Inhalation toxicity - Yes	
Action on Organism	Bacteriostatic in most cases	Bactericidal	Advantage ozone
Mode of action	Cell wall lysis	Nucleus Lysis on DNA	No recurrence with ozone, no re-growth
<b>Action on Bio fouling</b>	Fair	Excellent	Advantage ozone
<b>Specific action on Gram negative and boiler tolerant gram negative (BTGN)</b>	Not very good. Requires high dose and long contact time. Bacterial resistance observed.	Excellent against Gram Negative bacteria and boiler tolerant bacteria	Advantage of ozone in product water
<b>Measurement on line and dependence on water report</b>	Not possible to relate on line measurement with bacteriological count	Possible, accurate and totally dependable	Advantage of ozone
<b>Cost</b>	Economical	Capital costs	Advantage chlorine
<b>Operation Ease</b>	Easy to operate	Needs careful operation	Advantage chlorine

## UV V/S Ozone

Pathogens of concern in product water treatment system consist of:

- ▶▶ Bacteria especially gram negative strains
- ▶▶ Virus

### Bacteria

UV is most effective against bacteria followed by protozoan and least effective against virus. The normal UV dosage suggested for water treatment is between 20 and 40 mJ/cm<sup>2</sup>. At this dose, most bacteria show a 2-4 log inactivation.

### Disadvantage of UV: Potential for Reactivation

Because UV irradiation does not immediately

result in cell lysis, there is some opportunity for a UV inactivated cell to regain viability through repair mechanism. One such mechanism is called photo-reactivation.

Following UV inactivation, exposure to wavelengths in the range of 350-450 nm (present in sunlight) triggers an enzyme that can repair UV inflicted damage to the DNA of the bacteria. Not all bacteria have this ability to reactivate and it has been found that reactivation decreases with increase in dose from 20 mJ/cm<sup>2</sup> - 140 mJ/cm<sup>2</sup>.

As most UV generators are designed at the lower range, the potential for reactivation is a reality!

### Virus

Viruses are extremely resistant to UV irradiation. California 22 standards require a minimum of 140 mJ/cm<sup>2</sup> dose for inactivation of polio virus, while rota virus needs a minimum of 50 mJ/cm<sup>2</sup> dose for effective inactivation and adenovirus needs a minimum of 120 mJ/cm<sup>2</sup> dosages. This is clearly lower than the dose recommended by most UV manufacturers.

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