Wastewater Innovations
Making sanitation a sustainable business

Technology: Ozone Disinfection

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Description

Ozone (O_3) is the product of oxygen (O_2) molecules dissociated by an energy source into oxygen atoms and colliding with an oxygen molecule to form an unstable gas. For most wastewater treatment plants, ozone is generated by using a high voltage alternating current (6–20 kilovolts) across a dielectric discharge gap that contains an oxygen-bearing gas. The underlying reason that ozone is generated on-site is because of its instability and fast rate of decomposition to elemental oxygen after generation.

Ozone is a very strong oxidant and virucide. Its mechanisms of disinfection include: (i) direct oxidation or destruction of the cell wall with leakage of cellular constituents outside of the cell; (ii) reactions with radical by-products of ozone decomposition; (iii) damage to the constituents of the nucleic acids; and (iv) breakage of carbon-nitrogen bonds leading to depolymerization.

Applicability

Ozone disinfection is suitable for medium- to large-sized treatment plants, with its utilization placed after secondary treatment. Aside from its capability for disinfection, ozone can also be used to conduct odor control.

Performance

Performance of ozone disinfection was tested in two areas in the United States–Belmont and Southport Wastewater Treatment Plants, both in Indianapolis, Indiana. Ozone disinfection was required at both treatment plants from 1 April through 31 October 1985. In 1989, a disciplined process monitoring and control program was initiated where a significant effect was noted particularly on process performance due to changes in wastewater flow, contactor influent fecal coliform concentration, and ozone demand.

Cost

Factors such as the manufacturer, site, capacity of the plant, and the characteristics of the wastewater to be disinfected affect the cost of ozone disinfection systems. Ozonation costs are generally high compared with other disinfection techniques.

The table below shows the cost estimates for an ozone disinfection system capable of treating 4 million liters per day of wastewater.

Cost Item	Cost ($)
Capital Costs	
Oxygen Feed Gas and Compressor	329,532
Contact Vessel (1,892 liters per minute)	5,380–6,725
Destruct Unit	
Small (around 0.85 cubic meters per minute)	1,076
Large (around 3.4 cubic meters per minute)	1,345–1,614
Non-component Costs	47,076
Engineering	16,140–20,175
Contingencies	30%
Annual O&M Costs	
Labor	16,140
Power	90 kilowatts
Others (filter replacements, compressor oil, etc.)	8,743

Note: O&M = operating and maintenance
Source: Champion Technology. 1998.

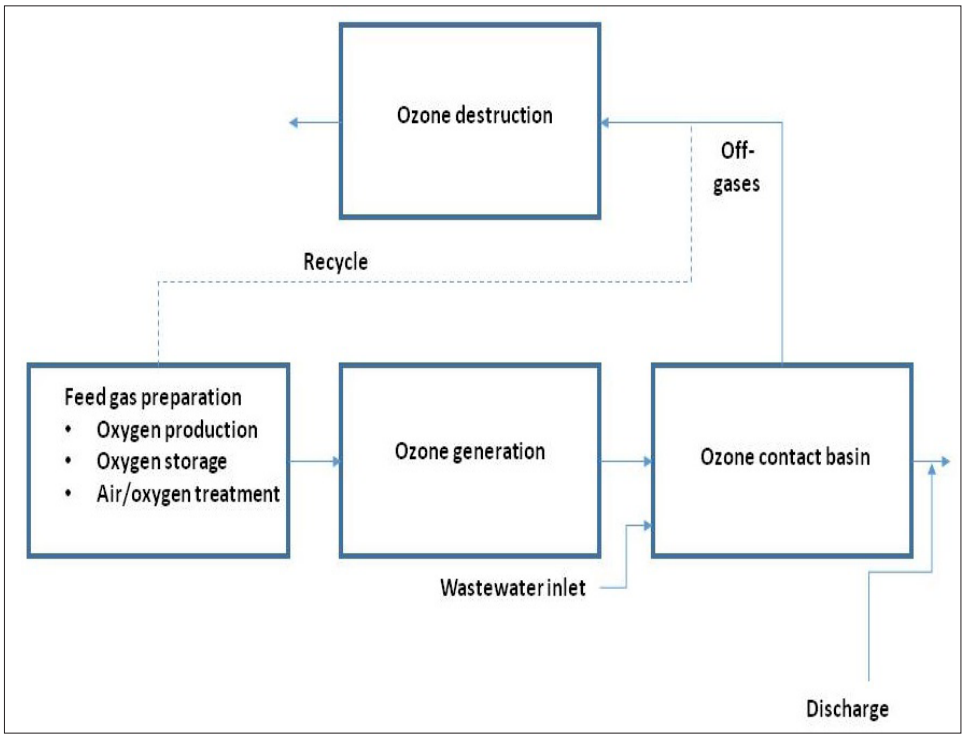
Advantages

- Ozone disinfection is more effective than chlorine in destroying viruses and bacteria.
- Ozonation process utilizes a short contact time (approximately 10–30 minutes).
- Because ozone decomposes rapidly, no harmful residuals are needed to be removed after ozonation.
- Except for those protected by the particulates in the wastewater stream, there is no regrowth of microorganisms after ozonation.
- Ozone is generated on-site resulting in reduced safety problems associated with shipping and handling.
- Ozonation facilitates the increase of the dissolved oxygen (DO) concentration of the effluent.

Disadvantages

- Low dosage may not effectively inactivate some viruses, spores, and cysts.
- Technology is complex, requiring complicated equipment and efficient contacting systems.
- Ozonation requires corrosion-resistant material (e.g., stainless steel) because of its very reactive and corrosive nature.
- The process is not economical for wastewater with high levels of suspended solids (SS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), or total organic carbon.
- Exposure can be extremely irritating and possibly toxic.
- Capital and energy requirements can be relatively high.

Process



Source: United States Environmental Protection Agency (USEPA). 1986.

Notes:
Costs are updated to 2013 prices using GDP deflator.
In this document, "$" refers to US Dollars.

References:
Champion Technology. 1998.
United States Environmental Protection Agency (USEPA). 1986. *Ozone Process Schematic Diagram.* Design Manual: Municipal Wastewater Disinfection.
United States Environmental Protection Agency (USEPA). 1999. *Ozone Disinfection.* Wastewater Technology Fact Sheet. http://1.usa.gov/OgQMNB.