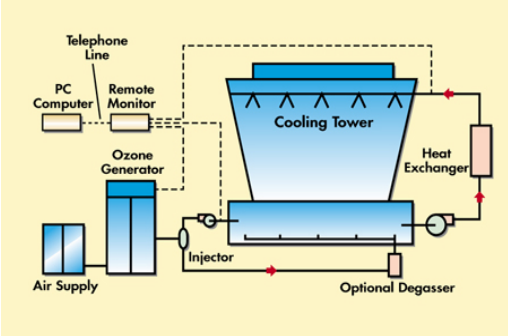
OZONE TECH

OZONE FOR COOLING TOWER WATER TREATMENT

Introduction: Chlorine and other chemicals have been the choice of oxidation and disinfection for over a decade in this region. Very little attempt was made in taking into consideration alternative and cost effective technologies which are not only economical but are much cleaner and also meet all the stringent environmental regulations.

When properly applied, ozone is an attractive stand alone alternative to multi chemical water treatment systems for cooling towers. It is a strong oxidizing agent with respect to bacteria, viruses and protozoa. In addition, its simultaneous oxidation of organic matters results in highly improved water quality. Ozone's strong biocidal characteristics are due to the combination of its high oxidizing potential and its ability to diffuse through biological membranes.

Microorganisms, particularly bacteria and viruses, develop immunity to chemicals when used over a prolonged period of time. Consequently, biocides need to be changed or rotated for effective control of microorganisms. However, there is no microorganism that is known to have developed a resistance to ozone till date.



Ozone Schematic

The mechanism of killing: Ozone's killing mechanism is by direct lysing of cellular walls of the microorganism. Ozone readily oxidizes organic matter in bacterial membranes, which weakens the cell wall and leads to cell rupture. The internal

Tower Sump after Ozonation

cellular material/plasma is released into the external environment, which causes immediate death of the cell. In contrast, chlorine and other oxidizing and non-oxidizing biocides must be transported across the cellular membrane where they act on the nuclear reproductive mechanism or enzymes life giving reactions in the cell. This mechanism of disinfecting is not as effective or efficient as ozone since these biocides need to be used in higher concentrations or much longer contact times.

Elimination of Legionella Pneumophilia: The use of ozone in cooling towers can check cooling tower associated diseases such as Legionnaires' disease caused by the bacteria Legionella pneumophilia by virtually killing planktonic (free swimming) bacteria and indirectly by eliminating conditions that favor Legionella amplification, i.e., the elimination of biofilms and amoeba and other protozoa that feed on biofilms and which serve as Legionella host. It is a documented fact that, some protozoa serve as hosts for Legionella pneumophilia, which enables rapid proliferation of Legionella. Ozone's biocidal action on protozoa eliminates any possibility of protozoan acting as host for Legionella pneumophilia.

Monitoring of Ozone Levels: Ozonation of the cooling water is on a continuous basis so as to maintain an ORP of 650-750 mV. At 650 mV the water is

Ozone Tech (Singapore) Pte Ltd.
10 Anson Road;#13-01 International Plaza; Singapore 079903; Phone: +65 6764 9667
Website: www.ozonetech.com.sg ; E-Mail: info@ozonetech.com.sg; Skype ID: ozone-tech

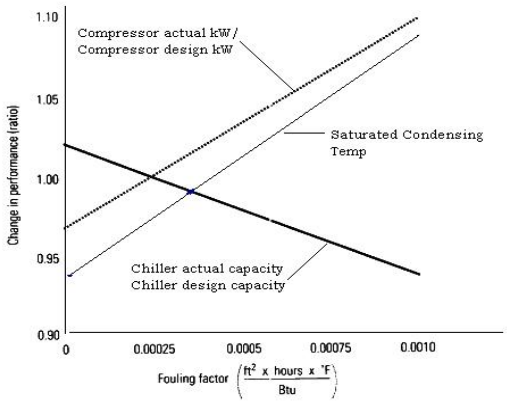
considered, by the WHO to disinfected and fit for human consumption. This monitoring of the ORP is real time based on a closed loop control system with the ozone plant. This ensures that water in the cooling system is kept disinfected at all times and also ensures that only the required amount of ozone is generated from the ozone plant. No excess ozone is produced which might find its way in to the atmosphere. However, for safety reasons, ozone residual sensors in air will be installed to sense ambient ozone levels in the event of leaks in the system. These sensors will cut the power supplies to the ozone generators there by ceasing ozone production. Simultaneously, the sensors also activate the ventilation system to remove any residual ozone from the plant area.

Cycles of Concentration	% blowdown of the make up water
2.00	50.00
4.00	25.00
6.00	16.67
8.00	12.50
10.00	10.00
12.00	8.33
14.00	7.14
16.00	6.25
18.00	5.56
20.00	5.00

Water Savings Using Ozone

The ozone plant will be adequately sized and will have a turn down of 10-100 % for automatic control and adequate redundancy features so that in the event of an equipment failure or under maintenance, the stand by equipment takes over providing uninterrupted supply of ozone from the plant, 24 hours a day, 365 days in a year.

Major advantages of Ozonation: 1. One of the biggest advantages in using ozone for cooling systems is in the water savings. Ozone systems operate at as high as 15 -20 cycles of concentrations; unlike



Fouling Factor Vs Energy Consumption

chemical systems, which are designed for 6 cycles but generally, operate at 4 cycles due to operational constraints. Based on PUB water quality, it is estimated that ozone system can operate at 15-20 cycles. In a local case study, a comparison has been made and it can be shown that the effective saving in water consumption alone can be as high as 20%. This is a substantial quantity in water scarce Singapore.

Fouling Thickness and Resulting Increase in Energy Use		
Scale Thickness (in)	Fouling Factor ($hrft^2$/BTU)	Energy Increase %
0.006	0.0005	5.3
0.012	0.001	10.6
0.024	0.002	21.5
0.036	0.003	32.2
0.048	0.004	43

Increase Energy use means Decrease Efficieny and Higher Costs

Power Savings using Ozone

2. There can also be substantial savings in energy consumption due to higher heat transfer efficiency in the condenser tubes due to low fouling factor.

3. The ozone system can also be adapted to the NEWATER, which is of a higher quality than the current PUB water supply. Using NEWATER, the system can be operated at higher cycles, there by substantially reducing water consumption

and releasing PUB supply for other use.

4. It should be noted that since ozone is used as a stand-alone water treatment system, no chemical import or handling is required. The non-use of chemicals ensures that there is total elimination of aqueous and air borne chemical emissions from the cooling system in the form of blow down and drift. The blowdown volume using ozonation (15 cycles) is only 21% of that of chemical treatment (4 cycles). The virtual elimination of chemicals in blow down combined with reduced blow down volume ensures less loading in the wastewater treatment plant thereby reducing treatment cost.

Ozone Mixing

5. The ability ozonated towers to operate under scale free and slime free conditions without any fouling, increase the heat transfer efficiency of the cooling system. Clean chiller condensers have a fouling factor of 0.00025.The heat exchangers operate at the rated efficiency at this fouling factor. Any increase in fouling factor decreases the heat transfer efficiency with a corresponding increase in the energy consumption of the cooling system. The US Department of Energy recommends the use of ozone as an energy saving system by which savings up to 20% in chiller power consumption has been achieved.

6. Micro organisms, particularly bacteria and viruses, develop immunity to chemicals when used over a prolonged period of time. Consequently, biocides need to be changed or rotated for effective control of microorganisms. However, there is no microorganism that is known to have developed a resistance to ozone till date.

Ozone cooling Tower in Operation

7. Apart from the above environmental benefits, an operation cost comparison was done between chemical and ozone treatment system. Substantial savings in operating cost can be achieved based on water and chemical savings alone. If energy savings are also factored in, the savings will be substantially higher. A small improvement in heat exchanger efficiency, results a large savings in terms of dollars and cents.

The advantages of using ozone for cooling tower water treatment are well documented in the literature by institutions and companies such as:

- **International Ozone Association**
- **The Cooling Tower Institute**
- **NASA**
- **IBM**
- **US Department of Energy, etc.**