ACHIEVING OZONE RESIDUAL IN PACKAGED WATER

OZONATION IS MORE THAN JUST INTRODUCING OZONE IN THE WATER. OZONE MASS TRANSFER (MIXING) IN WATER TREATMENT IS VERY IMPORTANT TO ACHEIVE RESULTS. OFTEN THESE ASPECTS ARE NEGLECTED

In majority of cases in Today's packaged Water Plants in India, the Ozone is mixed with the water by introducing the ozone from the Ozonator into the Treated water tank. (Diffusion method) .Ozone users often complain that they are not achieving residual ozone levels .A combination of inadequate ozone dose & concentration , contact time & lack of application technology could likely be the root cause. This practice of ozone Mixing defeats all purposes of the Utilization of ozone for the following reasons:

1.Studies have indicated that properly designed pipeline dissolution systems (for 0.1-0.2 ppm ozone residual) or a well designed Ozone Contactor provide significantly improved mixing over bubble diffusion system. Stable ozone residuals are never achieved by these methods because the incoming water flow and the applied ozone feed gas are usually spread across the entire cross sectional area of the tank weakening the available energy input for two phase mixing. These tanks are to be specially designed to prevent:

a. Channeling of gas bubbles
b. Ozone flow back-mixing and short circuiting
c. Inadequate gas liquid contact

Invariably these systems result in incomplete treatment of water.

OTSIL provides pipeline dissolution system and pipeline ozone Contactors to provide aggressive and nearly homogenous mixing of the ozone in the water by ensuring sufficient energy dissipation across the venturi injectors and turbulent regime present in the pipe line contactors. For higher ozone residual exceeding 0.3 ppm, a contact Tank can be incorporated providing a required contact time under a recycling mode.

DANGERS OF INCOMPLETE OZONE REACTIONS DUE TO LOW MASS TRANSFER

Natural waters contain varying quantities of humic and fulvic materials (organic compounds) . These are low molecular weight substances that can be degraded to simpler non polymeric oxidation products. These are all readily bio-degradable products that represent food for the micro organisms. Some of these have know to pass RO and even ultra filtration. Where Ozone is not used sufficiently, the bio-fouling that is allowed to form after the treatment train could also be a source. Therefore if the ozonation is not allowed to complete, to further oxidize these compounds, than there is an increased risk of micro-organism growth by producing assimilable food .Contamination have been reported weeks after bottling . Thus care to be taken that all the reactions are complete and organic oxidized.

OBTAINING RESIDUAL OZONE – ORP VS PPM

Most often what that is required by most plant operators is the PPM content of ozone in the water. Depending on PPM reading for defining the residual ozone content will not be a very accurate method for the following reasons.
Obtaining Residual Ozone, is the combination of various parameters that affect the kinetics of Ozone. The following factors play a very important part.

1. The dosage and concentration of Ozone.
2. The temperature of the water
3. The methodology of ozone dissipation
4. The pH of the water
5. The type of pre-treatment and the subsequent contact time for ozonation.
6. The ozonation process

1. THE DOSAGE AND CONCENTRATION OF OZONE & PRESSURE

The ozone being a sparingly water, its dissolution in water is governed by Henry's law. The higher the concentration of the ozone the more it dissolves. It is a normal procedure that in bottled water manufacturing the Ozone concentration use will be around 1.2% w/w. By using a higher concentration a high PPM can be achieved. This process is particularly used in food processing industries and seafood industries. Oxygen concentrators are deployed to increase the concentration. To obtain a residual Ozone of above 0.5 ppm , Ozone at above 6 % concentration, specially designed ozone Contactors and a water temperature of 5 Degrees cel was required in one installation in a seafood industry . The normal dose required under non pressurised conditions can exceed 3-4 mg/liter of processed water , If a higher pressure is developed during Ozone Mass Transfer , we can obtain the required Ozone residual with a lesser Ozone Dose.

2. THE TEMPERATURE OF THE WATER

This plays a very crucial role. The lower the temperature the more the Ozone will dissolve. The following table will make this point very clear.

Water Temperature. Degrees Celsius							
	0	5	10	15	20	25	30
OZONE (O_3) in Air	OZONE (O_3) in Water						
1% by wt (=12.07 g/m^3; = 6,044 Ppm-vol.)	8.31	7.39	6.50	5.60	4.29	3.53	2.70
1.5 % by wt (= 18.11 g/m^3; = 9,069 ppm-vol.)	12.47	11.09	9.75	8.40	6.43	5.29	4.04
2% by wt (=24.14 g/m^3; =12,088 ppm-vol.)	16.62	14.79	13.00	11.19	8.57	7.05	**5.39**
3% by wt (= 36.21 g/m^3; = 18.132 ppm-vol.)	24.92	22.18	19.50	16.79	12.86	10.58	8.09

Note: ***The concentration of Ozone gas is determined at a standard temperature of 20 Degrees. Cel. (68 Degrees. F) and a standard pressure of I atmosphere (101 kPa).***

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The normal temperature of water will be around 30-35 degrees which means that the amount of ozone that dissolves will be around 2.70ppm only. The remaining ozone that is introduced in the water will be in the un dissolved form that will be utilized for other reactions (slow) such as TOC reduction, precipitation of Iron, manganese etc it is only the dissolved ozone that contribute to the Ozone residual.

3. THE TYPE OF OZONE MASS TRANSFER DEPLOYED

Ozone Can be introduced into the water by three methods

a. venturi b. diffusers c. Static Mixing OR a combination

The venturi mode is a flash mixing that can guarantee 95% transfer of ozone . For primary ozonation and for bottled water normally this type is preferred , in combination with the other modes of ozone Mass transfer. The selection of the venturi will play a very important role. It is the dissolved Ozone that will respond to the residual tests and likely to remain in the water for a longer time. Diffusion methods are deployed for higher grade ozone applications and can be either dome type or radial type. Static mixers are very useful in Ozone mass transfer and can be deployed in combination to increase ozone mixing.

4. THE pH OF THE WATER

Ozone dissociates into hydroxyl group at higher pH. Therefore if the pH of your water is around 7.5 and 8.0, you can be rest assured that some of the Ozone will covert itself to hydroxyl group that will effect the residual ozone level. Hydroxyl group is poor disinfectants though they are powerful oxidizing agents

5. THE TYPE OF PRE-TREATMENT AND THE SUBSEQUENT CONTACT TIME FOR OZONATION

Whenever chlorine is used as a primary disinfectant the residual chlorine that will always be present even after carbon filtration will effect the residual ozone. It has been seen that even with best of carbon filtration, small amounts of chlorine, (as low as 0.05 PPM) is normally present. This will effect the residual ozone measurement. One way of avoiding this during measurement is to use malonic acid reagent while measuring ozone. Introducing Pre Ozonation is another useful way to obtain a better quality water. Pre Ozonation can avoid the use of chlorine and when used along with Carbon filtration can remove more than 90-95% of all water pollutants such as Phenolic compounds, pesticides and odor /color producing compounds. Pre Ozonation therefore improves the taste of the water.

6. THE OZONATION PROCESS

Even with the use of chlorine as a primary disinfectant as high as 5.0 PPM it has been noted that the total organic content of the water will still remain beyond 300 to 400 PPB. This TOC will consume ozone. Therefore if ozonation is used at the final filling level it may be difficult to achieve residual ozone of 0.3 PPM. Using a recycling system where the water is repeatedly ozonated can help achieve the required Redox level (residual ozone).

Moreover to facilitate proper transfer of ozone after injection of ozone into the water, it is mandatory to introduce a Multiple contact U tube assembly system or contact tanks. The use of a well designed contact tank will enhance the ozone mass transfer and the CT values are reached consistently .

OXIDATION REDUCTION POTENTIAL (REDOX)

Because of these difficulties in Ozone measurement as well as the inaccuracy of the method used to determine ozone residual, it is strongly recommended to depend on the ORP method then the PPM method. An ORP of 900 mV will correspond to a ozone residual of 0.2 -0.4 PPM with no doubts on any inaccuracy that may creep in during other methods of determination.

OTSIL. Provides the ORP technology that allows the plant operator to make accurate assessment on the level of ozonation required before filling.

OTSIL have ozone generator generating ozone from 3 GPH to 50 GPH and upwards with a concentration of 1.2% w/w to 14 % OTSILs application methods will help the achievement of Redox level of above 900mV... All the Ozone generators are compatible with oxygen and can be used to generate 95% more ozone at the concentration of around 6% w/w. , OTSIL can also provide a fully automatic pressurized Ozone System that can be used for higher ozone residual. These are imported from France or Germany.

OZONE RESIDUAL , E.COLI DESTRUCTION & MICROBIAL GROTH.

The final sanitation level in water is often judged by the presence of E.Coli (most difficult pathogen to kill) and the microbial growth (Total plate count after 48 hours.) . Maintaining a residual ozone of just 0.03 ppm with a contact time of just 1 sec. can almost result in a 99% destruction of E-coli. A 0.02 ppm residual ozone can achieve a NO MICROBIAL GROWTH result. With a good Ozone contact system very often this level is almost exceeded and hence Ozonation is the surest way to achieve water quality standards.

A well-designed ozone disinfectant system could achieve the objectives listed in the table.

RESIDUAL OZONE IN RINSING WATERS:

The Ozone residual requirement for rinsing waters are very much higher . This is because while rinsing, the contact time provided are in seconds with the results only a high ozone residual can provide the required CT coefficient. The Ozone residual requirement for rinsing water is as high as 1 PPM ozone residual and these level are never obtained in conventional ozone systems . Very often , with existing water temperature of over 30 degrees, we need to maintain the pressure during ozone mass transfer to over 4 bars to achieve these levels.

In food processing Industries ozo0ne residual of over 2-3 PPM are often attained and used .

Often there is a doubt if we can obtain a higher Ozone residual by increasing other parameters such as Ozone dose., ozone contact time etc. The problem is under normal atmospheric conditions the solubility Ozone has never been able to increase beyond a certain level and these levels are insufficient to achieve Ozone residual of over 0.4 PPM . Alteration of the pressure of ozone mass transfer with lower ozone doses is perhaps the surest way to achieve higher ozone residuals.

STORAGE TANK CLEANSING With OZONE

Virtually every water storage tank will develop mineral and biological deposits on its inner walls over time. They can be slimy films or rigid crusts, depending on water composition. There are several major problems associated with these buildups. One problem is they provide habitat and shelter for various microorganisms, which can contaminate the stored water and become increasingly resistant to conventional, Chlorine-based treatment methods. In case of heavy contamination, fragments of these layers can break loose and appear in the water distribution system. Furthermore, tank walls degrade as a consequence of microbial activity of harsh cleaning procedures, requiring frequent tank surface repair.

The most common procedure for tank cleaning is currently high pressure rinsing with water, followed by an application of hypochlorite solution. This method provides temporary surface disinfection. However most of the wall deposits and many of the microorganisms they contain remain in place. This leads to rapid re-accumulation of the germ population. Previous methods for complete removal of wall deposits often had the drawback that they were either damaging to the tank surfaces apply.

The use of ozone provides a safe and simple alternative to conventional cleaning and disinfection methods. Deposits Formed in the Tanks and the pipes are due to a factor called Biological Fouling that forms a convenient surface for precipitated Minerals in the water to accumulate & form scales

Bio-film is a common term used to describe the accumulation of microorganisms and their by-product excretions onto surfaces of a water treatment system. Because most microorganisms prefer to become attached to a surface, more and more microorganisms will adhere to the surfaces of a water system. As microorganisms die, they become nutrient sources for other micro-organisms. Over time, a film consisting of living and dead organisms will form. A slimy cover called a glycocalyx surrounds the organisms and serves to trap nutrients from the water source and protect the organisms from chemical destruction

The precipitation of Minerals depends on the Composition of the water (Soft water produces less precipitation than hard water) where some ions loose & exceed their solubility limits due to changes in pH and precipitate . The accumulation of these precipitates on the Bio-film surfaces later on forms what is known as scale. The improvements in water tank hygiene reduce the need for drinking water chlorination, improving water taste and reducing treatment costs.

There are two common options for controlling microbial growth in a distribution and storage system: Ozonation and heat.(steam sterilization) There is a growing trend toward using ozone in storage and distribution systems because of its relatively low capital and operating costs compared to hot-water generation and storage. It also has the added value of reducing the total organic carbon (TOC) to levels well below those proposed for USP 23 Purified Water (500 ppb).

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