By Jeff Roseman

Porous PTFE Tubing

Testing and Applications of Porous PTFE Tubing for Transferring Ozone into Lake Water to Reduce Bacteria, Coliform and *E.coli*

Products research and testing sometimes reveals information that was not sought, but was discovered in the testing parameters. Hypotheses are drawn and tests are set up to prove or disprove ideas. Parameters are set and many times the tests disprove a hypothesis, but the data may also uncover new theories.

Recent studies were conducted on porous PTFE tubing to test the efficacy of how well the tubing transfers ozone into water. Porous tubing is often used in applications such as hot tubs, spas, swimming pools and aquaculture projects to bubble ozone or oxygen into water. While its effects are similar to diffusers or air stones, the tubing can be used in various applications and retrofitted to areas where it can be a better method of ozone or oxygen delivery. The tests were conducted to prove how well this tubing worked using UV ozone generators and Corona Discharge generators.

Information from ozone manufacturer's spec sheets, plus research on ozone performance, proved the tests to be very beneficial. Various parameters were set and known outcomes were theorized. This article is written from a different perspective than the norm. Bringing some insight on how porous PTFE tubing performs, along with beneficial information on disinfection. Many ozone experts in the field may find this information "ho-hum," but for people looking for new and better applications, this article should stimulate some creative ideas using PTFE porous tubing.

Hypotheses

Test PTFE porous tubing for transferring ozone into lake water to reduce bacteria, coliform and *E.coli*. It is assumed that the bubbling method would work and be efficient for many applications.

Method

The porous PTFE tubing was used to bubble ozone into water and tested to reduce bacterial counts. Although atmospheric transfer is not as good as venturi and pressure contact chambers, in some applications it is an acceptable and usable method. Corona Discharge and UV ozone generators were used. The UV generator does not produce as much ozone by percentage by weight but does provide bacterial reduction. The Corona unit produces more ozone by percentage by weight and reduces bacterial counts quite considerably. The venturi method of transfer was also tested for a comparison of the two methods.

Lake water was gathered from an area inhabited by ducks and geese to assure the bacteria, coliform and *E.coli* levels were high. The water was tested using a Hygicult, TPC and Hygicult, E/b-gur testing reagent and incubated. Ozone was bubbled into the water for about four hours and these bacterial tests were conducted at intervals of 60 minutes over the four-hour period. UV ozone was used on the first tests.

A Corona unit was employed as the ozone-producing medium with the next set of tests. Every hour, for about four hours, a test was taken and the testing vials incubated.

There were 12 tests conducted over the course of a few weeks to determine various factors. Each water sample was tested for beginning bacterial, coliform and *E.coli* levels as well as pH, temperature, TDS (total dissolved solids), ORP (oxidation reduction potential) and, in some cases, DO (dissolved oxygen). These parameters were checked before and after to determine if there were any changes caused by the ozone.

The tests revealed how pH affects the effectiveness of oxidizers, such as ozone and chlorine. When water is balanced and pH is near 7, the H+ and OH- ions are equal and the oxidizers can react more effectively.

A second method of ozone transfer, the venturi, was tested for comparison of the bubbling method using the porous tubing. The Corona and UV generators were both used in this test.

Copper ionization was introduced in another test. This was done out of curiosity and proved to be very educational. It was not the main focus of this experiment or testing, but was conducted as a different control mechanism.

A few of the tests were replicated to assure accuracy and to repeat results. Changing parameters of gathering data in various methods made the results more conclusive and comprehensive. The "Method" section discussed earlier, was condensed considerably in order to provide detailed results and conclusion areas.

Results

The hypotheses proved true in one sense and false in another. There was a significant bacterial reduction when using the porous tubing, but only under certain parameters. The Corona Discharge ozone generator proved to be the most effective source of ozone when used with the porous tubing. Bacterial levels were reduced from >107 to <103 and the coliforms and *E.coli* were eliminated. This was, in a way, known going into the experiment because the percentage by weight production of ozone is much greater than that of UV-produced ozone. The contact time played a significant role in both applications in the transfer of ozone into the water. Ambient air was used to produce the airflow across the ozone reactors so there was not as much ozone created in the bubbling experiment.

The venturi method used an oxygen

Close up of porous PTFE tubing and bubbles formation.

concentrator with the Corona Discharge unit and created a much higher ozone concentration than the UV unit. Both systems created significant bacterial reduction when used with the venturi method of delivering ozone. Atmospheric pressure was the means in which the ozone was able to rise and dissipate into the water, as this experiment did not employ the use of a pressure tank.

A subsequent bubbling method test was conducted using a taller chamber and the bacteria was reduced from >107 to <103 while using the UV ozone generator. The taller chamber allowed for longer contact time, thus creating the needed bacterial reduction. While using a venturi to transfer the ozone into the water, the results were very favorable using both the UV and Corona. The Corona, of course, was able to reach higher ORP levels faster than the UV, but this was expected because of the concentration of ozone created. Copper ionization proved very beneficial in reducing bacterial counts. This test was conducted to see how synergistically the ozone and copper could work together. The copper did a great job of reducing bacterial counts and proved another hypothesis. The copper level was controlled at less than 1.0 ppm. Drinking water standards are set at 1.3 ppm so this was slightly below the MCL standard set by the EPA and very effective in controlling bacteria.

The last test was set up, reducing the pH in the water, to show how balanced water enhanced the oxidizers. When the H+ and OH- ions are in line, chlorine and ozone can react better and the ORP levels are increased for more effective bacterial control. The ORP levels varied with the balancing of the water, but one example was a pH of 8.4 and an ORP of 586 mV and when the pH was brought to 7.0, the ORP jumped to 785mV. Bacterial reductions were very significant at these levels of ORP.

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Conclusions

There were several conclusions drawn from the tests. The bubbling of the ozone through the porous tubing proved beneficial if the bubbling process was set up properly and had enough ozone concentration and contact time to reduce bacterial levels. Both the UV and Corona Discharge systems proved effective, but the Corona was by far the most efficient method with greater reductions at a faster rate. The use of porous tubing would need to be analyzed closely on any application to obtain data and feasibility of its use. Hot tubs, spas, pools, ponds, fountains and aquaculture are a few applications where this type of product could be implemented. Using longer lengths of this tubing, plus longer rise times, would provide good ozone and oxygen transfer into the water source. Other good applications would be oxidizing contaminants, such as iron, in atmospheric tanks or ponds for aeration.

The venturi method proved successful for both UV and Corona systems. But again, each application would need to be analyzed, the source water tested and a proper system designed to achieve desired results. A pilot study is always the best method of testing to find parameters that would affect success of using ozone.

Copper ionization was a test that was not considered at the beginning of this study, but after seeing the synergistic effects, this type or treatment warrants further investigation on many applications. This disinfection method has been used on cooling towers, pools, spas and greenhouses for several years, but in limited capacities.

The balancing of water is known to have a great effect on enhancing halogens, such as chlorine and ozone. These tests really proved the fact that proper pH is essential. Always note that alkalinity should be adjusted before the pH. For best results, proper levels for alkalinity should be between 80-120 ppm and pH should be from 7 to 7.4. ORP levels rise very sharply when the pH is brought in line.

Although some conclusions can be drawn from testing, there is nothing like real-world applications. Lab experiments can provide data and measurements, but when employed into any treatment situation, there may be unknowns that need to be analyzed and considered. Always consult a qualified or experienced supplier to obtain information and insight to help with designing systems. Trial and error methods can be costly and not beneficial to the customer. Remember, the customer is looking for a solution to a problem, not just wanting to purchase products. Closing a deal is one part of the process, but rectifying a situation is the real reason you were contacted. WQP

Authors Note:
Information of this research had to be condensed for reasons of simplicity and space. If there are any questions, please contact the author.

References:
"Ozone – A Reference Manual," prepared and distributed by the Water Quality Association.

About the Author

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