KROHNE
measure the facts

KROHNE Whitepaper

Improving Ozone Measurement

By Rich Lowrie, WWW Industry Manager

The clean water we enjoy in our homes is sometimes taken for granted, but have you considered the ways it gets treated on its way to you? A newer popular treatment method involves the use of Ozone, a powerful oxidizing agent, which is an inorganic molecule made up of three atoms, instead of two as found in the Oxygen we breathe. Ozone is formed from oxygen by electric discharges or by ultraviolet light.

Ozone is widely used in drinking water treatment because of the excellent disinfection and oxidation qualities it possesses. It is recommended to use ozone for pre-oxidation along with a sand filter or an active carbon filter (GAC). After treatment with Ozone, the filters remove the remaining organic matter. This combination has several benefits: Removal of organic and inorganic matter and micro-pollutants, such as pesticides; enhancement of the flocculation/coagulation-decantation process and reduction of disinfection byproducts along with odor and taste elimination.

The formation ozone from oxygen occurs with the use of energy. This process is carried out by an electric discharge field as in the CD-type ozone generators (*C*orona *D*ischarge, the simulation of lightning), or by ultraviolet radiation as in UV-type ozone generators (simulation of the ultraviolet rays from the sun). In addition to these commercial methods, ozone may also be made through electrolytic and chemical reactions. In general, an ozonation system includes passing dry, clean air through a high voltage electric discharge, which creates an ozone concentration of approximately 1% or 10,000 mg/L. For treatment of small quantities, UV ozonation is the most common while large-scale systems use either corona discharge or other bulk ozone-producing methods.

There are two methods of adding ozone gas to the water treatment process. In one, water is passed through a venturi throat which creates a vacuum and pulls the ozone gas into the water. In the other, the ozone is bubbled up through ceramic diffusers into the water being treated. Since the ozone will react with metals to create insoluble metal oxides, post filtration is necessary.

Prior to 2014 the Region of Halton's Burlington Water Purification Plant, in the Greater Toronto Area, was capable of producing 220 MLD of clean drinking water. From 2001 through 2004 the plant underwent a major upgrade which included the use of Ozone (using Corona Discharge) as the primary disinfectant and this upgrade increased plant capacity to 263 MLD without changing the footprint. The raw water the plant treats is pulled directly from Lake Ontario and distributed throughout the region. Winter and summer demand varies greatly, as does the seasonal raw water quality.

The ozone system installed at Burlington Water Plant is capable of providing 550 kg of ozone daily. This easily satisfies the disinfection process but also allows a 4 mg/L dose of ozone at full plant capacity for taste and odor events.

Figure 1: Greater Toronto Area's Burlington Water Purification Plant during major capacity upgrade.

Shortly after the startup of the plant with the new ozone disinfection system, operations personnel noted an unusually large number of process shut downs throughout the day when treatment flows were below 50 MLD. Given the impact, plant operations and maintenance teams began the task of identifying the cause of the problem and working towards finding a solution.

Ultimately, the problem was found to be in the measurement of the O_2 (oxygen) and O_3 (ozone) gas flow streams. As the ozone system was designed for controlling the water's taste and odor, this key process equipment was sized to meet higher gas flows to match the new water production rates. Therefore at lower water flow rates the result was that very low flow of oxygen and ozone were required. So in order to run the plant at lower flows, the operations staff had to run the ozone generator at lower than optimal ozone concentration in order to achieve a the necessary gas flow. This not only made the operation of the ozone generator inefficient, but also increased operational costs.

This measurement has historically been done with thermal mass flow technology. This is usually a very reliable method when the application requirements are matched by the instrument. Unfortunately in this case, however, the required flows of O_2 and O_3 were below the nominal 10 to 1 turndown range of those flow meters and into their low flow cutoff range. Thus, when the flows of O_2 or O_3 dropped below the 20 L/sec specification, the flow indication went to 0 L/sec and the plant would experience an ozone generator shut down due to the minimum flow rates not being achieved. An indication of no ozone flow would also show that proper disinfection was not being delivered.

With the cause of the problem discovered, the group reached out to their vendors for a solution. The majority of the solutions recommended all had at least one drawback with the exception of the solution put forth by Angelo Valente of ACI, the KROHNE representative in the region. Angelo suggested a Transit Time Ultrasonic flowmeter to solve this measurement problem. Angelo explained how the transit time is measured and that the gases being measured did not require separate and unique flow

KROHNE, Inc. 55 Cherry Hill Drive, Beverly MA 01915 (USA) http://us.krohne.com 1-800 356-9464 info@krohne.com

calibration factors and that density, temperature and sonic velocity of the fluid being measured did not influence the measurement. Transit time ultrasonic measurement measures the time it takes for a pulse to travel across its diameter in two directions, one with and one against the fluid's flowing direction, along the same chordal path. The only part of this process that is relevant (other than the ability of the fluid to carry acoustic waves) is the difference in pulse transit time between the two directions. This transit time measurement is directly related to the fluid velocity. Given the fixed cross sectional area of the meter, the volumetric flow is easily determined by multiplying velocity by area.
The deciding factor, however, was the turndown of the meter. Transit time meters measure from zero flow which means that achieving specified accuracies is possible in turndowns of 100 to 1. These key attributes led to the purchase of the KROHNE OPTISONIC 7300 Ultrasonic Gas Flow meters for both gas applications.

Figure 2 KROHNE OPTISONIC 7300C meters for Oxygen and Ozone gas flow applications

The plant also took the opportunity during the flow meter upgrade to install modulating actuators to ensure that ozone was not only properly measured, but properly dosed. The new KROHNE OPTISONIC 7300 flow meters started registering the flow as soon as they were initiated. As a result, there were many immediate tangible benefits to plant operations:

- Ability to achieve optimum ozone concentration of 10% at all treated water flows, including 50 MLD and the ozone generator is able to run efficiently.
- Since the ozone generators are running optimally, overall gas use has decreased significantly which has resulted in lower operating costs. Low gas flow rates of 5 L/sec are achievable.
- The correlation between oxygen gas flow and ozone gas flow values is very apparent and creates operator confidence in the values reported.
- Plant shutdowns and disruptions due to low gas flow have been eliminated, thereby greatly improving plant uptime.

Plant personnel have agreed to be available for questions. Please reach the author for their contact information at r.lowrie@krohne.com or by phone at 1-800-356-9464, Extension 1113.

KROHNE, Inc. 55 Cherry Hill Drive, Beverly MA 01915 (USA) http://us.krohne.com 1-800 356-9464 info@krohne.com