Update for the pH Pilot Project at Tri-County Water Treatment Plant

Overview

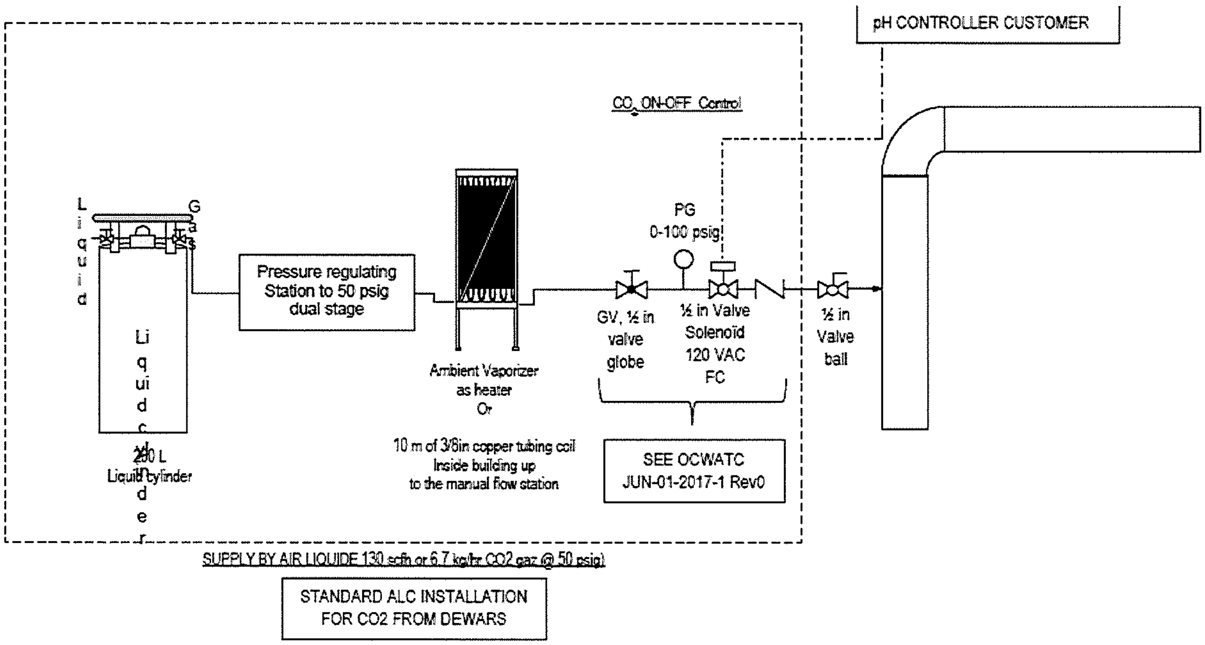
The Tri-County WTP has been experiencing higher pH levels in the raw water supply which can result in potential disinfection issues when the pH rises above 8.5. The only pH control available was to use the gas chlorine system on the raw water intake in order to lower the pH. This was used year round to ensure when using sodium hypochlorite for primary disinfection that the pH levels were maintained below 8.5. This practice was not ideal as the system was designed for zebra mussel control and to supplement for primary disinfection. The current design was not intended for pH control. As well, the Tri-County DWS experiences high total THM concentrations that are further increased when using chlorine on the raw water. In 2010, the decision to use carbon dioxide to reduce the pH was decided when Stantec was consulted in regards to the higher pH values as along with the increase in THM formation since the start-up of the new water treatment plant in 2009. Stantec looked into alternative chemicals to reduce pH however, carbon dioxide was determined to be the most suitable option.

Carbon Dioxide

Carbon dioxide (CO2) was the preferred option for pH control. This is due in part to the ease of operation as well as being safer for handling. CO2 can effectively adjust pH without the consumption of alkalinity and has a high level of process control. As mentioned, it is much safer and easier to handle than bulk liquid acids. Any leaks can be vented to atmosphere without posing a risk to the health and safety of the public/operators. The reaction of CO2 with water produces carbonic acid which further breaks down into carbonates and bicarbonates. This reduces the pH through the hydrogen ions that are produced. Carbon dioxide monitoring equipment was installed to ensure the safety of our workers. The carbon dioxide is purchased through Air Liquide Canada Inc. which is NSF/ANSI 60 certified for drinking water.

Equipment Installation

The manifold is provided by Air Liquide and contains two 240L CO2 cylinders attached to manifolds that automatically switch the cylinder in use based on the cylinder pressure. The manifold has three pressure gauges; one pressure gauge for each cylinder and one pressure gauge for line pressure. When the pressure in the cylinder drops to 200 psig it will automatically switch the feed to the other cylinder and a red light on the manifold will appear indicating a replacement of the cylinder is required. The CO2 is injected based on a feedback loop through the PLC and the SCADA system which operates based on pressure as well as the downstream pH values. The goal of the injection system is to ensure that the pH doesn't drop below 7.5.



SCADA Control

The solenoid valve that controls the feed of the carbon dioxide is controlled by the SCADA system which opens when the pH level is above the user controlled setpoint (value set at 7.5). The system will only feed the carbon dioxide when there is a sufficient flow rate coming from the lowlift pumps. Alarms are initiated should the pH reach the high or low level alarms which are user controlled setpoints. These alarm conditions, if activated will shut down the system to ensure no further water is produced nor pumped to the distribution system. If faults occur on the analyzers that control the opening/closing of the solenoid valve then the valve is defaulted to close.

Process Control

Sufficient continuous monitoring of pH levels already existed at the Tri-County WTP in order to provide the necessary information for alarming and control of the carbon dioxide system. The CO2 system is injected after the strainers at the WTP in the raw water prior to the membrane filters. This allows for sufficient mixing to lower the pH prior to the addition of sodium hypochlorite ito meet primary disinfection.

Additional Monitoring/Testing

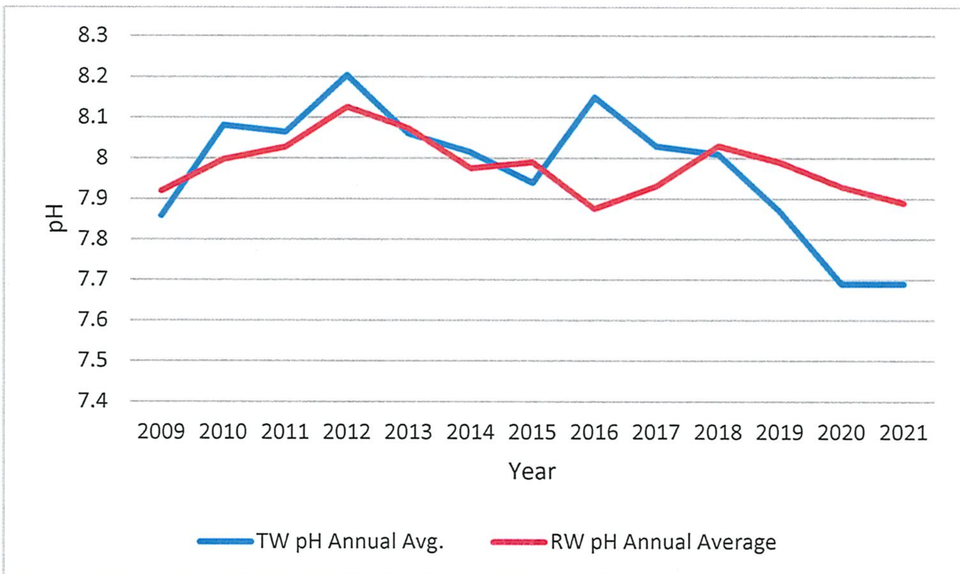
Schedule C of the DWWP stipulates additional required monitoring for this pilot project. As specified in the DWWP, quarterly samples are to be collected from two residential plumbing locations and tested for lead and copper, along with additional water quality parameters for LSI calculation. In addition to these requirements, Alkalinity and pH will be monitored more frequently than the regulatory requirements set out in O. Reg. 170/03 Schedule 15.1. Alkalinity is being monitored in the raw water, treated water and at the end of the Tri-County DWS at the West Lorne Standpipe. The system is also being monitored for disinfection by-products (THMs and HAAs) in the treated water as well as the distribution water at the West Lorne Standpipe.

Monitoring/Testing Results

The pH adjustment has benefited the disinfection system as optimal disinfection occurs when pH levels are maintained at 7. The higher the pH the more hypochlorite (OCl-) is present which is 100 times less effective as a disinfectant as opposed to hypochlorous acid (HOCl). Therefore, adjusting the pH to below 8.5 is crucial to ensure effective disinfection of the drinking water.

The pH of the treated water is stabilized when using the CO2 system. The annual average pH value in 2020 and 2021 was 7.69, refer to Chart 1 . With this lower pH in the treated water the disinfectant is in the hypochlorous acid form and provides more effective disinfection.

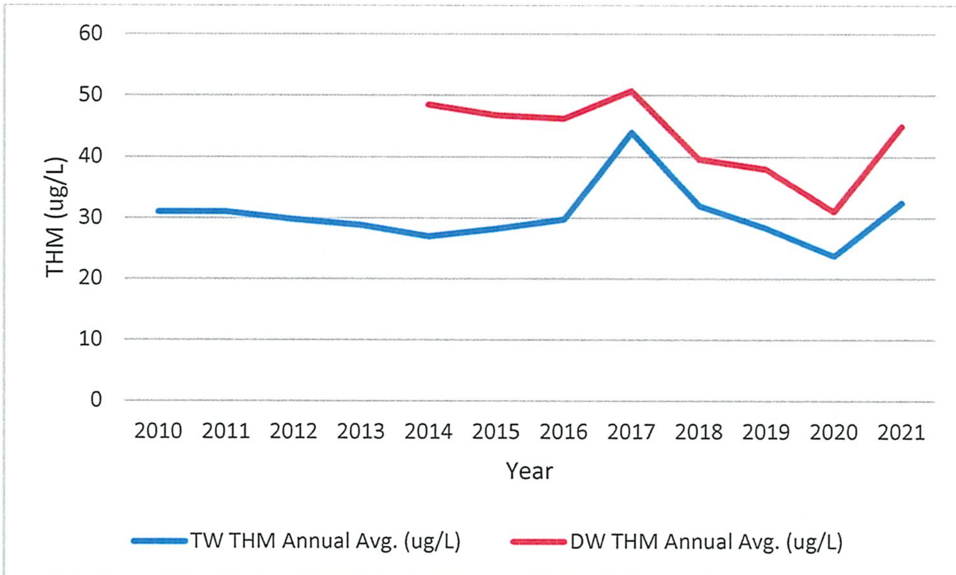
Chart 1. pH of the raw water compared to the treated water.



THMs results have shown a reduction since the CO2 system was installed in 2019, refer to Chart 2. However, the THM average in 2021 showed an increase. There are a variety of factors that contribute to THM formation:

1. Higher pH
2. Higher organic loading
3. Chlorine demand

Chart 2. Annual average THM concentration in treated water and distribution water.



In 2021, Lake Erie experienced a low dissolved oxygen event resulting in a fish kill. This likely had an effect on the THM results due to an increase in organic load and chlorine demand.

Distribution System Sampling Results

Alkalinity monitoring has been conducted to ensure sufficient alkalinity is provided to maintain a stable pH throughout the distribution system. Maintaining a stable pH and sufficient alkalinity in the system is imperative for corrosion control of lead, copper and iron and for the stability of cement-based linings and pipes. For a pH between 7-9.5, optimal alkalinity for lead control is between 30 and 45 mg/L as calcium carbonate. The lowest concentration observed is 88mg/L.

There have been two plumbing test locations sampled on a quarterly basis for alkalinity, copper and lead. These results have indicated no adverse effects.

Cost Summary

We currently operate with two tanks on site at all times and order 1 replacement tank every two weeks subject to raw water flows and pH. A review of life cycle costing took place with the chemical supplier and it appears that the majority of the system has an asset life of 15 years. It is anticipated that annual costs related to pressure relief valve/actuators could average out at around $1,000.00 per year potentially. In 15 years, the gas manifold may require replacement and the current price of that unit is around $6,000.00.

There is a monthly rental invoice which is based on the number of tanks on-site at a given time and the daily rate per tank is $1.47/day. The monthly rental on tanks depending on how many are on site at a given time during the month could range from $140.00 to $170.00 per month. The chemical cost is $310.50 per tank and we would go through around 2 tanks per month. The amount of usage depends on raw water pH and flows.

The following table provides an overview of operating costs which are generally comprised of the tank rentals and carbon dioxide usage.

Year	**Costs**
2020	$8,744.22
2021	$9,305.86 to date

With respect to costs, it seems to be a very cost effective process in the lowering of pH with low life cycle costs going forward.

<u>Summary</u>

Overall the pH Pilot program has shown to be effective at stabilizing and lowering the pH levels in the treated water for disinfection purposes. There have been no adverse effects to the distribution system by the addition of the CO2. THM results were showing a steady decline, with the exception of 2021. This could be from the poor water quality experienced in the fall of 2021.

At this point, we seek board direction on whether we can continue with this process and seek MECP authorization to incorporate into our Drinking Water Works Permit.

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