PH ADJUSTMENT USING CARBON DIOXIDE

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Background and Problem

The Elgin Area Primary Water Supply System (EAPWSS) is located in Central Elgin, Ontario, and has a current rated treatment capacity of 91 million litres per day (MLD), an annual average production of 51 MLD, and serves an estimated population of approximately 100,000 people. The plant draws raw water from Lake Erie source water, which has an average pH of 8.27, which is higher than the pH required for optimum coagulation. In the past, the plant used acidified alum as a means of lowering the pH, but since the amount of the acid in alum was fixed, the alum dosage needed for optimum coagulation could not be accurately controlled. As a result, a higher alum dosage was used than needed. In order to achieve optimum coagulant dose, it was necessary to separate the coagulant and pH depression chemicals.

Solution

A number of workshops and laboratory analyses were completed to select the appropriate chemicals for adjusting the raw water pH before the coagulation process. It was found that capital costs of either chemical system (sulfuric acid or carbon dioxide) required for pH adjustment were approximately the same. It was decided to proceed with carbon dioxide (CO2) as it poses less risk for operators and has lower maintenance costs than sulfuric acid. Carbon dioxide is inert and non-corrosive, and will only become active when dissolved in water.

Process Description

Liquid CO_2 is delivered to the Elgin WTP and is stored in a 50 tonne CO_2 tank. A series of pressure reducing valves reduces the system pressure from 350 psi to 110 psi before entering the chemical metering panel (See Figure 1). This reduction in system pressure changes the chemicals physical state from a liquid phase to a gas phase. The chemical metering panel contains a mass flow controller that produces an output linear with mass flow rate. The feed rate is set manually and trimmed from a feedback loop that averages the readings of the raw water pH prior to entering the flocculation tanks. Once a targeted pH of 7.0 is achieved, the established CO_2 dosage rate can then be flow paced to

Figure 1 - Carbon Dioxide Chemical Metering Panel

Note:

1. Pressure Regulator
2. Pressure Gauge (Typ.)
3. Thermal Relief Valve
4. Needle Valve
5. Mass Flow Meter
6. 3-Way Ball Valve (Typ.)
7. Flow Indicator
8. Back Pressure Regulator
9. Solenoid Valve
10. Spargers (Typ. of 2)

the total raw water flow prior to entering the flocculation tanks. The chemical metering panel also contains a normally closed solenoid valve, needle valves, three way isolation valves, flow indicator, pressure relief valve, back pressure relief valve, and a thermal relief valve. The chemical panel can be controlled manually using a local control panel, three way valves and bypass piping.

The CO_2 is then introduced and dissolved into a raw water carrier stream producing a weak carbonic acid solution. The CO_2 gas is discharged through spargers which diffuses micron-sized gas bubbles creating a large gas-liquid interfacial area enabling a high CO_2 transfer rate. Added mixing time was provided by maximizing the length of piping from the CO_2 injection point to the carbonic acid injection point located in a yard valve chamber. An injection quill spanning the 750 mm diameter raw watermain is installed to promote better mixing of the carbonic acid into the raw water, prior to the flocculation tanks.

Figure 3 – Carbon Dioxide Storage Tanks

HVAC and Gas Detection

The Carbon Dioxide Room is gas tight and is ventilated at three (3) air exchanges/hour continuously and 30 air exchanges per hour during an emergency through an independent air handling system. The make-up air handling unit provides tempered air supply into the facility. The return air is then exhausted through a roof mounted exhaust fan. A CO_2 gas detection system activates the emergency HVAC system to supply high rate ventilation, if the detected carbon dioxide levels exceed the calibrated limits. An alarm will also annunciate on the plants SCADA system.

PULL QUOTE TO COME


Figure 2 – Raw Water Booster Pumps

Outcome

The pH adjustment system has been operational since December 2012. The EAPWSS Water Supply switched from acidified alum to straight alum and is now benefiting from reduced chemical and maintenance costs. With high raw water pH and unpredictable fluctuations in raw water turbidity the carbon dioxide system has allowed the Operators to have better control of the coagulation process. Carbon dioxide is a safe to handle, easy to apply, efficient and ecologically sound product. Carbon dioxide also reduces high pH levels rapidly while it shows self-buffering when it reaches neutral pH levels. This self-buffering feature allows precise end-point control without the danger of overshooting into undesirable low pH levels.