SWITCHING FROM CHLORINE GAS TO SODIUM HYPOCHLORITE – IS IT WORTH THE TROUBLE?

OTCO Water Workshop
March 6, 2013
Presented by:
John Spetrino, Aquarius WTP Superintendent
&
Rich Siepka, Aquarius WTP Lead Maintenance
Background
Aquarius WTP, located in Lake County east of Cleveland, went online in January 1985.

- Average daily flow of 9.7 mgd and design capacity of 20 mgd.
- Treatment process consists of rapid mix, flocculation, sedimentation, filtration, and finished water storage in two 0.585 MG clearwells.
Chlorine gas in 1 ton cylinders was originally used since plant’s inception. The facility was surrounded by open fields but now is surrounded by residential housing.

Changes in the regulation of hazardous chemicals (Section 112 of the Clean Air Act) prompted re-evaluation of disinfection system.

Potential danger of an accidental release of chlorine gas was a major concern.

Sodium hypochlorite (NaOCL) was considered and ultimately selected as the alternate disinfectant.
Original Disinfection System
Number of chlorinators: 2
Maximum feed rate: 6 mg/L = 42 lbs/hr
Type of storage: 1 ton cylinders
Storage capacity: 15 -1 ton cylinders for 30 days min usage
Type of feeders: Floor-mounted, cabinet vacuum-type
During construction of the current system, most of the original system had to be removed while still allowing the WTP the ability to disinfect finished water.

The original system remained in service by removing as much as possible of the gas feed equipment and leaving only the required components and onsite storage to adequately feed chlorine.
Current Sodium Hypochlorite System
A phased construction approach was used for the installation of the current sodium hypochlorite system. Due to project budget limitations, lengths from the source and desired splits, the carrier water method was used to convey hypochlorite to feed points within the plant.
The current hypochlorite system includes two bulk storage tanks, one day tank, three feed pumps, new feed piping, distribution panels, and spill containment.

Sodium hypochlorite is stored in bulk cylindrical shaped 6,100-gallon polyethylene tanks providing a total bulk storage of 12,200 gallons.

Sodium hypochlorite flows by gravity from the bulk storage tanks to a 550-gallon polyethylene day tank.
Current Sodium Hypochlorite System (cont.)

One feed pump is dedicated to feeding sodium hypochlorite solution to the settled water flume.

A second pump delivers sodium hypochlorite solution to the filter effluent but is also capable of feeding hypochlorite to other feed points in the plant.

A third pump is provided as a back up to either of the other two pumps.
Shipments of 12% - 15% sodium hypochlorite are received by tanker truck.

The tanker truck connects to a Camlock quick connect coupling on the exterior of the building and pumps directly into one or both of the bulk tanks.

Exterior spill containment is provided at the loading station.

Feed rate adjustment of the feed pumps can be performed locally or remotely from the plant’s SCADA system.
Feed requirements (@ 15% trade solution):

Typical Feed Concentration: 3 mg/l of chlorine
Maximum Feed Rate (@ 24 mgd): 20.2 gph
Average Feed Rate (@ 9.7 mgd): 8.2 gph
Minimum Feed Rate (@ 6.0 mgd): 5.0 gph

30-day Storage Requirement: 12,100 gallons
Design Considerations
Design Considerations

Several years of actual feed data and Ten State Standards were used to determine the required storage volume and feed rates.

Variable speed peristaltic pumps were selected as feed pumps because they do not allow vapor lock to occur, are easily primed, can be flow paced, and most importantly the sodium hypochlorite does not come in contact with any of the pump parts.

In the event of a leak, WTP personnel are notified by the SCADA system.
Elevated bulk storage tanks designed on “bridge-type” platforms were used to allow for gravity feed and to accommodate a smaller footprint for the spill containment area.

The bulk tanks contain reverse floats, ultrasonic sensors, and a 2-inch water line to provide dilution water for “washing” the tanks as well as dilution of the sodium hypochlorite (if needed).

Alarms for detecting spills in the containment area were also provided.
Design Considerations (cont.)

Section view of new storage/day tanks
Because of sodium hypochlorite’s corrosive nature, fiberglass was used for all grating, pipe supports, access ladders, stairs, and structural members.

Manual control valves for transfer of sodium hypochlorite between the bulk tanks and the day tank were provided because we wanted to remain consistent with the way our other chemical feed systems were set-up.

Vented ball valves specifically designed for use with sodium hypochlorite systems were selected to prevent the buildup of gas in the feed system.
In the event of a spill, a chemical sump pit receives the runoff and is pumped through a Camlock-type quick connect coupling on the side of the building to a tanker truck for disposal.

Current feed points at the settled water flume, the discharge of the 6-filter beds, the original two chlorine mixing tanks, and the entrance of the clearwell were maintained for plant flexibility.

The hypochlorite feed system is tied to the WTP’s SCADA system to allow for adjustment of feed rates remotely throughout the plant.
Construction
Construction

Spill Containment Wall
Construction (cont.)

Storage & Day Tank Pad Forms
Construction (cont.)

Finished Bulk Storage Tank Pad
Construction (cont.)

Sump Pump Pit & Alarm Panel
Construction (cont.)

Splitter Valves for (6) Filter Feed Points
Sodium Hypochlorite System Performance
The current sodium hypochlorite system has been operational since May 2006.

Transfer to the current system was very smooth with the switchover occurring during a normal work day.

The current system has eliminated the possibility of a dangerous chlorine gas leak that could have seriously injured operators and the public located near the WTP.

Proper ventilation of the sodium hypochlorite storage tanks has decreased the odorous presence of chlorine in the storage/feed area and provided a better environment for plant operators to work in.
An initial concern during design was that the sodium hypochlorite would have a very short shelf life. That was not the case at Aquarius.
There were some negatives with the new feed system:

The cost of using sodium hypochlorite is approximately twice as much than with chlorine gas; however the trade-off of cost for safety was deemed acceptable by Lake County staff.

The paddle wheels used to indicate flow at each of the six filters became unusable because of calcium carbonate buildup and a reaction with the brass bodies of the paddle wheels. This potential issue was overlooked during construction. The contractor has replaced the existing paddle wheels with an indicator more suitable for use in a sodium hypochlorite system.
Use of multiple individual dosing pumps located directly at the feed points would allow staff to feed sodium hypochlorite neat rather than rely on carrier water.

The trade-off is increased capital and O&M cost, but the reduced potential for the nuisance of calcium carbonate buildup may be worth the investment.
During the summer of 2007 while doing our preventative maintenance flushing it was discovered that we were experiencing a higher than normal amount of flushing time in system.

It was determined that the pH of the lake water had increased. The sodium hypochlorite naturally increases the pH so we determined that this caused the Zinc-Orthophosphate to start flaking off from the pipes.
Improved Sodium Hypochlorite System
Since our startup in 2006 we have had some maintenance issues throughout the whole sodium hypochlorite feed system. We had our maintenance staff research improvements and re-design some of the system. The following slides will show some before & after pictures to show these changes.
Improved Sodium Hypochlorite System (cont.)

Before: (Polyethylene) Storage Tanks
Improved Sodium Hypochlorite System (cont.)

After: (PVC) Storage Tanks
All three pumps can deliver sodium hypochlorite solution to the settled water flume or to the filter effluent.

One pump can deliver sodium hypochlorite solution to the rapid mix tank.
New carrier water and sodium hypochlorite feed line was installed.

This allowed the sodium hypochlorite to be fed neat from the day tank over to this point.

The sodium hypochlorite is then injected into carrier water to be delivered to the six filters.
Summary
A few things we learned that should be researched before going into this project is:

1. The type of material that is being used for the storage & day tanks.
2. The life of these tanks – We found that the average life is 5-7 years.
3. Know that there will be precipitation if the carrier water is not softened.
The Lake County Department of Utilities is pleased with its conversion from chlorine gas to the new sodium hypochlorite disinfection system at its Aquarius WTP.

Although there are maintenance issues inherent with sodium hypochlorite systems, the increased safety of the new system to WTP personnel and the surrounding community are worth the few inconveniences.
QUESTIONS???