Largest Ozone Facility in North America Meets Regulatory Requirements and Remediates Taste & Odor Problems

Sidestream Venturi Injection—Basin Nozzle Manifold Contacting System
Wylie, Texas

Mazzei®

CASE STUDY

World Leader in Mixing and Contacting Technologies

The Problem: In October 2008, the North Texas Metropolitan Water District began working to add ozone to its four interconnected water treatment facilities which operate as the Wylie Water Treatment Plant (WTP). Sitting on 442 Acres, Wylie was designed to treat up to 770 MGD of raw water using coagulation, settling, multi-media filtration and chlorine disinfection. The decision to add ozone was prompted by the need to satisfy both the regulatory requirements and the desire to remediate taste and odor problems.

The Solution: To minimize ozone dosage and the potential for bromate formation, the preliminary design called for ozone to be added after chemical coagulation and settling had removed a majority of the raw water solids but prior to final polishing with multi-media filters. The design also called for conversion of the multi-media filters to bio-filters to remove assimilable organic carbon and provide additional removal of taste and odor compounds. However, the cost and time required to re-bed 100 filters made immediate conversion unrealistic. Consequently, it was agreed that the conversion to bio-filtration would be phased in slowly as filter media replacement became necessary.

Early in the design phase the decision was made to utilize sidestream Venturi injection (SVI) to help minimize the size and maintenance of the 11 ozone contact basins that would treat a future maximum flow of 890 MGD. To ensure the SVI ozone effluent was well mixed into the raw water flow, basin inlet channels were constructed to allow confined space gas mixing of all incoming water with a single BNM (FIGURE 1).

To provide turn down, each BNM was designed to operate using either a single or dual SVI with the number of duty injectors sequenced with ozone feed requirements. During a final review of the SVI–BNM process piping, members of the design team became concerned that the long horizontal pipe runs required to connect the remote Venturi injectors with nozzle manifolds, combined with the lower pipeline velocity of a single SVI flow, would cause extreme stratification of the injectors' 2-phase effluent and result in pockets of gas slug feeding into the BNM. If gas slug feeding occurred, the BNM would provide poor gas mixing and low ozone transfer by burping large gas bubbles into the basin water flow, similar in behavior to a fine bubble diffusion grid operating with leaking gaskets.

To test the validity of their concern, Mazzei ran a multi-phase CFD analysis on Wylie contactor 4-1, which had the longest horizontal pipe run from SVI to BNM and therefore was potentially most likely to experience low ozone transfer from phase separation and slug gas feed into its BNM. Mazzei proposed two possible piping modifications and set up the analysis to examine phase separation on three different piping configurations (FIGURE 1).

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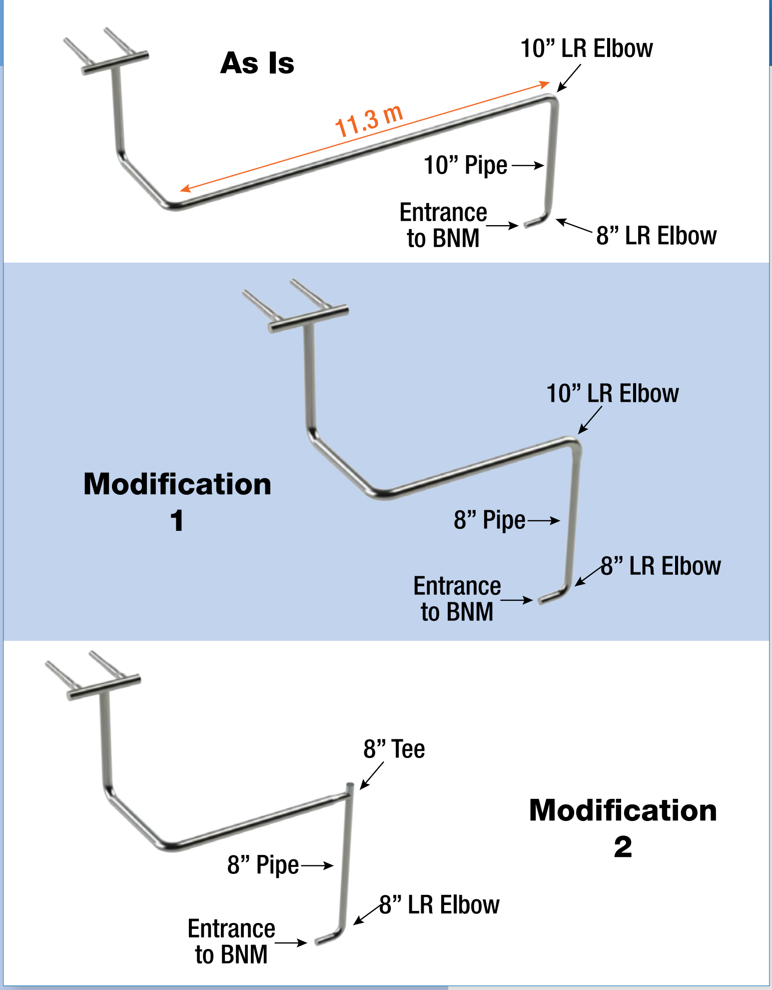

FIGURE 1: Contactor 4-1 SVI-BNM piping options

The CFD analysis verified that significant phase separation occurred by the end of a 11.3m horizontal pipe run. This phase separation continued through the 10” LR elbow for both the “As is” and “Modification 1” conditions (FIGURE 3). On “Modification 2”, the single branch flow through an 8” tee remixed the stratified flow producing a homogenous mixture at the tee outlet. The analysis also showed significant mixing by the vertical pipe drop in all three test conditions which produced a mostly homogenous mixture at the BNM inlet for the “As is” condition that was similar to the end of pipe mixture produced by “Modification 2”.

The Results: The mixing provided by the vertical pipe drop resolved Mazzei’s concern of low ozone transfer from slug gas feed which allows the SVI-BNM installation to proceed per the “As is” piping design. Each of the 11 contact basins were provided a single BNM with 2 duty and 1 stand-by SVI. The final SVI design operated at an energy cost of 0.99 kW/ kg of applied ozone at the peak ozone design dosage of 3.5 mg/l. A site visit made on October 2, 2014 showed the average ozone transfer efficiency for plants 2, 3 & 4 (*Plant 1 was not in operation at the time of the visit*), was > 95%, with exception of plant 2, which showed an ozone transfer efficiency of < 92%.

When Mazzei inquired about the low ozone transfer of plant 2, Wylie operators explained that accidental over feeding of Ferric Chloride had resulted in carryover of coagulant solids into the ozone contact basin, fouling the strainers on the SVI pumps as well as the dissolved ozone sensors. The 0 mg/l dissolved ozone reading from fouled ozone sensors had subsequently caused a prolong overfeeding of ozone, while fouling of the SVI pumps caused low water flow across the gas injectors, increasing injector gas liquid mixing ratios and reducing the discharge velocity of the BNM gas mixing nozzles. Since Mazzei’s visit, the plant has scheduled a change out of the pump’s strainers to a larger mesh and has made repairs to their chemical feed system to avoid future upsets from coagulate carry over.

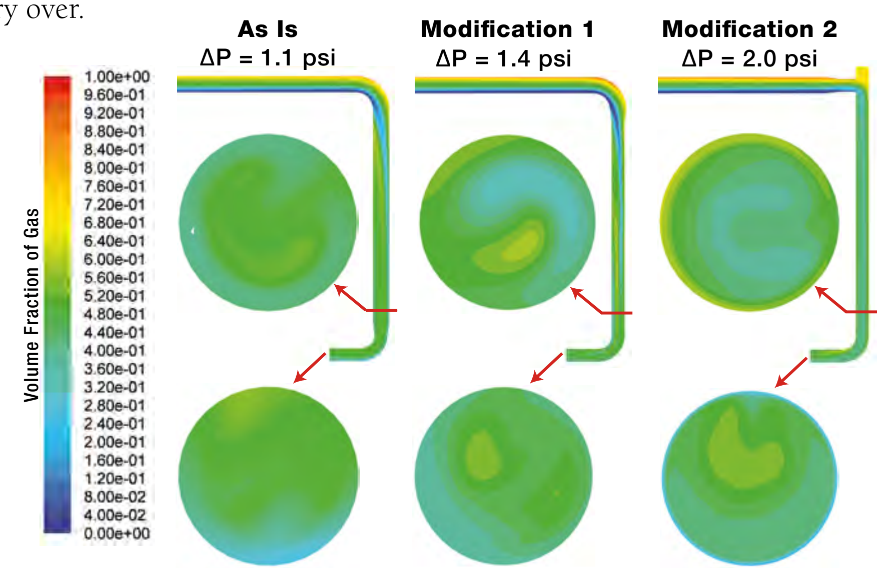

FIGURE 3: CFD analysis contactor 4-1 SVI-BNM piping options

To get a better understanding about how a SVI-BNM system works, take a look at this animation.

For additional information on how Mazzei can assist with your water treatment goals, contact us at:

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