PUMP STRAWS

Avoiding turbulence to stop cavitation

Jim McElvogue

When system upgrades at the Ames Water Pollution Control Plant (Ames, Iowa) led to problems with effluent reuse pumps, it took a clever operator, some polyvinyl chloride (PVC) pipe, and a simple idea to get things flowing properly again.

When originally constructed in 1989, the facility – a two-stage trickling tower filter facility with an accompanying solids contact process – did not include effluent reuse in its design. The original plan was to extract and treat water from onsite wells for facility use. But the well water contained a high iron concentration that requires extensive treatment with iron filters, potassium permanganate, and sodium hypochlorite. The labor-intensive pumping and treatment system required cleaning and flushing to maintain the 189,000 L/d (50,000 gal/d) that the facility uses.

After a few years, it became apparent that using effluent water could be a highly cost-efficient alternative. Facility personnel designed and installed an effluent water system. The new system used well casings but installed the units in the effluent channel rather than underground.

THE CITY OF AMES WATER POLLUTION CONTROL PLANT IN IOWA MOVED ITS EFFLUENT REUSE PUMPS INTO THE SAME BUILDING AS ITS NEW ULTRAVIOLET DISINFECTION SYSTEM. THE FILTERS, BACKWASH, AND PRESSURE CONTROL SYSTEM USE PRESSURE SENSORS TO RELAY INFO TO THE VARIABLE SPEED DRIVE CONTROL FOR THE PUMPS TO MAINTAIN A CONSTANT PRESSURE AND PUMPING CAPACITY.

TURBULENT WET WELL

The original pumps were located outside of the facility's main buildings with the controls and filters housed in a small shed. But the design of a new ultraviolet disinfection system provided the opportunity to move the system inside to facilitate maintenance. But this change also created an unexpected problem.

The new pump location sits directly downstream from the of UV dosage control gate. As the water flows over the gate, it falls into the wet well and creates considerable turbulence near pump intakes. This turbulence caused pump cavitation and a complete loss of pressure. It rendered the effluent reuse system unusable.

THE BROWN PUMP CASINGS EXTEND INTO THE WET WELL IMMEDIATELY BELOW THE ULTRAVIOLET DOSAGE CONTROL GATE. HOWEVER, THE TURBULENCE OF THE WATER CAUSED CAVITATION IN THE PUMPS, RENDERING THEM UNUSABLE.

All photos courtesy of Jim McElvogue

SIMPLE SOLUTION

Solving the turbulence and resulting pump cavitation problem could have taken several paths. Any engineered solution would require a considerable amount of time and incur substantial costs. Any time with the system down

meant a return to the well pumps and treatment system to provide the needed water.

One possible remedy included relocating the effluent pump system. This change would mean major costs for reconstruction, plumbing, and electrical work. Another solution could have been building a baffle to deflect water with the accompanying design, construction, installation, and testing. Both were viable solutions, but the question of who would pay for the fix – owner, engineer, or contractor – was unresolved.

Then, Joseph Krebs, one of the facility's operators, offered a simple fix: move the pipe intakes away from the turbulent area. Krebs suggested building a "straw" for the intakes to pull water from a few feet down the effluent channel rather than right beneath the overflow gate.

City staff used stainless steel pipe restraints and anchors to attach PVC pipes to the pump intakes and routed the pipes downstream a few feet. Effluent water completely floods the end of the oversized pipe and provides a source of water not entrained with air.

Because leaks were not a concern, operators used stainless steel screws instead of glue to join the pipes. This allowed greater flexibility in installing the pipe by providing the means to adjust the pipe lengths and route. Installation took less than a day and cost was minimal.

The fix restored full pumping capacity and pressure. As a side benefit, it also reduced the intake of algae that had led to pump plugging problems before. Algae that grow in the final clarifiers and ultraviolet disinfection system come loose and travel down the effluent channel. The extended intake pipe deflects the algae away from the pumps. The larger pieces of algae that used to plug the pumps can't be sucked up the extended intake in this configuration.

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OPERATOR JOE KREBS INVENTED A SOLUTION TO THE PROBLEM BY PLACING "STRAWS," MADE OF PVC PIPE, AROUND THE PUMP CASINGS AND EXTENDING DOWN THE EFFLUENT CHANNEL. THE PIPES ESSENTIALLY MOVE THE INTAKE TO A LESS TURBULENT AREA.

THE INTAKE PIPE (WHITE PVC SECTION) STRETCHES OUT OF THE TURBULENT PART OF THE EFFLUENT CHANNEL.

BECAUSE THE ENTIRE INTAKE PIPE TYPICALLY IS SUBMERGED, KREBS USED STAINLESS STEEL SCREWS, INSTEAD OF GLUE, TO JOIN THE PIPES. THE SCREWS OFFER MORE FLEXIBILITY IN INSTALLING THE PIPE BY PROVIDING THE MEANS TO ADJUST THE PIPE LENGTHS AND CONFIGURATION MORE EASILY.