By Jon Steele, KRWA Technical Assistant

Loss of Chlorine Residual Leads To a Much Deeper Issue at Inman, Kansas

Darren and Dallas Alexander prepare to remove the first section of column pipe from the discharge head.

It's interesting how sometimes things become more involved than they first appear. I recently responded to a phone call from city of Inman Superintendent Rod Boeger regarding a loss of gas chlorine injection at Well No. 3. My initial thought was the problem is the typical check valve failure which filled the head with water, or it was a loss of vacuum, etc. After arriving Rod and I headed out to the well field for a closer look. Inman operates three wells, each with a capacity of 400 gpm.

The first thing I do when working with a gas chlorination system is to make sure all safety equipment is present and in proper working order including the ventilation, switches, monitoring equipment, etc. If there is a deficiency, I point it out to the operator and discuss the proper corrective action. In this case, all aspects were in good condition. The first test I perform is to remove the feed line tube from the regulator head, cycle the pump and check for proper vacuum. Having experience with these systems will tell you that simply placing your thumb on the end of the tube will confirm whether or not the vacuum is sufficient to operate the system.

Actually, it is as simple as that. Either there is sufficient vacuum or not. Having no vacuum is usually the case, and so troubleshooting begins from there. The problem might be inadequate booster pressure or perhaps there is a leak in the hose between the ejector and the regulator. If no leakage in the feed line tubing can be found, then we need to evaluate the booster pump. Properly operating pressure gauges are essential to check the boost pressure. Each ejector has different boost requirements to make them function properly. The best advice is to refer to the manual on the particular style of ejector. Yes, the manual I'm referring to is that which is supposed to be in the file cabinet with other information on all of the system's critical infrastructure equipment. If the impellers in the chlorine booster pump are worn, the pump may not be creating the pressure needed to operate the system. And if the pressure is sufficient there may not be enough actual flow due to plugging of the injection nozzle. In either case the result is the same; if there's a loss of vacuum, the chlorine will not be injected.

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If it has been determined that proper vacuum is present, I inquire about the repair history of the regulator head itself. Generally, I work with the operator and rebuild it. In the case of the call from

Safety first when working with chlorination systems …

As anyone who works with gas chlorine knows, safety is a concern. Special equipment is necessary and safety precautions need to be practiced. Chlorine gas is 2.5 times heavier than air and expands 480 times when released to air. For that reason, here's a word of caution when changing gas cylinders. I recommend operating the pump with the cylinder valve off until the ball in the metering tube drops to the bottom and the button is drawn completely in. This will evacuate that small space filled with pressurized gas that is between the regulator head and the cylinder valve thus preventing a pressurized gas release into the atmosphere. It is amazing how powerful even that small amount of chlorine gas can be and this simple procedure will save operators from an unpleasant experience.

KRWA Circuit Rider Jon Steele tests well performance and electrical system at Inman.

Inman, there was no vacuum which led me to believe it was a possible leak in the hose and eventually to the ejector.

Upon disassembly I noticed a small piece of debris partially plugging the ejector nozzle, blocking the water flow. This small nozzle hole is the very heart of the system. It is actually a safety feature by design: lose vacuum and the system loses chlorine gas feed.

In a modern gas chlorination system, a booster pump boosts water pressure and forces it through the small hole in the ejector at a high rate, which in turns creates vacuum by a venturi effect. An ejector is simply a venturi device very similar to a garden hose sprayer. In the case of providing assistance to the city of Inman, after a series of tests we determined the pump impellers were also badly worn and the ejector had a small piece of debris stuck in the port hindering the flow. Thus, there was no vacuum on either account. We removed a stone from the injector port. The next question was, "Is there a more serious problem?"

The next logical step was to flush the strainer screen; we then reconnected the tubing. It immediately plugged again. This caused Rod and I to consider a more serious problem. We removed the Y strainer completely and took it back to the shop for disassembly as it required more tools than we had on site. After we removed the stainless steel screen we noticed it was packed completely full of gravel.

This answered the question as to what happened to the booster pump and why it wore prematurely. Water Well Pumps are not designed to pump sand and gravel. Now the question is what is going on in the well. In my mind, there were three possible issues:

Problem found – a .75-inch hole in the column pipe.

Experience counts …

I want to credit the late Robert "Bob" Vincent of Ground Water Associates of Wichita, Kansas. He was a mentor to me. I learned much from Bob and spent many hours applying things learned from him during training sessions he conducted for KRWA and developing a close affiliation with him over the years. Bob was always the professional – and he was so effective in the way he'd let me know if I didn't have all the facts that were necessary to make a determination of a well problem. I would happily return to the project to correct my shortcomings, and then together we would review the data and he would explain his observations and conclusions. I frequently see letters and reports to public water supply systems with his signature at the bottom. Robert Vincent was definitely a profound leader in the water well industry. KRWA and systems owe him a great debt of gratitude. He certainly was a "Friend of Rural Water" as the award from KRWA proclaimed already in 1995; Bob is missed.

- Sand may not have been removed properly from the bottom of the well during original construction
- A hole in the casing perhaps was allowing gravel to be drawn inside the well and into the pump
- A hole in the pump discharge pipe might be jetting high-pressure water against the screen agitating the gravel pack

Pump, well performance testing

More investigation led us to conduct a pump and well performance test. This type of test should be conducted at least annually as it should be part of a comprehensive preventive maintenance program. Many operators check static water levels and are aware of the need to do more to have a good maintenance program.

Here are terminologies that are part of a pump and well test:

- Static Water Level: The depth to the water in a well from a given point with the well at rest and after it has fully recovered from the last pumping cycle.
- Pumping Water Level: The depth of the water from a given point at a certain time during a pumping cycle.
- Pumping Rate: Volume in Gallons Per Minute of discharge
- Drawdown: The amount of difference between the Static Water Level and the Pumping Water Level
- Specific Capacity: The gallons of yield per each foot of drawdown
- Shut Off Head: The psi reading during pump operation against a closed valve
- Electrical Data: Motor voltage and amperage readings

This photo shows the chlorine ejector and gravel that was removed from the Y strainer.

Good maintenance programs should have the information for each of the aspects listed, such as static water level, pumping water level, etc. Public water systems should have this information readily available. In addition, systems should have a record of all maintenance procedures or repairs that have been made such as well construction logs, design data, and water quality information on each individual well. This information is useful in determining the nature of problems, such as pump wear, well efficiency, and electrical efficiency. If a system has all of this data when the components are new then the system can track changes to schedule reviews and maintenance procedures. A regular test of the master meter on the wells is also important to ensure meter registration accuracy and correctly account for potential water loss.

It always amazes me how little is known about a public water system's supply wells by the system owners or staff members. On many occasions when assisting public water supply systems, I have sifted through stacks of files and papers in order to find well logs or design information. Frequently the operator is new and wasn't involved with the construction or any well rehab. Sometimes we can find all the needed information but many times, only a portion is available. If the installation of the well was completed by a larger company, the company may still have records and so that's where we go to request the information.

Going back to the call for technical assistance at Inman, I recommended to Superintendent Boeger that the well be taken out of service until the pump could be pulled, and the

The 9-stage pump is lowered to the work trailer.

discharge pipe and the line shaft be inspected. I also recommended a down-hole inspection of the well casing and screen. The city agreed to those suggestions.

The next step was to collect all the information on the well. This meant conducting a pump and well performance test. An inorganic analysis was also needed. We then assembled a file of all records we could find including well logs, design data and drawings, pump data, maintenance and repair records. Once this information was gathered, and having the inorganic analysis, the city contacted Alexander Pump & Services in St. Marys, Kansas to discuss the project and the possible repair and treatment scenarios.

After conducting the pumping water level portion of the well performance test, we noticed the cable was wet way above the static water level where there should have been no water. Answers to the problem were now coming into focus. This was a good indicator that the problem was most likely due to turbulence from a hole in the discharge pipe and high pressure water spraying against the side of the well screen. In fact, that is what the problem turned out to be. There was a .75-inch diameter hole directly above the pump and water was spraying out against the side of the well, dislodging the gravel pack, forcing gravel through the slots in the screen.

The down-hole camera inspection provided more information. The well casing and screen were in excellent condition after 25 years of service and no further work was needed except a good disinfection treatment before the pump would be reinstalled. Sometimes on steel well casings, there can be galvanic corrosion where the stainless steel screen meets the mild steel casing. This well at Inman was in great shape and there was no need for acid or surge blocking as the screen was extremely clean. Typically surge blocking, acid and chlorine treatments are sometimes needed in order to clean a well after years of service especially if iron and manganese are present in any appreciable amounts.

I thoroughly enjoyed working with Superintendent Boeger and Dallas and Darren from Alexander Pump & Services. The city has a good project with a well that should provide many more years of good service. This is just one of the many examples of technical assistance that KRWA provides daily, working together to make a difference.

Annual conference

I encourage readers to attend the upcoming Annual Conference & Exhibition at Century II in Wichita, March 24 – 26. The program is reprinted in this magazine and it's also online at www.krwa.net/conference. Talk to the vendors who are there who can provide services for your water or wastewater utilities – from funding agencies to the guys who pull pumps or clean out lagoons. You'll be glad you made acquaintances.

Jon Steele has been employed by KRWA as a Circuit Rider since 1995. Jon is certified as a water and wastewater operator. He has more than twenty-five years experience in public works, construction and industrial arts.