Case History

RE-Ox® Use by Kansas City Area Water Utility

Abstract

In 2006, a Kansas City area water utility started using RE-Ox® as part of its water treatment for the 110 M gpy of water it provides to its 1400 customers. The system wanted to reduce its chlorine demand to minimize DBPs in anticipation of the new EPA Stage 2 Disinfection Byproducts Rule, and to optimize its water quality for its customers. The system found that after the first four months, the treatment is exceeding expectations by reducing the chlorine demand 16–31%, reducing TTHMs 66% and HAA_5 28%, all while water quality was maintained and unsolicited customer compliments were received.

Background

The system obtains its water from two sources; its own two wells, which it chlorinates with gaseous chlorine and chloraminated water purchased from the City of Kansas City, Kansas, Board of Public Utilities. The distribution system has 65 miles of pipe ranging from 1-1/2" PVC to 24" ductal iron, one 39,000 gallon standpipe and a new 1.5 million gallon reservoir. The two differently treated waters are distributed to separate areas and do not mix with each other. The water system does not secondarily treat the chloraminated water. The efforts for periodic biofilm burn-off phases are executed by the water wholesaler (KC BPU).

The stated mission of this Kansas City area water system is to provide its customers with the highest water quality possible. Because it is a small utility, among its challenges are maintaining its water quality and distribution system with limited staff.

From its experience and research, the system has come to view flushing as labor intensive, causes interruptions in service, wastes water and is not effective in removing the scale and biofilm deposits that develop in water distribution systems and cause chlorine demand. Pigging can remove scale deposits, but is expensive and labor intensive. Pigging requires that the system be taken out of service to be done in sections and also consumes extreme quantities of water. Phosphates condition water but do not remove deposits and are a nutrient source for bacteria.

The utility investigated RE-Ox technology, a new specially formulated cleaning bleach engineered to eliminate scale and biofilm deposits from pipe during normal operations while maintaining water quality. It has the unique ability to readily penetrate inorganic deposits as well as organic deposits/biofilms and destroy the organic glue that holds them together. RE-Ox is non-hazardous, neutral pH, odorless and tasteless in water, and is NSF Standard 60 Certified for drinking water. RE-Ox technology is being used to control deposits/solids in various industries, including food processing, agriculture, healthcare and hospitality water distribution systems.

By removing and preventing the formation of scales and biofilm in pipe, chorine demand is reduced so that residuals can be maintained thereby elevating water quality.

In an article in the March 2006 issue of the KRWA publication, The Kansas Lifeline, Pat McCool, consultant to the Kansas Rural Water Association, stated: *"A chlorine residual is important as its presence is an important indicator that contamination has not occurred and the water is safe to drink."*

The community of Dustin, Oklahoma, solved red water, elevated turbidity and low chlorine residuals it had had for years by cleaning a portion of its distribution system. In an article in the May 2006 AWWA Op-Flow magazine entitled, "Reducing Chlorine Demand with Chemical Cleaning," the system operators, William W. Harjo, and Charles Selvidge, and consultant Ulrich Reimann-Phillip, wrote, *"While it hasn't solved all the system's problems, cleaning much of the infrastructure has helped eliminate excess chlorine demand and reduced the red water and turbidity complaints."*

The Kansas City area water system is also anticipating impending Stage 2 drinking water regulations before compliance is actually required. By lowering chlorine demand, the DBPs created in the distribution system will correspondingly be reduced and help it qualify for a waiver to many requirements of the Stage 2 DBP Rule.

In addition to reducing its already relatively low chlorine demand and DBPs, the utility was also interested in RE-Ox for its water softening characteristics.

Pilot Tests

Kansas Department of Health & Environment was reluctant about the water system using RE-Ox even though it is NSF Standard 60 Certified and allowable in Kansas public water per state statute, so a trial was conducted to demonstrate the applicability of the technology to treat public water systems. In November

2005, in conjunction with other Kansas City area water utilities, the system conducted a Pilot Trial in which RE-Ox® treated chlorinated well water removed solids from scaled and tuberculated pipes and valves taken from service. The results were so noteworthy that a second trial was performed using RE-Ox in the chloraminated water the system obtains from KC BPU.

The first Pilot Trial consisted of pipe and valves taken from service and assembled to receive the flow of RE-Ox treated water.

Result Averages

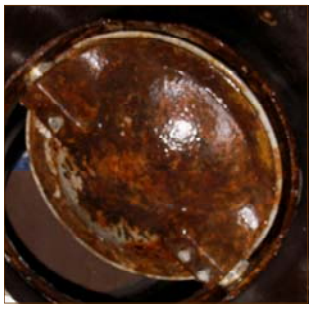
Water	Cl_2	ORP	pH	TDS	Turbidity*
Raw Water	1.52	666	7.44	449	0.46
RE-Ox Treated Water	1.70	685	7.74	464	0.21
Discharge Water	1.64	730	7.32	463	0.42

* data corresponding with incident at supply well not included in turbidity averages

Result Averages for the first Pilot test showed:

- The chlorine residual was maintained in the discharge water.
- The RE-Ox treatment contributed only an average of 0.18 ppm.
- There was no significant change in average turbidity between the city water and the discharge water.
- Virtually no observable solids were found in the catch basin.

24" BFV
Before RE-Ox Treatment



24" BFV
After RE-Ox Treatment

Untreated Control Pipe

Pipe **After**
RE-Ox Treatment

8" Pipe
Before RE-Ox Treatment

8" Pipe
After RE-Ox Treatment

The results of the First Pilot Trial showed deposits were removed from the pipe and valve surfaces with RE-Ox in chlorinated water.

Untreated Control Pipe

Pipe **After**
RE-Ox Treatment

The results of the Second Pilot Trial showed deposits were removed from the galvanized pipe and meter surfaces with RE-Ox in chloraminated water.

The first part of the Pilot Trial represented an on-line constant flow treatment in which scale was softened and reduced, chlorine demand was reduced and turbidity was not adversely affected. The second part represented an off-line flushing treatment wherein the balance of RE-Ox® softened scale was flushed out of the system. The second trial in chloraminated water also removed scale and tuberculation deposits from galvanized pipe and water meters. Water samples were taken and tested throughout both trials and showed that water quality was maintained. The trials showed that eliminating the deposits that create chlorine demand facilitated chlorine residuals. A representative of the utility stated, *"The system cleaned up, just like the RE-Ox personnel said it would. It cleaned up the mains from 24" diameter and down, as well as the valves, which had been difficult to operate."* (Detailed pilot trial reports are available)

RE-Ox Treatment of Kansas City Area Distribution System Water

With the success of the pilot trials, the system obtained the support of the Kansas Department of Health & Environment , and in February 2006 began injecting RE-Ox into its chlorinated water. RE-Ox is injected directly into the water at the well house after the regular chlorine gas injection with a "Chemilizer" brand water-driven proportional pump from 330 gallon totes at a rate of approximately 1/20,000 RE-Ox to treated water. Instruments housed at the utility's plant measure the chlorine residuals and monitor the water pumps.

Special sampling at various points throughout the distribution system was done prior to treatment concurrent with the pilot trials from September 9, 2005, to November 3, 2005, to establish a baseline.

Treatment Results (first four months)

The chlorine demand in the utility's water distribution system after RE-Ox treatment began compared to before treatment was calculated by comparing the difference in the chlorine residuals just after chlorination at the well houses to those out at the sampling / distribution sites. The system increased the number of sampling sites and locations of a few of the sites during the treatment phase to better observe the results of the RE-Ox treatment. The utility was able to follow the RE-Ox cleaning process from the well houses through the system. As it monitored the free and total chlorine, sampling results came closer and the ORP increased. Comparing all the distribution system sites before and after yielded a 1.72 ppm average Cl_2 before and 1.63 ppm after. With an average of 1.08 ppm Cl_2 before RE-Ox and 1.19 ppm during treatment between the two wells, the respective demand was 0.64 ppm compared to 0.44 ppm during the first four months of monitored treatment showing a 0.20 ppm (31%) reduction. If the dead end sampling point (#9) is eliminated from the sites calculated (since it will take longer for this leg to reduce with its minimal flow of treated water), the reduction is 0.12 ppm (23%) (0.52 ppm before, 0.40 ppm after). The chlorine demand in the dead end leg has reduced 0.30 ppm (21%), from 1.46 ppm before to 1.16 after. If just the sites that were exactly the same location as sampled before treatment baseline are calculated, the chlorine reduction was 0.07 ppm (16%), from 0.44 before to 0.37 after.

Water testing, as required by the state, showed that the water quality was maintained. The water provided by the system is sampled three times each month and submitted to the laboratory at Kansas Department of Health & Environment for testing to ensure that its water is safe and meets all requirements.

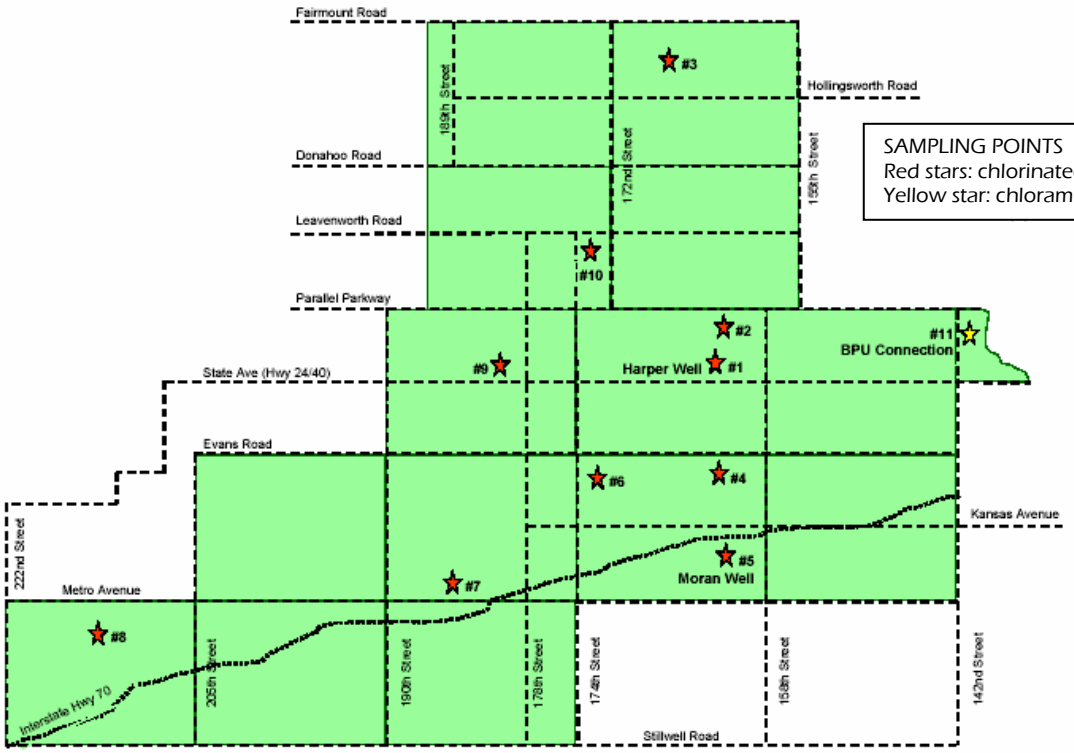
Disinfectant byproduct tests on the chlorinated water sample taken at 214th Street on 9-8-05 before RE-Ox treatment resulted in 16.0 ug/l TTHMs and 6.9 ug/l HAA_5. Tests on water sampled from the site on 7-21-06 after/during RE-Ox treatment revealed 5.43 ug/l TTHMs and < 5.0 ug/l HAA_5. This represents a reduction of 66% in TTHMs and > 28% reduction in HAA_5.

Stage 2 Disinfection Byproducts Rule

The utility receives some of its finished water from KC BPU, so the EPA considers it a Consecutive system. It is subject to the requirements of the new EPA Stage 2 Disinfection Byproducts Rule, which has been developed to improve the quality of potable water and provide additional protection from disinfection byproducts. Trihalomethanes (TTHMs), haloacetic acids (HAA_5), chlorite, and bromate form when chlorine reacts to organic matter found in water and in the distribution system deposits (system chlorine demand). The Stage 2 Rule will limit exposure to two groups of DBPs: trihalomethanes (TTHMs) and haloacetic acids (HAA_5). Utilities will be required to conduct an evaluation of their water distribution systems known as the Initial Distribution System Evaluation or IDSE. The purpose of the IDSE is to identify the locations with high concentrations of DBPs, problem areas, initial disinfection regimes and operational inadequacies that cause systems to develop DBPs. The systems will use these locations as sampling sites for the Stage 2 DBP Rule compliance monitoring. A waiver for this monitoring can be obtained under conditions that include the finding that for eight consecutive quarters within a specified eligibility period, no samples exceed 0.040 mg/L for TTHMs and 0.030 mg/L for HAA_5. The reduction of DBPs brought by the reduction of chorine demand from the RE-Ox treatment, will only aid this water system with the waiver requirements.

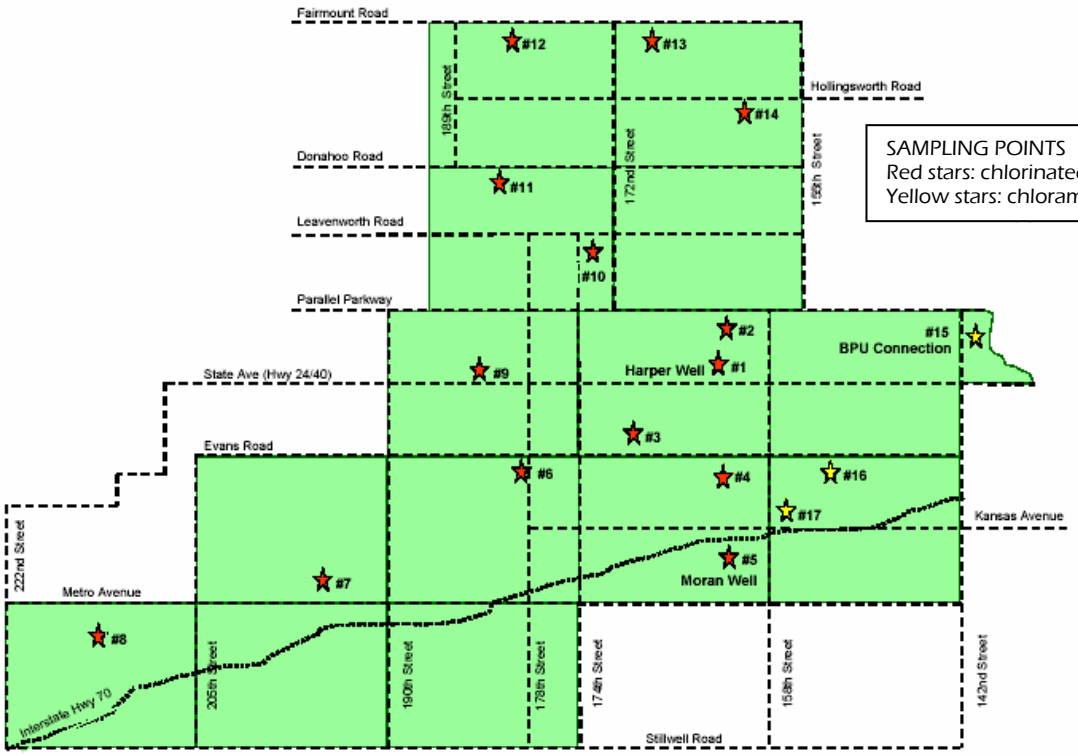
Kansas City Area Water Utility

BEFORE RE-Ox ® Treatment Sampling Points



Kansas City Area Water Utility

AFTER RE-Ox ® Treatment Sampling Points



Chlorinated Water AFTER RE-Ox® Treatment
Averages of 8 Samples Taken from Each Sampling Point Location
(During Period of March 6 through May 10, 2006)

Sampling Point #	TDS	ORP	Free Available Cl2
Harper Well (1)	440	671	1.52
Moran Well (5)	448	667	1.73
2	430	648	0.86
3 (revised location)	445	717	1.73
4	449	705	1.48
6 (revised location)	449	704	1.40
7(revised location)	448	672	1.35
8	449	679	1.34
9 (dead end, revised location)	469	610	0.47
10	441	683	1.33
11(new location)	443	675	1.16
12 (new location)	442	665	0.86
13 (new location)	440	675	1.07
14 (new location)	440	688	1.25
Distribution System Average*	**445**	**677**	**1.19**

* Samples taken from Harper & Moran Wells not included in Distribution System averages.

Chlorinated Water BEFORE RE-Ox® Treatment
Averages of 17 Samples Taken from Each Sampling Point Location
(During Period of Sept. 9 through Nov. 3, 2005)

Sampling Point #	TDS	ORP	Free Available Cl2
Harper Well (1)	395	658	1.63
Moran Well (5)	424	680	1.81
2	398	623	1.20
3	428	607	1.27
4	441	663	1.33
6	442	648	1.35
7	422	527	0.66
8	446	643	1.22
9 (dead end)	475	427	0.26
10	426	641	1.37
Distribution System Average*	**435**	**597**	**1.08**

* Samples taken from Harper & Moran Wells not included in Distribution System averages.

Customer Comments

Since starting to inject RE-Ox® into its water, the utility has received no complaints. Somewhat surprisingly, they have received many unsolicited compliments from customers. System personnel stated: *"Customers have said that their glassware is no longer cloudy even without the use of products for the dish-washer rinse cycle. Others call to say that their show-erheads and spigot filters are no longer clogged with scale, and their soap lathers much easier. One cus-tomer remarked that his water had changed and his softener was working much better than before. He commented that his dishes were coming out much cleaner, his shower was not scaling up any more, and he no longer had a scale ring in his toilet basin."* Upon inspection of his softener, it was discovered that it was on the "bypass" mode. The customer was amazed and appreciative that the water system was treating the water to make it perform the way it did. He was ex-tremely pleased to learn that his home would not need sodium softening in the future because of the use of RE-Ox in the water."

Comparison to Chloraminated Water

The compliments from customers regarding the softening / conditioning benefits of RE-Ox treated water are due to it being a scale and biofilm reducing water, whereas non-treated water and the chloraminated water are not. The chloraminated water is significantly deposit forming. Also, the chlorine demand in the chloraminated portion of the distribution system creates problems maintaining a chlorine residual and the correct ratio between ammonia and chlorine resulting in, among other issues, taste and odor problems in the water. Interestingly, the DBP testing of this system's chloraminated water (TTHMs - 52 ug/l, HAA_5 - 28 ug/l) revealed significantly higher results than its chlorinated water (TTHMs – 16.0 ug/l, HAA_5 – 6.9 ug/l). Plans are being considered to use RE-Ox to reduce the chlorine demand of the chlorami-nated water part of the distribution system.

Conclusion

The philosophy of this utility is to exceed expectations and deliver the highest quality water possible to its customers. By cleaning the distribution system with RE-Ox, thereby reducing chlorine demand, it is able to maintain greater residuals with less chlorine, minimize DBPs, deliver a conditioned, high performance water and keep its commitment to quality to its community.

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For more information, contact:

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