Case Study
Premature Failures of Mild Steel Continuous Slot Well Screens

Executive Summary

Water purveyors in California have experienced premature failures of water wells constructed with mild steel continuous wire-wrapped screen. Laboratory testing was conducted to evaluate the properties of this type of well screen. The results show a clear relationship between the type of steel, the amount of open area in continuous wire-wrapped well screens, and corrosion rates.

Background

Beginning about 1981 well screens constructed of triangular-shaped mild steel wire wrapped around an array of mild steel support rods were introduced and heavily marketed in the southwestern United States. Some water purveyors were attracted to the mild steel wire-wrapped screen because of its high percentage of open area and availability in slot sizes smaller than 0.050-inch. However, most selected it as a less expensive alternative to stainless steel continuous wire-wrapped screens.

When mild steel continuous wire-wrapped screen was introduced to the water well industry, Roscoe Moss Company (RMC) recognized its clear potential for accelerated corrosion. The most undesirable post-installation scenario was as follows:

1. The mild steel wire and internal rods (with their large surface area) would be subjected to aggressive groundwater quality conditions.
2. The corrosion of the mild steel wire would result in a widening of the numerous slots between the wires.
3. The widened well screen slots would allow aquifer material and gravel pack to pass through the screen and into the well. A portion of the sand would pass through the pump and damage its internal mechanism.
4. The numerous small welds that join the wire to the array of rods would be weakened by corrosion; and, in the worst-case the well screen would collapse.

This memorandum presents a brief overview of laboratory testing that was conducted to assess corrosion effects of mild steel screen. It also includes case studies that briefly describe the experiences of several water purveyors who installed production wells using mild steel continuous wire-wrapped screen.

Laboratory Testing

In 1982 a laboratory testing program was conducted to evaluate the corrosion rates of three types of mild steel well screen: 1) RMC “Standard” louvered screen; 2) RMC “Ful-Flo” louvered screen; and 3) continuous wire-wrapped screen. The testing program began with preparation of mild steel screen samples. Each sample had the following dimensions: 21

inches in length and 12 inches in diameter. Three samples of each material were prepared as presented in the table below:

3/16" wall thickness	5/16" wall thickness	Standard Parameters
RMC Standard louvers	RMC Standard louvers	Continuous wire-wrapped
RMC Ful-Flo louvers	RMC Ful-Flo louvers	---

All of the samples were tested by Trusdail Laboratories in Los Angeles, California. The testing began by weighing each sample to determine its initial weight. Then the collapse strength was determined by deflecting the sample at 0.2 inch. The samples were placed in a closed tank and exposed to a 5% salt mist at 95ºF. Periodically, the screen samples were removed, examined, cleaned, weighed, and then replaced in the tank. After 1,900 hours of exposure, the samples were removed, examined, cleaned and weighed for the final time. Afterwards, the collapse strengths were measured once again.

The results of the laboratory testing showed that:

1. Weight losses were proportional to the surface area of the samples.
2. Collapse strength losses were proportional to the weight loss of the samples.
3. The percentage of weight loss for each continuous wire-wrapped screen sample was greater than that of the louvered screen samples.
4. The original and final collapse strengths of the continuous wire-wrapped screen samples were significantly less than those of each of the louvered screen samples.

The results above validated the concerns expressed by RMC as to the corrosion potential and post-installation scenario for water wells constructed with mild steel continuous wire-wrapped well screen. However, the true effects became very clear when water purveyors began to experience problems with their wells that had been constructed with these materials, as presented in the several case studies that follow.

Reports from Water Purveyors

Southeastern Mojave Desert

In 1995 a rural municipal water utility expanded its existing water system by drilling a new well to an approximate deep of 400 feet. The well was completed with 8-inch mild steel continuous wire-wrapped well screen and gravel packed. When the well was put into service, the utility found that it needed frequent cleaning due to clogging of the screens caused by iron bacteria.

After 4 years of service the well was being rehabilitated once again to improve its performance. It was during one of these routine rehabilitation episodes when a serious problem developed. As the well screen was being cleaned, the wire in the screen began to separate from the longitudinal rods that would have eventually caused a massive. Given the importance of the well to the water system and the high cost to drill a replacement well, the utility elected to install a mill-slotted liner. Although the liner made it possible to continue operating the well, the performance of the well was markedly reduced. The production of the well declined to 50% of its original capacity.

Based on the utility's experience with the mild steel continuous wire-wrapped screen, it concluded that future wells would be completed with stainless steel to provided added strength, durability, and longevity. The utility reported no similar experiences with failures in those wells completed with other types of steel and screens.

Cerritos, California

A major Southern California water purveyor installed a new high-capacity water well in the Orange County ground-water basin to augment its existing water supply system. The well was designed by a third party working in collaboration with the water company. The well was designed and constructed with mild steel continuous wire-wrapped well screen. After about 5 years of operation, the purveyor hired a contractor to redevelop the well. The well was initially treated with acid to remove scale and biological matter that had clogged the well screen. When the acidifying was completed, the contractor used a dual swab to agitate the well. The final step was chlorine treatment. After chlorinating the well, the contractor was removing the tool when it became stuck within the upper 20 feet of well screen. The tool could not be removed; however, the contractor was able to disconnect and remove the eductor pipe.

With the eductor removed from the well, the contractor conducted a video survey of the well to assess the damage. The video showed that the circumferential wire had separated from the interior rods and spiraled into a coiled mass that completely blocked the interior of the well. In its post-development assessment, the water company concluded that most likely scenario was that the mild steel wire and interior rods of the well screen had corroded significantly. In its weakened condition, the acid treatment and swabbing had combined to result in the failure of the well screen. Unfortunately, a video survey was not conducted before the well was redeveloped; therefore, this scenario could not supported by direct visual evidence.

La Habra, California

As the water purveyor for the municipality, the City installed a new, deep well in the La Habra ground-water basin to serve as a source of potable water supply. The well was drilled to its target depth by a reverse-circulation rig and constructed with mild steel blank casing and mild steel continuous wire-wrapped well screen. In connection with the pumping tests of the well, measurements were made with a Rossum Sand tester to confirm that sand production was acceptable, i.e., less than 5 parts per million during the initial pumping test. The well was put into operation and served as an important source of municipal water supply.

Approximately 7 years after the well was put into service, the City discovered that the well had begun to pump sand and even some larger material that appeared to be from the gravel pack. Given the City's concern for the well's condition, the decision was made to remove the pump and conduct a downhole video survey to inspect the casing and wire-wrapped well screen. The video showed clear evidence that that the mild steel wire-wrapped well screen had corroded and that in places the slots were significantly enlarged. As direct result of its enlarged slots, the well screen was unable to retain the gravel pack and formation materials.

Consequently, both gravel pack and formation materials were entering the well and passing through the pump.

Having made this significant finding, the City decided to rehabilitate the well. However, during the course of the rehabilitation work, the contractor's tools became stuck in the well and could not be removed. As a result, the well was permanently removed from service and abandoned.

In retrospect, the unfortunate set of circumstances leading up the eventual abandonment of this particular well could have been avoided. For instance, had the well been constructed of a more durable steel, such as 304 stainless steel, the well screen would have been markedly more resistant to corrosion. This design change would have precluded the corrosion of the well screen and saved the City the loss of the well and the cost to replace it.

Findings

The results of laboratory testing and case study experience show the propensity of mild steel continuous wire-wrapped well screen to corrode prematurely. In contrast, there were no reports of similar corrosion problems in wells that had been constructed with mild steel or other types of louvered screens.

Conclusions

The findings suggest the following conclusions:

- Water wells constructed with mild steel continuous wire-wrapped screen are decidedly more susceptible to corrosion when exposed to aggressive water quality conditions.
- Evidence shows that the types of problems that can occur in mild steel wire-wrapped screened wells includes 1) separation of the circumferential wire from the rods; 2) unacceptable sand production; and 3) collapse.

Recommendations

For most applications, continuous wire-wrapped well screen should be constructed with Type 304 stainless steel. For those wells that are installed in highly corrosive water quality conditions, it may be advisable to select Type 316L stainless steel.