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Save Energy by Refurbishing and Coating Pumps

Monroe County Water Authority (N.Y.) discovered that coating pumps prevents or at least impedes a decline in pump performance and corresponding increase in energy consumption from internal corrosion and tuberculation buildup. **BY PAUL MAIER, CHRIS KING, AND RICHARD METZGER**

IN 2005, THE Monroe County Water Authority (MCWA), Rochester, N.Y., began a pilot study to reduce the interior roughness of three horizontal split case (HSC) pumps that were mechanically rebuilt. Pump performance (head, flow, and efficiency) hadn't returned to the original manufacturer's specifications through the rebuild efforts. MCWA staff wanted to see if reducing a pump's interior roughness through sandblasting would have a positive effect on pump performance and efficiency.

Concerned that corrosion and tuberculation would quickly return after sandblasting, MCWA began looking for acceptable coatings that could be applied to protect the pumps' interior surface after sandblasting and perhaps even enhance their interior smoothness. MCWA decided to use NSF 61-approved brushable ceramic-filled epoxy coatings because of their availability, ease of application, and low cost.

POSITIVE RESULTS

The results of the post-coating field testing surprised MCWA's most skeptical staff. In each of the three cases, pump efficiency was increased by more than 8 percent from the sandblasting and coating efforts. Overall performance of all three pumps was restored to original manufacturer's specifications.

Based on the study's results, MCWA applied for and received a 2007 grant from the New York State Energy Research and Development Authority (NYSERDA) to conduct research on the use of ceramic epoxy coatings to increase pump performance and efficiency on a variety of pumps, ranging in size from 20 hp to 600 hp. MCWA also decided to look at the potential benefits of coating pump impellers, agreeing with NYSERDA to compare performance increases from sandblasting only vs. sandblasting and coating to see if the coatings actually make a difference in pump performance.

The project's experimental design stipulated that performance increases from mechanical refurbishment and sandblasting and coating would be evaluated independently so each step's contribution toward increasing pump

A series of photos shows the results of MCWA's pump-coating process (from left to right): pre-sandblast, post-sandblast, post-metal filler, impeller coating, and post-top coating.

Photos show a 150-hp HSC pump installed in 1978 before (left) and after (right) sandblasting and coating. MCWA field tests have shown some encouraging results of the benefits of sandblasting and coating pumps as an essential step toward returning a pump to its original manufacturer's specifications.

performance could be measured. The MCWA/NYSERDA study revealed some surprising findings, including the following:

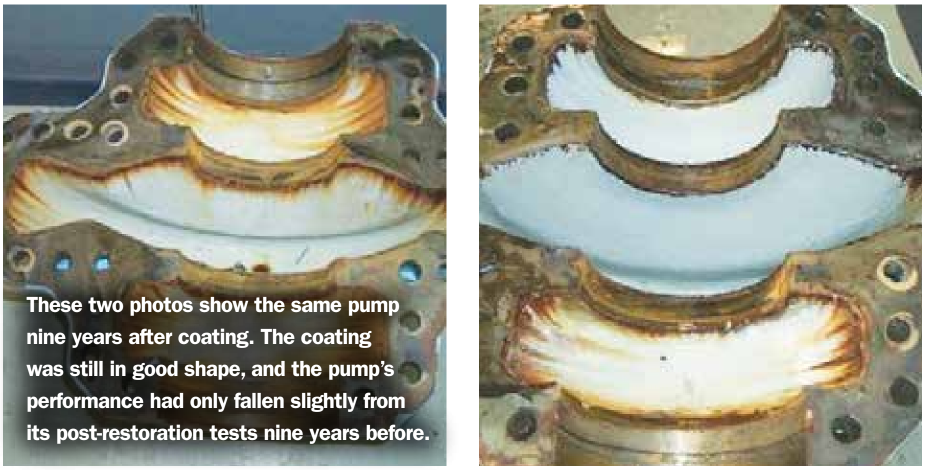
- The study showed that however much a pump's performance falls below its original manufacturer's performance curve (head, flow, and efficiency), on average, mechanical restoration only restored approximately 50 percent of a pump's performance. Sandblasting and coating were necessary to restore the remaining 50 percent.
- Pumps that were sandblasted and coated had on average 4.6 percent higher efficiency after restoration than pumps that were sandblasted only. Efficiency of several of the sandblasted-only pumps began to decline within several months of being returned to service, whereas the sandblasted and coated pumps lost less than 1 percent efficiency even after several years of service.
- Subsequent internal inspections of coated pumps have revealed the coatings have adhered well and show minimal signs of wear even after nine years of operation in the field.

CORROSION AND TUBERCULATION

The effects on flow and pressure loss in unlined pipelines from internal corrosion and tuberculation is well known, documented, and calculable. The Hazen-Williams equation (C-factor assessment), head-loss gradient, pitot tubes, etc., are examples of formulas, terms, and equipment commonly used to accurately measure, describe, and calculate flow through pipelines with consideration of the pipelines' interior roughness.

However, the effects of corrosion and tuberculation buildup inside HSC pumps isn't so well known or documented. There isn't a "C-factor" measurement of a pump's interior roughness that can be used to calculate the effects of the roughness on pump performance.

According to the US Department of Energy, "Pumping systems account for



These two photos show the same pump nine years after coating. The coating was still in good shape, and the pump's performance had only fallen slightly from its post-restoration tests nine years before.

nearly 20 percent of the world's electrical energy demand and range from 25 percent to 50 percent of the energy usage in certain industrial and municipal plant operations." Therefore, any technology that produces even moderate gains in pumping efficiency can lead to massive savings in terms of worldwide energy usage and help reduce greenhouse gases.

COATING DURABILITY

Although field testing has shown some encouraging results of the benefits of sandblasting and coating a pump as an essential step toward returning the pump to its original manufacturer's specifications (Figure 1), one of the project's early concerns was whether the coatings would last. Above are field inspection photos of the inside of a pump that was coated nine years ago and has been in service ever since.

Two coats of the ceramic epoxy coatings had been applied to the inside casings of each pump coated. Although it'd been a little like painting with honey, which made it somewhat difficult to apply and control the thickness of each layer, each coat was generally applied in layers 10–15-mm thick. There were some cracks in the coating that didn't show up in the photos, but overall the coating was still in good shape, and the performance of the pump had only fallen slightly from its post-restoration tests nine years before.

SANDBLASTING ONLY VS. SANDBLASTING AND COATING

In addition to determining performance and efficiency increases from each step of the restoration process (mechanical refurbishment, sandblasting, coating, and in several cases, impeller coating), MCWA also compared sandblasting alone and sandblasting and coating. Staff wanted to test if the coating positively affected pump efficiency and performance or if the performance increases were just the result of eliminating internal roughness and tuberculation. Would simply sandblasting the pump be as good as sandblasting and coating?

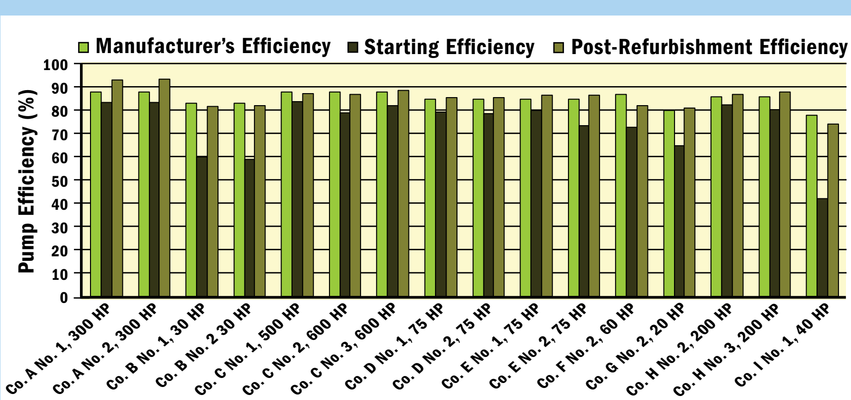
Three sets of identical pumps were selected for the comparison. One pump in each set was sandblasted and coated, and the other pump was sandblasted only. Post-restoration efficiency field testing results for the uncoated and coated pumps are shown in Figures 2–4 on page 19.

Figure 2 shows how initial pump efficiency of the two 20-hp pumps before restoration was about the same. However, the uncoated pump's efficiency after restoration consistently tested lower than the coated pump's. Although not shown in the figure, the uncoated pump's head and flow also have consistently tested lower than the coated pump's. Post-restoration testing of the coated pump hasn't shown a significant drop-off in efficiency. This would indicate a return of roughness in the uncoated pump that has resulted in lower efficiency from tuberculation buildup.

Figure 3 shows how initial pump efficiency of both 40-hp pumps more or less was the same. Post-restoration testing of both pumps indicates that efficiency of the coated pump was

Figure 1. Pump Efficiency Improvement

MCWA's pump coating program can result in efficiency and performance improvements that may exceed the manufacturer's published pump curve.



Applying a ceramic epoxy coating to the inside of an HSC pump significantly improves and maintains the pump's performance and efficiency.

8.8 percent higher than the sandblast-only pump. The uncoated pump's efficiency reduced 4.2 percent after two years of service, as shown in the post-restoration testing figure. The coated pump's efficiency declined less than 1 percent during the same time period. This suggests that corrosion and tuberculation buildup inside the uncoated pump is causing a decline in pump efficiency.

As shown in Figure 4, initial pump efficiency of the 60-hp pump to be sandblasted only was 2.8 percent higher than the initial pump efficiency of the pump scheduled for sandblasting and coating. However, after restoration, the coated pump's efficiency was 3.3 percent higher than the uncoated pump's (82.2 percent compared with 78.9 percent).

The uncoated pump's efficiency reduced 4.1 percent after two years of service, as shown in the post-restoration testing figure. The coated pump's efficiency declined less than 1 percent during the same time period. This suggests that corrosion and tuberculation buildup inside the uncoated pump is causing a decline in pump efficiency.

RECOMMENDATIONS

In short, applying a ceramic epoxy coating to the inside of an HSC pump significantly improves and maintains the pump's performance and efficiency. No one would buy unlined ductile iron pipe to be used in a municipal water system. Perhaps it's time to question the wisdom of purchasing unlined pumps as well.

MCWA has determined that sandblasting and coating should be part of any pump restoration program to increase pump performance and efficiency as well as reduce energy consumption. MCWA's goal is to prevent or at least significantly impede what seems to be the inevitable decline of pump performance with a corresponding increase in energy consumption during a relatively short period of time through internal corrosion and resulting roughness and tuberculation buildup.

Figure 2. 20-hp Pump Efficiency (Initial and Over Time)

Using three sets of identical pumps for the comparison, the first pump in each set was only sandblasted. The second pump was sandblasted and coated.

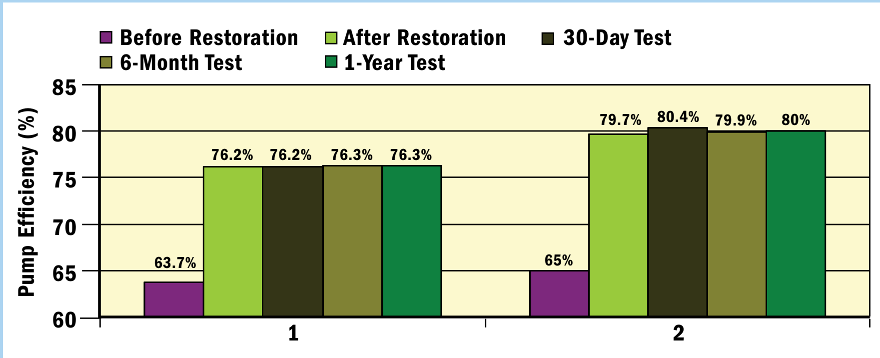


Figure 3. 40-hp Pump Efficiency (Initial and Over Time)

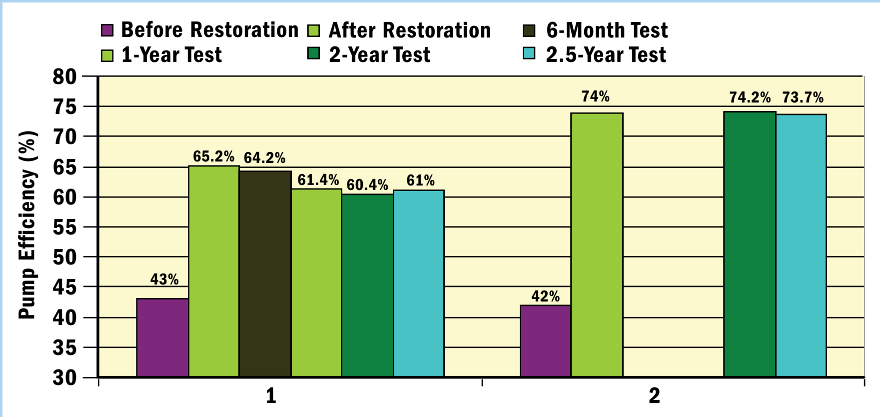


Figure 4. 60-hp Pump Efficiency (Initial and Over Time)