Waterworks saves energy

Results from a continuing study by New York's Monroe County Water Authority (MCWA) indicate that applying low-friction anti-corrosion coatings can restore pump efficiency to the manufacturer's new-pump specifications.

In addition to Monroe County, the Rochester-based MCWA supplies drinking water to customers in portions of four other counties, serving a total of more than half a million people. Demand averages 50 million to 60 million gallons per day.

The authority's pumps experience internal corrosion and rust build-up (tuberculation) in normal operation. The study revealed that cleaning and coating smaller horizontal split-case pumps yields significant efficiency improvements.

"We just couldn't believe it," says Paul Maier, MCWA water system analyst. "The results we got from lining pump casings with ceramic-filled epoxy coatings are encouraging news for water suppliers all across the country. Depending on pump size and usage, even a 2% increase in efficiency can pay back the cost of the coating and the labor to apply it in less than one year. In addition to lowering electric bills or increasing pump performance, these coatings may extend the service life of pumps.

Durability, of course, will be a factor in the long run — some of these coatings will last longer than others."

MCWA conducted the tests during 2004 and 2005 on five single-stage, double-suction, cast-iron, horizontal split-case pumps of less than 100 hp. Based on the encouraging results, the MCWA and the New York State Energy and Research Development Authority (NYSERDA) are jointly funding a test project to coat additional pumps and collect data during the next three years as part of the state's efforts to encourage the adoption of emerging or under-utilized energy-reducing products and technologies. MCWA engineers and maintenance technicians are now planning the next phase of the testing, which will monitor the effects of several coatings on the efficiency of larger pumps (1,500 hp to 1,750 hp).

MCWA engineers believe that reducing friction is the key to increasing pump efficiency. Without a good protective coating, over time, rust and corrosion produce a rough surface on the pump's interior casing so the pump must work harder to overcome efficiency losses.

Some of the pilot study's most dramatic results came from the MCWA's Moseley Road booster pump, a 75-hp Goulds Model 3405M with 5-in. suction, 8-in. discharge, and a 13.5-in. impeller. The MCWA maintenance department first dismantled and rebuilt the pump, installing new bearings, sleeves and wear rings. MCWA contracted with a local shop to sandblast the pump casing to achieve a white-metal finish (SSPC-SP5).

Next, two products from Devcon (www.devcon.com), chosen by the MCWA for their surface-friction coefficients, shear strength, cavitation resistance, immersion characteristics and overall corrosion-prevention properties, were applied to the freshly prepared casing. Devcon Ceramic Repair Putty was used to fill voids to a uniform surface profile, then two coats of Devcon Brushable Ceramic, which is certified for potable water applications, were applied.

The ceramic repair putty is a durable alumina-filled epoxy compound that repairs and protects worn metal by filling voids and curing to a hard, durable surface. The brushable ceramic is a precision-repair epoxy coating engineered to form a smooth, long-lasting protective barrier against wear, abrasion, corrosion, cavitation and chemical attack. Easily applied with a roller or short-bristle brush, it seals and protects new surfaces and reconditions old ones, improving the performance and longevity of pump casings, impellers, valves, tanks and other critical equipment. MCWA tested other brands of coatings on four other pumps, but variations in the size and condition of the pumps rule out definitive comparison between coatings with respect to their ability to increase pump performance.

The Moseley Road pump lined with Devcon coatings showed significant efficiency gains (see figure). Its efficiency increased by approximately 18% (from about 64% to 82%) as a result of mechanical refurbishment and the cleaning and coating efforts. Based on prior experience, MCWA estimates that at least half of this total increase in pump efficiency was attributable to the cleaning and coating efforts, while the other half came from mechanical refurbishment.

The flow, head and efficiency of the Devcon-coated pump were all restored to the manufacturer's new-pump specifications. In other words, after cleaning and coating, the pump was as good hydraulically as when it was new. When the MCWA tested the pump's efficiency approximately six months after commissioning, it showed no measurable decline.

For two of the five pumps in the pilot study, the MCWA crew replaced the bearings, sleeves and wear rings, but reassembled the pump without removing the interior rust buildup. Before sandblasting and coating, the crew then monitored the pump performance (suction, discharge, flow and power consumption) to compare energy efficiency with pre-rebuild readings and to establish a post-rebuilding/pre-coating baseline. This is the only way to quantify how much of a pump's total performance improvement is from rebuilding and how much is from coating. After several weeks, the pumps were again disassembled, this time for sandblasting and coating. While this type of baseline wasn't established for the Moseley Road pump and two others, one of the two pumps for which this baseline was established (Woodcliff Station) showed an overall 25% efficiency increase (11% from rebuilding and 14% from sandblasting and coating).

Forthcoming tests on the MCWA's larger pumps promise to be more scientific, as they will all be done with a post-rebuilding/pre-coating baseline.

Thanks to power monitors purchased and installed under an earlier load-shedding grant from NYSERDA, the MCWA is able to measure energy use in for individual pumps in real time. MCWA engineers had thought the demand portion of the electric bill for many pump stations was higher than it should have been, and they suspected that part of the reason was poor pump efficiency. But without the monitor, they were unable to accurately calculate a pump's efficiency in the field.

"We never thought that roughness of internal pump surfaces could be costing us so much money, so we couldn't justify the material and maintenance expense of cleaning and coating pump interiors," Maier says, "and there was very little information available documenting the effects of internal corrosion on a pump's overall efficiency. However, once the monitors were installed, our engineers began measuring the actual field efficiency of a pump and comparing it with the manufacturer's specified efficiency. After running tests on pumps in our distribution system, our engineers were shocked to find that many were operating 15% to 25% below the manufacturer's specifications.

"Obviously, the more you run a pump, the more electricity it uses, and the more you're going to benefit from increases in efficiency," Maier adds. The pumps selected for the pilot study were chosen because they needed mechanical work, not because they were large energy users. MCWA engineers didn't want to start with the larger, heavier pumps because of the extra labor involved. However, considering the significant improvement in pump efficiency achieved on smaller pumps in the pilot study, MCWA engineers are now excited that they may achieve similar improvements with their larger pumps where most of their energy dollars are spent.

It will be several years before the MCWA has data on the larger pumps (greater than 1,000 hp), but the authority is encouraging other municipalities to perform similar pump coating experiments. After extensive research, the MCWA has concluded that pump manufacturers and users have largely ignored corrosion-caused decreases in pump performance. Maier hopes that other water suppliers who don't have the resources to conduct their own testing will rely on MCWA results and begin coating their pumps.

Based on test results thus far, the MCWA is convinced that cleaning and coating pump interiors saves money. Because the horizontal split-case pump is one of the most commonly used in water distribution systems, MCWA results should be indicative of the potential for savings at other water authorities. The beauty of pump cleaning and coating is that it doesn't require sophisticated tools, equipment, expertise or training. Maintenance employees in even the smallest municipalities have the skills necessary to pull these pumps apart, clean and coat them. For municipalities without sandblasting equipment, the local auto body shop probably has sufficient capability. Coating pumps isn't hard to do, and based on MCWA's results, it appears to be well worth the effort.

For more information or an update on the MCWA's pump coating initiative, contact either Paul Maier or Chris King of the Monroe County Water Authority at paul.maier@mcwa.com or chris.king@mcwa.com.