By Thomas J. Day

Steps to improve performance and save money

Metering Pump Optimization to Reduce Operating Costs

Expensive and fluctuating power costs have forced water utility plant operators and management to re-examine the power requirements for every facility worldwide. This is because pumping is the second largest expense for a water facility and in any process industry.

Even with phase correction and properly implemented cycling in a facility, the overall efficiency of a pumping system is generally overlooked. This article takes a new look at optimization through the model of a small chemical metering pump dosing system, describes optimization techniques and outlines the costs experienced through an ineffective system. Recommendations are provided for optimizing the system.

The same considerations can then be scaled up to large pumping systems to show that the same method is applicable. This allows for focused training considering the basics of pumping systems and capitalizing on the functional similarities found in them.

The High Cost of Inefficiency

The renewed effort to remove costs from water processing has focused on the costs associated with pumping. Of all costs associated with a water utility, the second highest is electricity (labor being first). However, if most of the electricity in a facility is consumed in pumping operations and there is a labor component as well as a materials component, it is easy to deduce that pumping is really the second largest cost item at any given facility.

The U.S. Department of Energy has determined that approximately 10% to 40% of all power consumed is by pumping systems.

This makes sense if the reviewer considers the extent and nature of pumping operations.

In a water utility, the pumping process involves the shifting of water from one part of the plant to another, in and out of tanks and flow-through for chemical or other select treatments. If the water was not moved, there would be no treatment afforded to the conveyance. Seeing that the entire process of water treatment involves pumping, and all the pumps are electrically driven, it makes considerable sense to focus on the optimization of a pumping system to achieve power savings and reduced costs.

In examining the process stream, there are many types of pumps distributed throughout the treatment system, including large-capacity pumps that move large quantities of water into and out of treatment zones. There are small pumps to provide exact amounts of chemical into the process stream to treat the water. There is also an array of pumps for secondary and auxiliary functions related to the process (i.e., filter backwash). What becomes apparent is that there are some basic similar components among all these systems that vary only by size: pumps, piping and accessories. Considering only these common components, a study of optimization of the pumping system can yield positive and tangible results.

Visual Inspection of the System

In most cases, the process of a given facility was inherited by the managers and operators, or it was installed based on conditions of a given historic time period. Maintenance personnel are excellent at keeping the systems operational. What appears to be missing is the continual review to ascertain if changing conditions within a given footprint or facility are affecting the process loop, or if the original design agrees with current conditions. A visual inspection of the system, or “walking” the system, can yield significant information concerning a metering pump in operation and the resources it takes to maintain efficient operation.

Figure 1 contains a very idealized version of a generic process with chemical dosing attached. The number of bends in the pipe is minimal and there is a straight run for the chemicals to be injected. Most of the time, this is far from the case in a given facility.

Bends and changes in pipe elevation have significant impact on the overall performance of the pump. Changes made to pump piping can significantly affect the energy, or head, within a given pump system.

Therefore, if mechanics replaced pipe under emergency conditions, there is a significant chance that the head pressure has changed, causing the system to become unbalanced. Much of this can be identified by simply comparing the original drawings to the current piping network.

Some rules of thumb follow when inspecting the piping network attached to the metering pump. These include:

- Be sure that the suction pipe of the pump is at least one size (pipe diameter) greater than the suction fitting.
- Ensure that there are no bends or turns in the piping at least 10 pipe diameters leading to the suction side of the metering pump.
- Ascertain that any bends within the system are necessary (minimal amount).
- Identify any pipe runs more than 10 to 20 ft on either side of the system.

These four major but simple issues can cause the metering pump to require twice the power to operate. The same can apply to the entire pump system network.

The Quick Correction

When the rules of thumb identify one or several of the four points above as a situation, the following steps can be used to decrease the strain on the pump:

- Increase the size of the suction piping to account for starved suction using a net positive suction head (NPSH) calculator. A suitable one can be found free at www.miltonroy.com for download.
- Reduce any bends in the pipe that can increase the potential for system acceleration losses.
- Identify any significant changes in the piping network since the original installation.
- Use a standpipe or other similar device at the pump suction to reduce the suction strain when suction-starved conditions appear as a result of insufficient NPSH.

These are targeted to metering pumps, but the same philosophy can be applied to the entire pump network.

Cost Savings: The Bottom Line

To show how quickly this can add up, consider the metering pump using a single 1-hp motor that is 85% efficient on 115 VAC and 60 Hz power. Modeling purposes show this motor costs approximately $400 per year to operate considering 24/7 operation at 10 cents/kWh. This figure varies by...
location and tends to be higher because of transmission costs and other added fees.

If a pump is starved, it will require twice the horsepower to operate. This means that the pump that would ordinarily require $400 per year now requires a 2-hp motor and costs $800 per year. This occurs when the mechanic says there is simply not enough torque on the pump for the operation and spends the initial $250 for the 2-hp motor; now perhaps the system operates minimally well but at twice the cost and an increased one-time capital charge. By identifying the root of the problem, the starved suction, there could have been a cost savings rather than an increased cost. It may have cost the mechanic $250 in materials to install a standpipe, but the pump strain would have been relieved and $400 saved annually.

This does not sound like much, but consider that there are numerous chemical dosing systems within a given facility. It will not take long to accumulate several thousand dollars in increased costs. Expand this concept further to larger pumps; one could then consider reducing the large-horsepower motors to smaller motors and save power that way. This review of pump systems can provide significant cost savings in long-term operating costs and significant targeting of one-time capital expenditures.

System Optimization: The Cost Saver

The lessons learned in a metering pump system optimization can easily be translated into an entire pumping network by following the rules of thumb and identifying significant changes deviating from original design. Also, the original design may not be applicable based on changes within the physical footprint of the building over time. Walk your systems and inspect them to identify areas that appear difficult or may cause issues with the pump. Remember that the pump is only as good as the system that contains it. Also consider that the improvement techniques applied to a chemical dosing system can easily be translated to an entire pumping system, providing significant cost savings.

Article references are available online at www.wwdmag.com/lm.cfm/wd040803.

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