Peristaltic PERFORMANCE

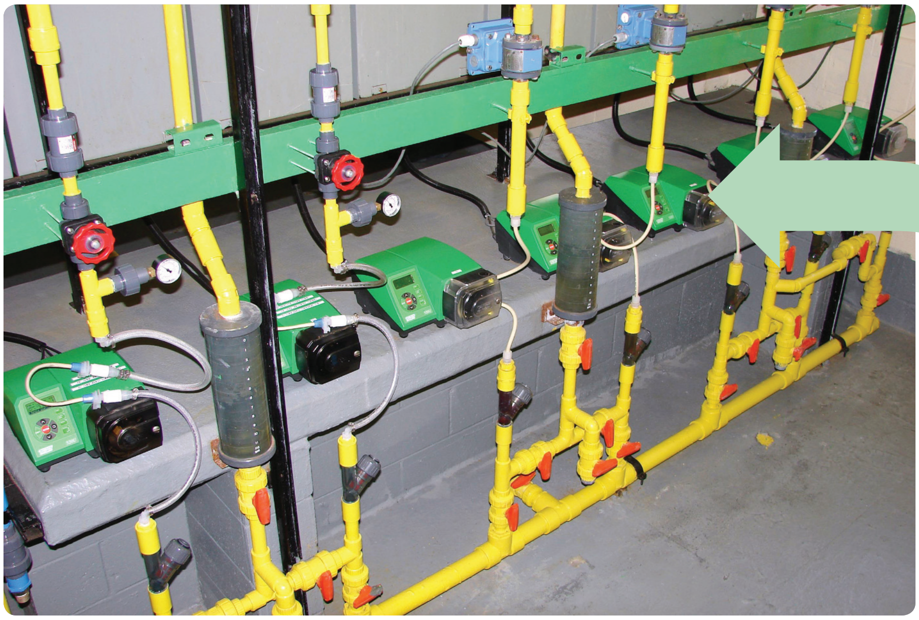
By Chuck Treutel

For years, the diaphragm pump has been the traditional pump of choice for chemical feed and chemical metering applications. Its popularity in these applications, as well as numerous others, is unquestioned. Diaphragm pumps fall into the larger class of positive-displacement pumps, which cause a liquid or gas to move by trapping a fixed amount of fluid and then forcing, or displacing, that trapped volume into the discharge pipe. Diaphragm pumps, along with progressive cavity pumps, make up a majority of the positive-displacement category.

Off-Gassing Interferes

However, chemicals used in these applications, such as sodium hypochlorite and aqueous ammonias, tend to off-gas. When they do, they will vapor-lock the diaphragm pump—that is, the diaphragm moves in and out but does not actually pump anything.

The Holland Board of Public Works (HBPW) in Holland, Mich., witnessed this problem firsthand. A municipally owned utility, the company provides electricity, fiber optics, water filtration and wastewater treatment to the city of Holland as well as neighboring Lake Town and Park



PERISTALTIC PUMPS HELP A MICHIGAN FILTRATION PLANT CLEAN UP ITS WATER ACT

Township. When the plant was constructed, it was decided that the industry-standard diaphragm pumps would be the preferred devices.

"We were having some problems with the off-gassing on our diaphragm pumps," said Jim Van De Wege, manager of the HBPW water plant. "The off-gassing, which is indigenous to sodium hypochlorite, was binding up the pumps. Plus, the configuration we initially had with all the threaded joints caused numerous leaks, and we were constantly changing the seal kits."

Like their progressive cavity counterparts, diaphragm pumps incorporate moving parts that come into contact with the material being processed, so wear and tear is inevitable. The amount of wear and tear experienced is largely a result of the flow rate, as well as the abrasiveness, corrosiveness and viscosity of the material being moved.

"We also had trouble getting them started," Van De Wege said. "We were always changing oil, and there were other maintenance issues. It became apparent that the diaphragm pumps would not be a suitable long-term solution for us."

This tenuous pump situation was obviously not acceptable for HBPW, a plant responsible for the pure-water needs of such a large area. The operation is particularly impressive; the HBPW water plant draws in an average of 13.2 million gal per day (mgd) of freshwater from Lake Michigan, which is transformed into potable water for slightly more than 50,000 people in Holland and the two aforementioned townships. The 38.5-mgd-capacity plant is located seven miles northwest of the city of Holland, with an intake crib located 4,500 ft out in Lake Michigan.

Providing the public with clean, usable water is no simple task. It is a carefully orchestrated process of acquisition, purification and distribution; the retention time of the water within the plant can be anywhere from 8 to 20 hours. The actual treatment of the water is a particularly sophisticated procedure, requiring the use of pumps at various stages to provide the necessary disinfectant (e.g., carefully measured amounts of sodium hypochlorite). If the pumps stop working and the sodium hypochlorite is not injected properly, the water quality will be drastically affected.

Searching for a Solution

Van De Wege explained that HBPW had experimented with some redesigned diaphragm pumps that claimed to offer improved off-gas properties. Some diaphragm pump manufacturers, recognizing this inherent vapor-locking problem, have added special degassing valves to their design in an attempt to alleviate this problem. Van De Wege even tried a retrofit off-gas valve, but he found this was not a viable option.

Eventually, Van De Wege was introduced to peristaltic pumps for chemical metering applications. Also referred to as hose or tube pumps, peristaltic pumps address the issues of wear and tear, clogging and off-gassing with a mechanism that is considerably different from other positive-displacement pumps. As a result, peristaltic pumping is increasingly displacing more complex and higher-maintenance positive-displacement pumps as the optimal process for chemical metering.

Based on the physiological principle of peristalsis, in which muscles alternately contract and relax around a tube to induce flow within it, the peristaltic design utilizes a rotor that remains outside the pumpage zone. As a result, the pump's rotor never actually touches the product being moved. Erosion of the rotor is virtually nonexistent, and clogging is rarely, if ever, an issue.

Peristaltic pump operation is elegantly simple. Fluid is drawn into a pump, trapped between two rollers and expelled from the pump. In a peristaltic pump, flow is proportional to pump speed, and the complete closure of the tube element at all times gives the pump its positive-displacement action, preventing flow drop or erosion from backflow and eliminating the need for check valves. Without check valves, peristaltic pumps eliminate the primary source of metering inaccuracy and will not vapor-lock.

Diaphragm pumps have internal valves that can stick, clog and not seat correctly (due to corrosion of the ball or seat), causing variation in flow that can jeopardize water quality. In addition, chemicals that have entrained gasses like sodium hypochlorite can vapor-lock diaphragm pumps, completely stopping flow.

The ability to pump mixed-phase fluids efficiently and to run dry makes tube pumps ideal for metering or transferring off-gassing fluids, particularly the sodium hypochlorite so prevalently used in the HBPW system. Peristaltic pumps also do not require the ancillary equipment commonly used with other positive-displacement pumps, such as double-mechanical seals, seal water flush systems, run-dry protection systems and inline check valves, further reducing their cost of ownership.

When replacement of a tube element is required, the procedure takes only a couple of minutes. Additionally, the change of the element is done quickly and safely where the pump sits, without the need for special tools. This is significantly less than the four to six hours typically required for rebuilding a diaphragm or progressive cavity pump (not including the additional time for pump removal, transit to and from the maintenance shop and reinstallation). Replacement tube element costs are extremely economical compared with the price tag for rebuilding a diaphragm or progressive cavity pump, in which wetted end replacement parts like ball valves, diaphragms, rotors and stators can cost up to 75% of the pump's initial purchase price.

HBPW's high-pressure, SCADA-ready peristaltic pumps feature flow rates of up to 7.1 gal per hour at 100 psi constant pressure; brushless DC motors; a 2,200:1 turndown; and NEMA 4X enclosure with washdown protection for harsh conditions.

In the HBPW system, the initial point where the peristaltic pumps are utilized is just past the intake water's point of entry. A bank of four pumps serves up the main disinfectant into the water as the primary rapid mix to begin the purification process. According to Van De Wege, the first four pumps are integral to feeding the plant's zebra mussel control system. This is a particularly critical stage; zebra mussels are a terrible nuisance, growing dense enough to block pipelines and clog water intakes of municipal water supplies and hydroelectric companies.

Three additional peristaltic pumps can provide additional disinfectant as needed at points further down the line. HBPW also sometimes adds aluminum sulfate to the water for purposes of coagulation. All of this material gets added in the plant's primary rapid mix, after which it is distributed to the plant's four settling basins. From there, it is sifted through 10 multimedia rapid sand filters before traveling to clear wells and then into the towns or to onsite storage facilities.

If HBPW needs to increase the chlorine residual at any point in the process, the additional pumps may be activated either to the secondary rapid mix or to the high-service line to boost the final chlorine residual. Van De Wege said that they also have the ability to add the compound at the secondary rapid mix and in the plant's high-service distribution line.

Two more peristaltic pumps are used later in the process for the fluoride feed system. Having the two pumps in conjunction provides a necessary level of redundancy. In the past, peristaltic technology was limited to low-pressure applications, and the pumps originally used by HBPW could not exceed 30 psi. Since that time and with the development of new high-pressure tubing technology, the plant has acquired peristaltic pumps capable of satisfying the high-service line's 80- to 100-psi requirement. The peristaltic pumps are set for various flow rates, depending on the point in the system where each is located.

Because the water flows will increase from 8 mgd in the winter to 30 mgd in the summer (based on the sprinkling load demand), the peristaltic pumps' huge flow range is a major advantage. Instead of buying two or three diaphragm pumps to cover the wide flow range, it is now possible to buy one peristaltic pump that, in some cases, can cover a 1,000,000:1 flow range.

An important element of HBPW's

peristaltic pumps is that they are SCADA-ready and feature both manual control and flow rate calibration.

It is no secret that water filtration plants are an attractive potential target for terrorists; consequently, the security aspect of the pumps cannot be overstated. The majority of water plants in the U.S. today are safeguarded with fences, gates, locks and in some cases, security officers. The peristaltic pumps at HBPW add an extra level of protection, as operators can put in a security code and a PIN number, effectively locking down the pump from unauthorized use.

Ultimately, according to Van De Wege, the peristaltic pumps have made a huge impact on the HBPW operation and the personnel that employ them. "Our people love them because they're extremely easy to maintain," he said. "We change the tubes just on principle every 30 days at the beginning of the month. We don't have to change the oil, the seal kits or the balls. Our operators also like the fact that they're so effortless to use and program. Actually, we like them so much, our power plant is planning on converting all their pumps to peristaltic."

This kind of performance is also why a majority of U.S. water filtration pumps are migrating to peristaltic pump technology. Its advantages are powerful, the lower total cost of ownership versus diaphragm pumps is well documented and it helps keep the water in places like Holland as fresh as it can possibly be. WWD

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