The Magazine For Pump Users Worldwide
PUMPS & SYSTEMS®

Diaphragm Pumps Ideal for Water Treatment & Reuse

Jim Carling Published September 2015

These pump types offer longevity, precision and minimal maintenance even when dealing with the harshest treatment chemicals.

Water is one of our most precious resources and—in drought-stricken areas such as California—is becoming more precious with each passing day. The metering pump plays a key role in treating water to make it suitable for reuse or disposal. Depending on the processes and chemicals required for treatment, hydraulically or mechanically actuated diaphragm (HAD or MAD, respectively) metering pumps may be the best option.

Pumping Options

Municipal wastewater plants engage in various treatment activities from removing solid material such as sludge and sediment to dissolving suspended organic material such as nitrogen and phosphorus to disinfecting water by killing disease-causing microorganisms.

The processes used to clean water also vary widely depending on the intended use of the final product. Drinking water requires more intensive cleaning than industrial process water or water that is to be reused for irrigation.

Each process involves a series of steps, including coagulation and flocculation, pH control, de-chlorination, chemical precipitation and oxidation, ion exchange, chemical neutralization and stabilization, and taste and odor control. Each step requires an assortment of chemicals that are used in different combinations until the desired water standard has been achieved. Several types of pumps can be used to meter the correct dosages of the chemicals used in these processes.

The two proven technologies that continue to dominate the industry are HAD and MAD metering pumps.

Benefits of HAD Pumps

The HAD metering pump is a field-tested design that has been around for decades, and it is built to last just as long. HAD pumps have been proven to handle the most aggressive chemicals at the full range of flow rates required in a treatment process.

The HAD liquid end has a Teflon diaphragm, which acts as a barrier between the piston and the process fluid. The piston's pumping motion is applied to hydraulic fluid, which causes the diaphragm to flex back and forth as the piston reciprocates. The HAD operates with equal pressure between the hydraulic and process fluids, eliminating diaphragm stress, because the pressure is essentially equal on both sides at all times.

This balance contributes to the longevity of HAD pumps. With other types of diaphragm designs, the tube or diaphragm contains the pressure. With no pressure on the non-process side, the pressure is unbalanced and the diaphragm (or tube) must withstand all of the process pressure. With an HAD pump, however, the diaphragm is balanced between two pressurized fluids and remains under low stress. None of the moving parts in the pump gets stretched or compressed, resulting in longevity—up to 96,000 hours—and minimal maintenance.

While the fundamental design elements of HAD pumps have been around for decades, they continue to evolve. Today's pumps feature advanced diaphragm materials, efficient hydraulic system designs, enhanced control interfaces, various motors and variable speed drives, electronic capacity adjustments for remote control, increased turndown (up to 1,000-to-1), and advanced technology diaphragm leak detection systems.

The single biggest pump issue operators face during water treatment is vapor locking. Gas bubbles from chemicals such as sodium hypochlorite can form in the head of the pump. Unless they are removed, the pump will compress the gas, clog the pump and prevent the chemicals from doing their intended job. Because treatment plants run large-scale operations with high-duty cycles over long shifts, ensuring continuous and accurate distribution of chemicals is critical.

Properly selected HAD metering pumps eliminate the problem of vapor locking by ensuring high fluid velocity through the pump head. Front-scavenging technology on the diaphragm evacuates the entire liquid end with every stroke, cleaning it out and evacuating the head so that air bubbles cannot accumulate and create vapor lock.

In addition to increased longevity and minimal maintenance, HAD metering pumps provide a long-term return on investment (ROI). According to Marc Sanchez, vice president of Cortech Engineering, a California-based distributor and solutions provider of pumps and process equipment, numerous ROI examples demonstrate the value associated with HAD metering pumps.

"Our customers are large municipal water treatment plants that process enormous volumes of water and wastewater on a daily basis," Sanchez said. "The cost of downtime vastly exceeds the incremental cost of the pump, and the peace-of-mind that comes from not having to worry about repairs or extensive maintenance can be priceless. Also, with a life expectancy of up to 30 years for the pump and a 10-year life on the hydraulically actuated diaphragm, it's easy to stand behind this technology. We install it. We let it run, and many customers will go more than a year before they even need to think about routine maintenance."

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Benefits of MAD Pumps

MAD metering pumps have been specifically designed for the water treatment industry, with features geared toward lower pressure environments than those in which HAD pumps operate.

Mechanically actuated pumps operate with a plunger directly attached to the diaphragm. The direct attachment of the piston to the diaphragm connects the pump's drive and motor to the liquid end, and the motion of the pump drive moves the diaphragm back and forth. This action causes suction from the supply tank, which pumps fluids through the conveyance infrastructure. MAD designs are suited for pressure peaks near 175 pounds per square inch (psi). The maximum life of the pump is achieved by replacing the diaphragm at recommended service intervals. As with any chemical that could cause gas binding, a degassing valve is recommended to release off-gases from the agitation or pressure changes experienced by a liquid that has off-gas characteristics. Like the HAD design, MAD metering pumps offer the same features that address vapor lock and ensure consistent, accurate delivery of chemicals.

For added assurance that the pump is operating as expected, an air-filled chamber on the drive side of the liquid end facilitates leak detection.

Because many of the chemicals used in water treatment are hazardous, a leak-free environment is required. Liquid ends (which come in contact with the process fluids) are designed to be leak-proof and highly durable. In some applications, a redundant, double-diaphragm rupture-detection system can further protect the pump from hostile chemicals and contamination by hydraulic fluids. This system consists of two separate diaphragms, a hollow intermediate ring and a pressure gauge. During normal operation, the two diaphragms are pushed tightly together and are separated only around their outside edge by the intermediate ring. The rupture-detection system senses pressure only when a diaphragm ruptures. Otherwise, the system is not affected by changes in pump discharge pressures.

Turndown in Water Treatment

Traditionally, metering pumps were limited to a turndown ratio of 10-to-1 while maintaining accuracy. One manufacturer broke that barrier almost 30 years ago with a design that increased turndown tenfold to 100-to-1 through variable speed technology controlling the pump's output. Although many pumps today boast similar capabilities, users must discern between standard turndown claims and turndown with steady-state accuracy.

Turndown is important for water treatment because the volume and quality of the incoming water varies on a regular basis. For example, treatment plants located on rivers deal with storms that can dramatically alter conditions.

These conditions can result in different levels of mud and accompanying sediment, which requires a significant increase in coagulant dosage to remove the resulting turbidity. Under normal operating conditions in applications like this, metering pumps routinely operate in the low end of the wide turndown range and still need to repeatedly provide ± 1.0 percent accuracy at any capacity setting.

Regardless of location, seasons also play a role in requiring turndown flexibility. Seasonal changes can alter influent water quality and impact chemicals such as sodium hypochlorite, which loses concentration more quickly in higher temperatures.

Both HAD and MAD pumps offer a variety of turndown ratios as a standard. With the addition of variable frequency drive (VFD) technology and remote stroke control, turndown as high as 1,000-to-1 with precise, steady-state accuracy can be achieved.

End users have a variety of choices that offer unique advantages. In one corner, the HAD design offers the longest life and the smallest maintenance requirements with performance that exceeds requirements in the water treatment industry. And in the other corner, MAD-designed metering pumps offer the same performance and accuracy, targeted toward lower-flow requirements.

Regardless of the design, the metering pump must deliver the performance, accuracy, reliability and simplified maintenance needed to meet today's water treatment challenges.