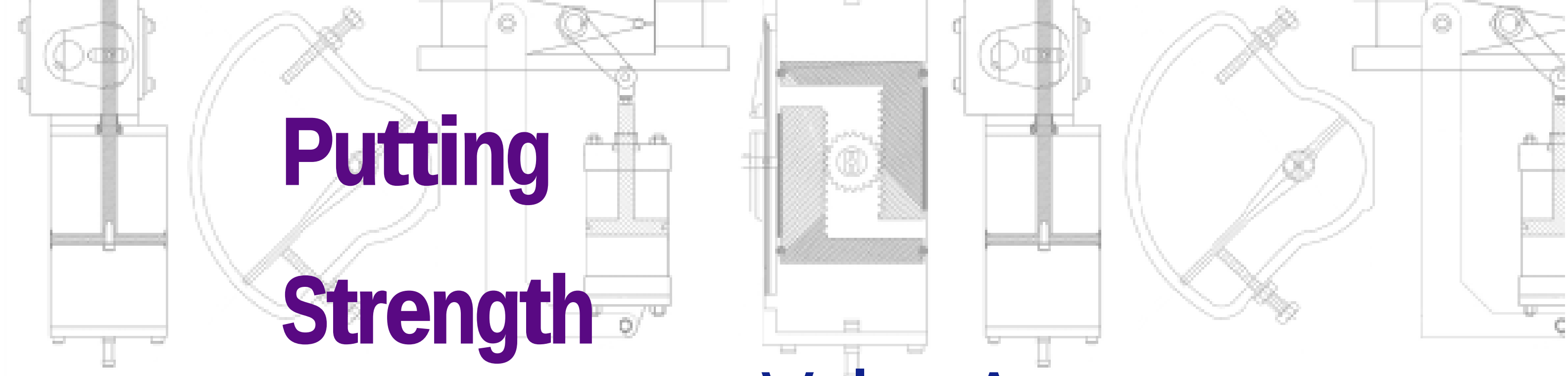


Putting Strength in Filtering Operations: Valve Actuators for Water Works Plants

By Fred Underwood

Summary: *Due to stricter government regulations, water plants are required to meet certain conditions regarding their operations. None is more crucial than the filtering process. Realizing many of these systems are antiquated, the importance is heightened with valve control. One company has explored some mechanical options with valve actuators.*

Few valve manufacturers make the mounting hardware for retrofits. One company sends its experts out into the field to help facilitate the installation process. Factory personnel or the qualified representative do the survey on the valve and return to the factory with the dimensions and recommended actuator sizing. The mounting plate is then fabricated, set up and tested with the actuator. This process also includes the correct control module to interface with the plant's existing PLC, SCADA or even older pneumatic systems. The actuator is then shipped to the plant with the correct valve-mounting kit.

Under pressure from recent mandates of the Safe Drinking Water Act (SDWA), water works engineers and plant managers are now forced to scrutinize all elements of their potable water treatment operations, and none is more important than filtering. Water leaving this point must fall within strict turbidity levels. Over the past decade, much attention was directed at plant control systems to achieve these levels. Like putting a dashboard from a new Cadillac in a Model T, harnessing these modern systems to antiquated valve actuators yields little gain if precise valve control can't be reproduced reliably.

In recognition of this, water works engineers are now turning to a new generation of pneumatic valve actuators up to the task of executing instructions of electronic control systems with the necessary precision to accurately control effluent flow. Surprisingly simple but rugged in construction, this new breed of actuators also meets the need to reduce downtime, and some of the first ones to debut in 1981 are still in operation without needing a spare (new) part. A cost-savings factor of up to 40 percent compared to electric actuators also explains the widening acceptance of new pneumatic actuators by plant engineers and managers faced with the responsibility of delivering potable water at a cost-effective rate.

Need to control filtering

The search for simple, accurate and reliable valve actuation has been prompted by the increasingly stringent mandates of the SDWA, which calls for turbidity levels of 0.3 nephelometric turbidity units (NTU) or less. Since filtration is typically the final step (before storage) in most water treatment operations, any water leaving the filtration process should be well within turbidity limits. Hence, any efficiency gains in filter operation will help plant operators not only meet federal clean water requirements, but also help reduce plant operating costs.

With the introduction of modern plant programmable logic controllers (PLC) and supervisory control and data acquisition (SCADA) systems, recommended process controls are already in place. Despite these gains, archaic valve actuation remains the weakest link in filtering operations.

Accurate valve control

Only certain conditions can achieve lower turbidity, and an important one is accurate valve control. Valves with actuators receiving commands from the filter control system to properly execute the backwash option are pivotal in the process. If the effluent valve doesn't shut off, backwash water containing the solids removed by the filter media will flow into the clear well. Plus, the measured turbidity levels will exceed the mandates. Actuators must operate the valves so they're precisely closed. There's no point in having the best PLC system if the actuators it controls aren't executing instructions accurately and reliably.

Since mixed-media filter performance is affected significantly by hydraulic characteristics, accurate valve control begins at the point of bed loading. Typical loading rates range from 2-8 gallons per minute (gpm) per square foot of filter bed surface area. These rates must be carefully metered by the effluent valve because as the filter bed becomes dirty and clogged with solids, the resistance to flow rises.

When the filter media is fresh and clean it will pass more water than the specified design gpm, so you must close the effluent valve to the point where it only allows the flow rate designed for the filter media at that time. Turbidity meter, or headloss, differential pressure transmitter instrumentation (DP or ΔP) tracks the levels and determines the most appropriate time to trigger a backwash. Accurate valve actuation allows the PLC or SCADA system to maintain the correct flow rate until such time.

As the media gets dirty near the end of the filter run and the filter becomes clogged, the effluent valve needs to open more. Ultimately, flow will cease when the resistance to flow is greater than the gravitational force compelling it. As the "head" (hydraulic pressure) increases, solids' particles are pushed further into the media bed. Solids will be driven completely through the bed and appear in the filtered water. Turbidity levels will increase and the filter controls will shut down the process.

Consistent flow

Performing a backwash prevents high turbidity levels, but it's an expensive and time-consuming process. That filter is out of commission during the backwash process, and it must use potable water that you just spent on cleaning. The key to operational efficiency is to keep the flow at exactly the right levels and backwash when necessary, determined by the filter control system and carried out by the actuators.

The quality of the backwash process itself relies on proper valve actuation. The inlet valve that feeds water from the clarifier to the filter is closed. At the other end of the filter, the effluent valve that transfers water to the clear well must be closed. When the backwash water and air is pumped underneath the media, it must only be diverted through the drain valve and returned to the recycle, or holding, pond.

Reliability is extremely important. If the filter effluent valve actuation fails during a backwash, then you end up with a leakage of the backwash into the potable water stream. This results in non-compliance turbidity problems. You can even disrupt a filter if you open a flow rate backwash valve too quickly. The valves must be ramped up at the right speeds at the right position, and then held there during the entire process.

Because valve control accuracy and reliability play such an important role throughout all filtering operations and meeting federally mandated turbidity levels, many older plants are currently involved in plant improvements and controls upgrading. In most instances, the original pipe galleries and valves will remain in place; however, a new control system is usually the first step to be implemented. This changeover immediately requires new actuators that interface with modern control systems. Still, until recently, electric actuators were the primary ones that came equipped to interface with the first electronic control systems.

Ills of electric actuators

In comparison to the replaced hydraulic or pneumatic cylinder power actuators, electric actuators seemed to be the only solution at the time. The first actuators were water-actuated cylinders fixed to the back end of a mounting plate, and had a lever on the cylinder shaft to push and pull the valve open and closed. Still, it wasn't easy to mount input controls and feedback mechanisms onto this crude device to interface with the new control systems, thus the progression from cylinders to electric actuators.

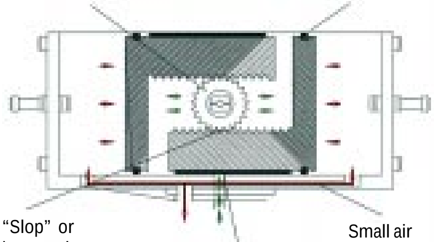
It didn't take long for the shortcomings of electric actuators to become apparent to water treatment plant operators—especially the repair and maintenance staff. The easily understood, piston-actuator problems could be diagnosed and repaired by in-house maintenance personnel, but not so for the more complex electric actuators.

Reciprocating pneumatics

Completely sidestepping the inherent problems of electric actuators, today's pneumatic actuators offer simple and reliable performance at a cost-effective price. Of course, certain mechanical insufficiencies inherent in the design of all reciprocating-cylinder actuators prevent them from meeting the precise control needs of today's water treatment plants.

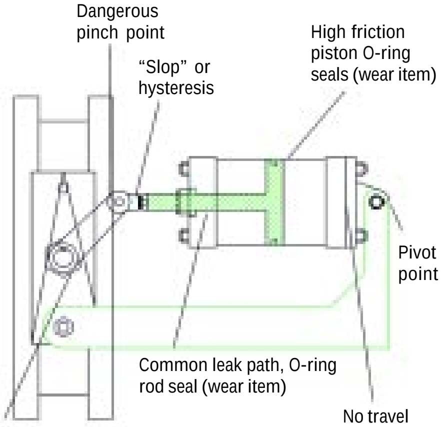
For example, rack-and-pinion designs suffer from a common leak path at the O-ring shaft seals that are subject to wear. The high-friction O-ring of the piston is also subject to wear and tear. Side-load compensation pads also wear over time. Collectively, these items dictate regular maintenance, and thus more plant downtime (see *Figure 1*).

Figure 1. Rack and pinion design



Typical piston actuator designs are also subject to heavy side load on the valve shaft. There are no travel adjustments and the design introduces unnecessary hysteresis—slop or play that occurs during the conversion of linear motion to rotary motion—which greatly affects accuracy and accelerates wear. These actuators also require the periodic replacement of their high-friction, piston O-ring seals. Additionally, it's difficult to mount the control components that interface with the PLC or SCADA control system (see *Figure 2*).

Figure 2. Piston actuator design



The scotch yoke actuator—an actuator that translates linear motion to rotary motion—design features more working parts, and is typically too large to fit into the cramped quarters of the filter pipe gallery. These actuators also require maintenance of their piston-ring seals (see *Figure 3*).

Figure 3. Scotch yoke actuator design

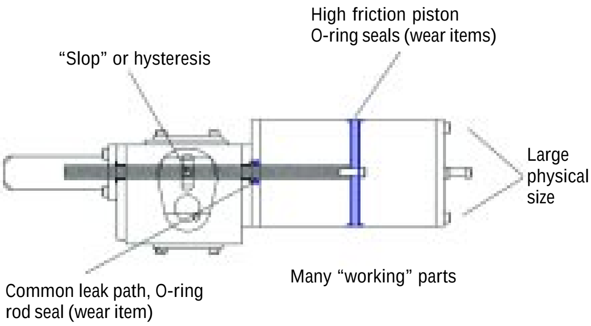
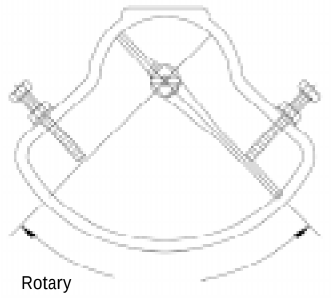


Figure 4. Actuator design



- Constant torque output
- No "slop," gears, levers or pinch points
- No O-rings to leak
- Simple, accurate and reliable
- Small "torque-to-size" ratio
- Low friction, smooth operation

A simple, new option

Rotary actuators were first introduced to the United States from Europe in the early 1970s. These rotary actuators meet American Water Works Association (AWWA) standards and have become a new option of choice for new facilities as well as plant upgrades.

The majority of this newfound success stems from the actuator's simple design, which utilizes only one moving part. By scribing an arc, all torque forces directed to the valve remain constant from fully open to fully closed. Without having to convert linear motion to rotary, "pinch points" are avoided. Pinch points are areas where an exposed lever is rotating and where a hand or item of clothing can become trapped during the cycle. Given a smaller torque-to-size ratio, compact vane actuators can fit into the tight quarters of filter galleries and still exert a tremendous amount of force on ¼-turn valves, for instance.

The vane design also ensures accurate control and no hysteresis. Because no O-ring seals are needed, vane actuators can provide years of service in demanding, high-cycle, fast operation and critical-modulating applications, thus allowing water treatment engineers to carefully control turbidity levels. The primary market is the public and private water/wastewater segment while the secondary market is industrial water treatment.

Conclusion

Given the lower costs, operational advantages and ease-of-installation afforded by pneumatic vane actuators, water treatment managers are awakening to this new option for optimizing their water production, avoiding downtime due to maintenance problems and remaining within federally mandated turbidity levels. In a not so roundabout way, vane actuators are allowing water works management to raise their water production while decreasing maintenance costs. Whether private or municipal, utilities can take these kinds of operational efficiencies straight to the bank.

About the author

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