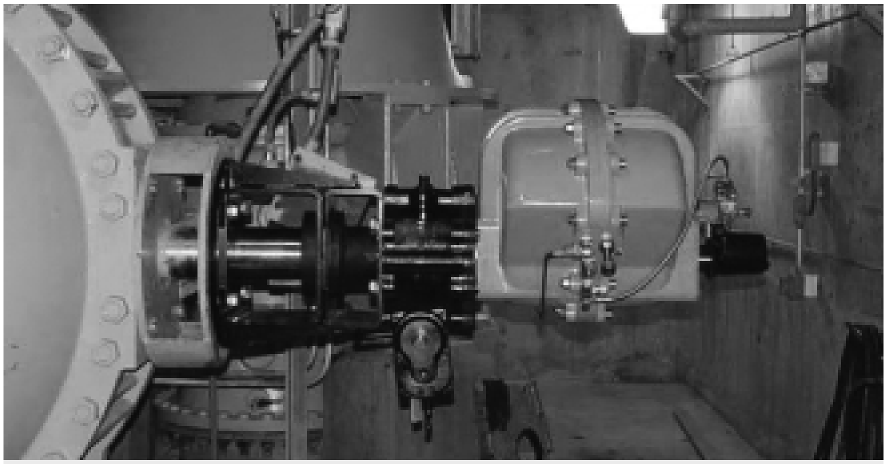


This 48″ ball valve with actuator includes a fabricated linkage kit to the valve.

A New Option in Valve Actuators Strengthens Control of Filtering Operations

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

In recognition of this need, water works engineers are now turning to a new generation of pneumatic valve actuators that are capable of executing the 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 is meeting the need to reduce downtime, as 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 when compared to electric actuators also helps to explain the widening acceptance of these new pneumatic actuators by plant engineers and managers faced with the responsibility of delivering potable water at a cost-effective rate. Additionally, the 'fail safe' (fail-closed or fail-open) feature that high-performance pneumatic actuators provide protects the plant during a temporary or extended power outage.

Need for Accuracy

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

Plant managers know that a delicate balance must be struck by maintaining the design flow rate of the filter. As pointed out in the turbidity provisions of the EPA Guidance Manual (April 1999):"The goal of maximizing water production may conflict with the objective of minimizing treated water turbidity.The operator must use good judgment in establishing operational goals and exercising process control to achieve optimal finished water quality production."

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

There are only certain ways to achieve a lower turbidity, and accurate valve control is one of the most important. 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 does not shut off, the backwash water containing the solids removed by the filter media will flow into the clear well and the measured turbidity levels will exceed the mandates.

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. The effluent valve must meter these rates carefully 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. Therefore, the effluent valve must be closed to the point where it allows only the flow rate that the filter media is designed to pass at that time. A turbidity meter or headloss DP instrumentation 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 becomes 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 and 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.

Performing a backwash prevents high turbidity levels. However, it is an expensive and time-consuming process so it is not performed until necessary. During backwashing that filter is out of commission. In addition this process uses the potable water that you just spent money cleaning. Therefore, the key to operational efficiency is to keep the flow at exactly the right levels and backwash when determined by the filter control system and carried out by the actuators.

The quality of the backwash process 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 be diverted only through the drain valve and returned to the recycle or holding pond.

If the filter effluent valve actuation fails during a backwash, there is a leakage of the backwash into the potable water stream resulting in non-compliance turbidity problems. A filter can be disrupted if you open a rate of flow backwash valve too quickly. The valves must be ramped up at the right speed to the right position and then held there during the entire process.

Since valve control accuracy and reliability play such an important role throughout all filtering operations, many older plants currently are being upgraded. In most cases, the original pipe galleries and valves will remain in place. However, one of the first steps implemented usually is a new control system. This changeover immediately requires new actuators that interface with modern control systems. Until recently, electric actuators were the primary actuators used to interface with the electronic control systems.

Electric Actuators

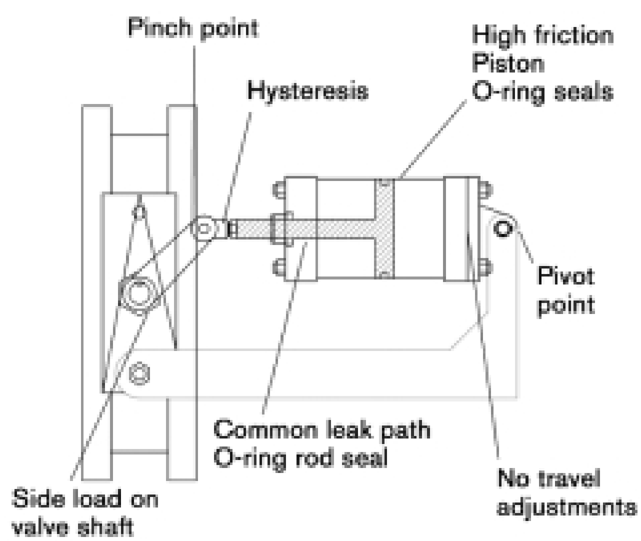
When comparing these electric actuators to the old hydraulic or pneumatic cylinder power actuators they replaced, they seemed to be the only solution at the time. The first actuators were water-actuated cylinders fixed to the back end of a mounting plate. They had a lever on the cylinder shaft to push and pull the valve open and closed. However, it was impractical 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.

The shortcomings of electric actuators quickly became apparent to water-treatment plant operators (especially the repair and maintenance staff). The easily understood piston-actuator problems could be diagnosed and field-repaired by in-house maintenance personnel, but not the more complex electric actuators.

Electric actuators generally have to be serviced by a factory representative. The representative's time and the actual parts are expensive. However, the real loss results from having the filter down. Factory technicians must be scheduled for a maintenance visit to the plant. This could take days, and water would not be flowing until the problem is fixed.

Another significant disadvantage with many electric valve actuators is that they do not offer a fail-safe condition. A power loss can cause filter galleries to flood if the electric actuator is

Figure 1: Piston Actuator Design



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frozen in its last position. While most electric actuators have a hand wheel override mechanism, once the power goes out, water will tend to overflow and flood the filter pipe gallery unless the valves move to a fail-safe position.

Additionally, when the filter galleries overflow, electric actuators are submerged in water and many times end up damaged. Replacement is an expensive process, as electric actuators cost up to 40 percent more than their pneumatic counterparts.

Reciprocating Pneumatic Actuators

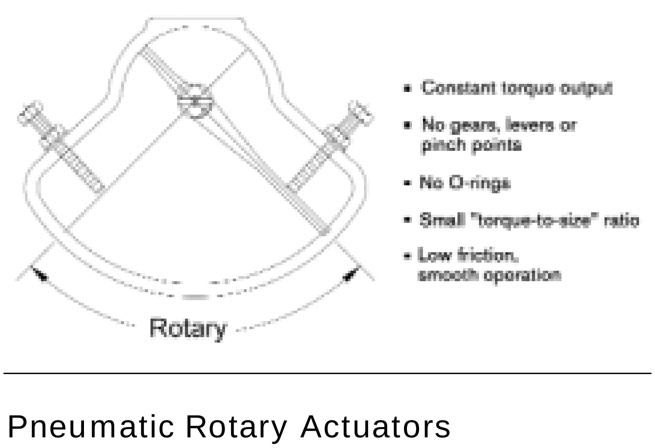
Today's pneumatic actuators offer simple and reliable performance at a cost-effective price, yet certain mechanical insufficiencies inherent in the design of all reciprocating-cylinder actuators prevent them from meeting the precise control needs of today's water treatment plants. For example, rack and 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 also is subject to wear. Side-load compensation pads also wear over time. Collectively, these items dictate regular maintenance and, hence, more plant downtime.

Typical piston actuator designs also are subject to heavy side load on the valve shaft. There are no travel adjustments, and the design introduces unnecessary hysteresis that greatly influences accuracy and accelerates wear. These actuators also require the periodic replacement of their high-friction, piston O-ring seals. Additionally, it is difficult to mount the control components that interface with the PLC or SCADA control system. (See Figure 1.)

The scotch yoke actuator design features more working parts, and typically is too large to fit into the cramped quarters of the filter pipe gallery. These actuators also require maintenance of their piston-ring seals.

Traditional piston-style actuators convert linear motion to rotary motion through cranks, gears or levers. This conversion creates unwanted hysteresis, side-loads, pinch points, high friction and torque loss. As a result, control-accuracy suffers and a higher level of maintenance is required.

Figure 2: Pneumatic Rotary Actuator



Pneumatic Rotary Actuators

Rotary actuators first were introduced to the United States from Europe in the early 1970s. These rotary actuators meet American Water Works Association standards and are finding themselves as a good option for new facilities as well as plant upgrades.

The actuator's simple design utilizes only one moving part. By scribing an arc, all torque forces directed to the valve remain constant from fully open to fully closed. Absent the need to convert linear motion to rotary, "pinch points" are avoided. 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.

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. (See Figure 2.)

One vane actuator manufacturer even designs-in a "default" setting to protect treated water in the event that a power grid goes out. The actuator can be set to a plant operator's specification as to whether the valve should be held in the open or closed position. The rotary vane of the actuator then automatically holds that position until power is restored.

Field Installation

Given the advantages inherent with rotary actuators, coupled with the fact that they are generally less expensive than electric actuators, facility engineers are installing them in water works plants more frequently. Some vane actuator designs come ready equipped for mounting into existing plants.

One problem is that the valve manufacturers do not necessarily make the mounting hardware for retrofit. Therefore, a facility engineer or a supplier must sketch something out on a piece of paper and take it to a local machine shop for drilling.

For challenging retrofits, some rotary-actuator manufacturers send their experts out into the field to help facilitate the installation process. Factory personnel or the qualified representative does the survey on the valve and returns to the factory with the dimensions and recommended actuator sizing. Given seven sizes to work with (torque outputs up to 150,000 inch/pound) and adjustable rotations from 80 to 100 degrees, the proper actuator for any given application can be found. Integral limit switches and positioners are installed. The mounting plate then is 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 then is shipped to the plant with the correct valve mounting kit.

Such turnkey installation procedures make it easy for plant managers on a tight budget to initiate plant upgrades from maintenance money.

The Bottom Line

While the accurate control made possible by rotary actuators helps lower turbidity levels, it is their reliability and low cost of ownership that really matters to most plant managers. Vane actuators are allowing water works management to increase their water production while decreasing maintenance costs.

Information for this story was provided by K-Tork, Dallas, Texas.