Metering Pumps: A New Definition?

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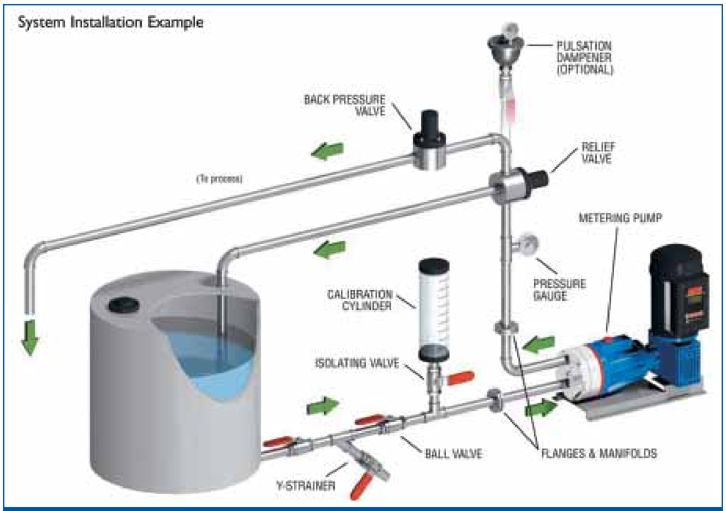
Time for tradition to step aside. New technology is taking center stage and redefining exactly what constitutes a metering pump.

When is a metering pump not just an ordinary metering pump? When it exceeds API 675 performance standards with "pulse-free" linear flow that is being accomplished through the latest technological improvements.

While many institutions and associations have developed performance criteria for metering pumps, the American Petroleum Institute (API) Standard 675 for controlled-volume, positive displacement pumps is perhaps the most widely cited. It specifies accuracy (performance at a set point) of ±1 percent, linearity (speed/flow rate relationship) of ±3 percent, and repeatability (return to set conditions) of ±3 percent.

The reciprocating metering pump is commonly used in applications requiring precise chemical injection. A good example is polymer feed systems at water and wastewater treatment plants, where polymers need to be delivered without damage in accurate, repeatable quantities.



Layout showing all of the equipment used in a complete metering solution for a pumping system.

Although metering pumps are noted for accuracy, linearity and repeatability, there is the potential for leakage, lost motion, and pumping inaccuracies during stroke adjustments. In addition, the intermittent, pulsating flow of metering pumps places a strain on the system.

By incorporating electronic flow control and a multiple-diaphragm design, new metering pump technology has been developed to overcome these operational drawbacks and give new definition to what constitutes a metering pump. For example, in the instance of polymer dosing, certain metering pump technology now incorporates variable frequency drive (VFD) electronic flow adjustment to create very low sheer and protect the integrity of the polymers during pumping.

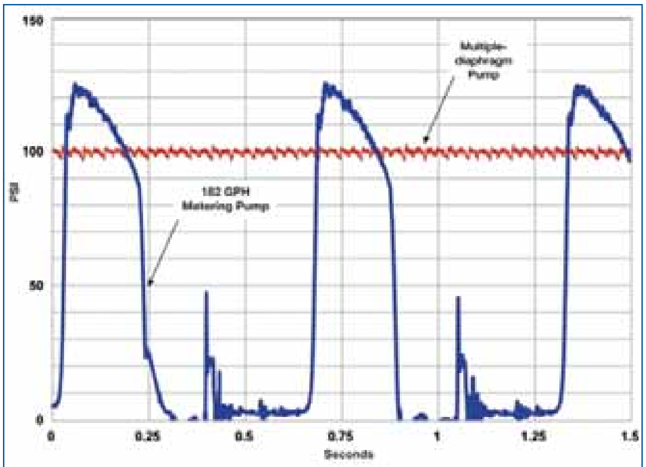
Metering Applications Uncovered for Sealless Pumps

In the early 1970s, multiple-diaphragm pump manufacturers introduced sealless pumps that were designed for agricultural applications and the burgeoning car wash market. Field-proven reliability and durability soon made some of these the pumps of choice in these industries. As potential new users learned the advantages of these sealless pumps, sales for them expanded into different markets.

This led some manufacturers to compile market data about the use of their products, which revealed that certain sealless pumps were operating successfully in applications that demanded accurate dosing. In fact, those sealless pumps would often replace standard diaphragm metering pumps.

There are similarities, because some of those sealless pumps and traditional metering pumps both feature hydraulically balanced diaphragms. Key differences, however, were that the newest sealless pumps offered electronic flow control and, with most models, multiple diaphragms.

In traditional hydraulically-balanced diaphragm pumps, the diaphragm is balanced between two fluids, the process liquid and the actuating medium. This balanced design allows for higher discharge pressure and higher flow rates



When tested under the same operating conditions at the same flow and pressure, certain multiple-diaphragm pumps provide smoother, almost pulse-less performance compared to a traditional, single-diaphragm metering pumps.

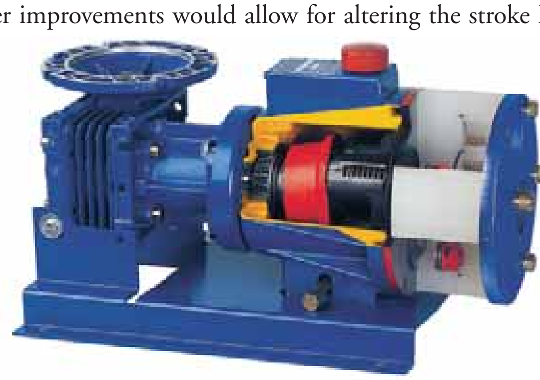
than the mechanically actuated diaphragm design.

These hydraulically balanced diaphragm metering pumps share several inherent features:

- Primary flow adjustment through change in stroke length via manual control.
- Single diaphragm per liquid end.
- Pulsating, intermittent flow.
- Limited flow and pressure range per plunger, diaphragm and liquid end combination.
- Dramatic footprint increases in proportion to flow and pressure capabilities.

Evolution to Accuracy: Electronic Flow Control

The flow rate of a metering pump can only be adjusted by varying the stroke length or speed. The first manual stroke length adjusters could not be used while the pump was operating, but later improvements would allow for altering the stroke length during the process.



Like traditional metering pumps, the newest metering pump technology offers the advantages of a sealless, hydraulically balanced diaphragm design. However, unlike traditional metering pumps, it also has electronic flow control to improve accuracy and a multiple-diaphragm design to reduce pulsations.

One method of adjusting stroke length is *amplitude modulation*, varying the radius of eccentricity of the plunger drive mechanism. A slider crank allows the stroke length to be altered by changing the length of a pivot arm, similar to the movement of a pendulum. This is attached to the piston, the stroke length of which corresponds to the size of the arc of the pendulum.

The other method, *lost motion*, can be further subdivided into mechanical and hydraulic lost motion. In mechanical lost motion design, the motor turns a worm shaft, which rotates an eccentric gear. A cam rotates with the gear and actuates the plunger through a cam follower. As the plunger moves forward on the discharge stroke, it displaces the fluid behind the diaphragm, which, in turn displaces the medium being pumped. A spring then retracts the plunger to its original position. Limiting the rearward travel of the plunger changes the stroke length and the resulting flow rate.

Hydraulic lost motion involves a change in the effective, as opposed to the actual, stroke length. In this design, the plunger reciprocates the entire length of the stroke, but a portion of the actuation fluid is deflected through a bypass valve.

With the growth of automation, pneumatic and electronic actuators were attached to the stroke adjustment mechanism for both amplitude modulated and lost motion metering pumps. Although convenient, there are resultant pumping inaccuracies during the adjustments due to the slow rate of change (typically one second per one percent of stroke length).

A recent improvement incorporated by the newest metering pump technology is the use of variable speed drive motors to change stroke speed instead of stroke length. AC and DC drives can respond more quickly, with approximate speeds of zero to maximum rpm in 0.5-sec and 1.3-sec, respectively. Faster flow correction results in greater long-term accuracy.

VFD motors are often less expensive than the electronic actuator alternative, and AC drives improve reliability, repeatability and linearity. Many of these drives are available with turn down ratios of 1000:1, as good or better than those that can be achieved using the electronic actuator in conjunction with the manual stroke adjuster.

Since full stroke length is considered optimum for metering pump performance, changing speed as opposed to stroke

Variable frequency drive (VFD) motors and controllers are usually less expensive than electronic actuators and provide full stroke length, thus improving accuracy, eliminating lost motion, and eliminating a potential leak path in metering and dosing applications.

length to alter flow represents a significant improvement. The newest metering pumps use only VFD motors and controllers, always at full stroke length.

Multiple-diaphragm Design Reduces Pulsations

Typical of most metering pumps is the single-diaphragm configuration, which is responsible for non-linear flow in metering systems. Pulsations can be minimized with dampeners and by multiplexing together several pumps, sequencing the diaphragm strokes. These options, however, add significant costs, size and maintenance to the system.

Some of the newest metering pumps have at least three (and as many as five) diaphragms per liquid end, each with a corresponding set of valves and pistons. Multiple-diaphragm pumps reduce acceleration loses and pipe strain, providing virtually "pulse-free" liner flow. This can eliminate the need for expensive pulsation dampeners and broaden the range of application opportunities for the pumps.

Traditional metering pumps also need to increase the sizes of the plunger, diaphragm and liquid end to handle greater flow and pressure demands. With the newest metering pumps, the wet end can remain constant because it can employ different gearboxes with different ratios to cover a wide range of flows and pressures. Changes in process requirements can be addressed simply by changing the gearbox, thus reducing pump acquisition, maintenance and downtime costs. In addition, spare part kits remain the same, reducing inventories.

The New Definition

When is a metering pump not just a "controlled volume, positive displacement pump" for metering? When it uses VFD motors instead of manual and electronic stroke adjusters to increase response time and accuracy. When its multiple diaphragms per liquid end virtually eliminate pulsations. When it employs interchangeable gearboxes to broaden the performance envelope.

These changes may provide solutions to user problems, but they also give the newest metering pump technology cause to redefine what makes a metering pump.

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