Progressive **Cavity Pump** Systems: When Precision and Repeatability are Vital

Underused dispensing technology can deliver consistent ±1% accuracy regardless of temperature, pressure or viscosity BY CAN LA

As recently as half a decade ago, operators of manual and automated dispensing lines had little ability to achieve highly accurate, consistent applications of adhesives, epoxies and other fluids, especially when desiring small depositions, working with viscous materials, and/or when attaining the fastest possible throughput speed was a priority.

For example, jetting valves—perhaps the gold standard for high speed, micro-deposit application capabilities—can be unsatisfactorily turbulent in their accuracy. Time/pressure dispensers and auger valves can deliver accuracy down to ±10% and ±5% respectively, but have a variance that might be unacceptable for many operators, with deposit size impacted throughout the process by temperature-driven changes in material viscosity, as well as fluctuations in air pressure created by the changing fluid level in the syringe barrel. And, the original volumetric or positive displacement pumps such as piston and gear pumps, while delivering the ability to get closer to the "holy grail" accuracy level of ±1%, are often more limited in bead size range and can manifest speed deficits due to their need to fill and refill between depositions.

For many organizations, of course, these limitations—and the mandatory balancing act among variables—were, and continue to be acceptable, with the necessary compromises falling within their business operating goals. However, for an increasing number of companies in numerous highly competitive industries, where attaining the optimum levels of accuracy, consistency and speed can translate quickly into a stronger market position and greater profitability, the search for a superior adhesive and epoxy dispensing option continued.

Adapting progressive cavity pump technology to new applications

Looking to heavy industry such as oil drilling and cement processing, innovative dispensing equipment manufacturers noted the potential of progressive cavity pump technology, a unique type of positive displacement pump technology long proven in use in a number of critical applications, such as continually moving large volumes of heavy oils and slurries from deep underground. With the technology now successfully miniaturized and adapted to a table top or assembly line appropriate footprint, progressive cavity pumps offer a number of advantages over incumbent dispensing methods.

For example, unlike other types of epoxy and adhesive dispensing solutions, including other types of positive displacement/volumetric pumps and time/pressure valves, a progressive cavity pump is both a sealed system and a continuous flow operation. Progressive cavity pumps have proven their ability to dispense microbeads as small as a microliter, using a wide range of materials with viscosities ranging from 1 to 300,000 centipoise or more. And, since internal material flow is continuous, rather than relying upon a filling/refilling approach, throughput speeds are consistently high.

Most dramatically, however, progressive cavity pumps can deliver volumetric dispensing accuracy up to ±1%, and do so consistently, unimpacted by ambient temperatures and pressures that plague unsealed pumps that are exposed to environmental conditions, or by variations due to changing material volume levels during operation.

How it works

The essence of a progressive cavity pump is that it operates by use of a continuous rotor/stator configuration, rather than by having material being ejected from filling/refilling chambers at fixed, separate intervals. In this technology, the feed fluid—from plain water all the way to high viscosity greases or solders—is held in a reservoir under positive pressure supplied by an air line which forces it out of the barrel into the fluid feed path and then to the rotor/stator chamber assembly.

The metal, single-helix rotor continuously turns inside a flexible rubber stator molded with a twin helix shaped aperture, forming a constantly shifting series of tightly sealed cavities which move a precise, consistent volume of material steadily and continually toward the pump outlet. From there, fluid is driven to the dispense tip outlet with a flow rate dependent upon the rotor rotation in the feed direction, precisely controlled by the desired specifications dialed into a proprietary controller paired with the system. Of note, with this technology the flow rate is adjustable at any time by changing the motor speed on the controller, as opposed to having to stop operation to adjust the pump itself, further enhancing speed and flexibility. The fluid is dispensed from the tip by means of a voltage signal applied to the motor, and shearing is achieved by reverse Z-motion/tip retraction.

The numerous benefits of progressive cavity technology

As noted, since the system is in constant motion and provides a nonstop flow (indeed, pumps based on progressive cavity technology are sometimes alternatively marketed as "endless" or "continuous" dispensing pumps), it is protected from many of the fluctuations in fluid pressure that can plague deposition accuracy in many operations. This factor all but eliminates the common scenario in which a small surge in pressure will suddenly increase the output of the material dispensed, and a drop back will decrease the bead size a few dispositions later. With other pumps, this is often not only experienced as the level of material decreases in the tube, but also with any instability in the pressure source, where, for example, an air compressor used for multiple purposes might drop in pressure if another load is placed on it, or surge when it is removed.

Many operations using other types of pumps are also plagued by temperature changes which impact viscosity. A small increase in temperature can increase viscosity and flow speed, and detrimentally increase the size of the disposition vis-a-vis the desired settings. Similarly, a small decrease in temperature can cause the fluid to slightly thicken and reduce the size of the deposition, likewise impacting the quality of the final product. As noted, progressive cavity technology protects against these unfortunate, but common scenarios, with the tight seal between the rotor and the stator helping to ensure that material in the cavities is well protected from ambient temperatures which can impact viscosity and therefore weigh on the system's ability to achieve consistent accuracy, and keeping volume steady, consistent and predictable. This factor also helps keep the system resistant to material leaks which can also wreak havoc on performance and create waste, with progressive cavity systems typically self-sealing against leaks at pressures up to 2 bar (30 psi) or higher.

Of note, the technology is also "gentler" and protective of the fluid itself. Many types of pumps might flatten soft solids and lead to reduced material performance or even clogging of the needle. Since a continuous moving rotor and soft stator causes less percussive impact on the material than, for example, a piston or centrifugal pump, even very soft, solid powders, flux and fillers can be mixed into the liquid without damage or deficits in performance.

In addition to protecting the integrity of filled materials, the progressive cavity pump also stands up to potential damage from them. In this regard progressive cavity pumps deliver superior longevity than many types of all metal pumps which rely upon inflexibly tight tolerances and are thus more susceptible to wear damage. In a progressive cavity design, the rubber stator tends to flex and not abrade against slurries and other harder particles, and, similarly, since the flow of the liquid is in smooth parallel

with the metal rotor, abrasive wear is far less likely to occur.

Indeed, with the wide range of viscosities it can handle—from 1 to 300,000 centipoise—and its material versatility, many users comment that progressive cavity pumps can allow them to adapt a single tool for numerous applications in an assembly process, for example, dispensing both sealing compounds and oils. Using one tool type for several applications, they say, can cut down on parts inventory, streamline training issues, and provide other cost–and productivity-enhancing benefits to their operation. Indeed, configurations exist that can even dispense two-component epoxies with precise mixing ratios and all the same dispensing accuracy advantages.

Set-up of progressive cavity pumps is pretty much the same as with familiar auger valve systems, whether the operation uses a syringe or a pressure tank, with similar cabling and routine five minute installation requiring no special skills or special tools. Of note, the rubber stator and metal rotor must be packaged separately to ensure that no deformation occurs to the rubber in shipping and the seal between them is tight. Joining them takes seconds. Lastly, a progressive cavity pump can provide maintenance advantages—in addition to being even more of a problem-resistant workforce than many types of pumps, its rotor/stator design can make it easier to clean and maintain due to the fact that it has fewer small parts to deal with.

Chemical compatibility and other considerations

Progressive cavity dispensing pumps are currently available from several companies, with some manufacturing their own brands and others purchasing and relabeling the equipment. The controller brand is proprietary to the system and must be paired with the pump, and so they are usually sold as a set.

While design and performance can be similar, the material composition of the stator can differ widely among suppliers and most operators should investigate it before purchase if they dispense any type of caustic or aggressive solvent such as acetone, MEK or xylene, or plan to use several such chemicals. Rubber blends used for the stator are proprietary and can differ in the level of chemical resistance they provide and the range of dispensed materials they can be paired with. Indeed, some manufacturers provide stators that are made from standard rubber; these pumps can only be used with benign, non-corrosive materials.

Most all manufacturers will ask for the MSDS for the materials that operators will be dispensing to help ensure compatibility with the stator and other elements of their systems. Some will also accept samples of the material to test in a lab setting to further ensure compatibility as well as provide potential users with estimated performance data, dispensing photos and settings information before purchase.

Another possible factor to consider is the relative availability of accessories and equipment that might be teamed with the pumps in operation, such as robots and automation, pressure tanks and feeding systems, and dispense tips and syringes. Some manufacturers might offer a fuller line, some might re-purchase or re-brand needed supplies and some might not have them available at all. For some operators, purchasing from different sources piecemeal to try to secure the lowest individual off-brand prices might be a strategy; others might prefer the benefits of single brand compatibility and a single source of product and system performance responsibility, enabling them to avoid the challenges of multi-vendor "finger pointing."

Also of possible importance to operators might be the familiarity of the pump manufacturer with the industrial automation market, their record with similar operations and their locations and infrastructure vis-a-vis the need for local repairs or service, lead times, or in-person assistance after the sale. Depending on an operator's available in-house expertise and business model, these elements could vary in importance, but should potentially be considered by many.

Finally, it should be noted that perhaps the biggest downside of progressive cavity pumps is that they are a more costly investment than many other types of pumps, and that, further, as of this writing, prices for similarly performing progressive cavity pumps can vary considerably in the marketplace.

Are progressive cavity pumps right for your operation?

Progressive cavity pumps are not for everyone, but for those operations that can benefit, the benefits can be considerable.

Certainly, every dispensing operation "wants" greater accuracy, and the progressive cavity pump is for most the only option that can get the operation to a ±1% accuracy level. Truth is, for some applications, repeatable accuracy, while "nice to have" might not translate directly into profitability and competitive advantage. Others might potentially benefit, but, due to internal politics, lack of funds, lack of knowledge or other factor, might not be able to break away from the way things had been done in the past.

As suggested, certainly of strong consideration is the fact that the one-time investment in a progressive cavity pump can be higher than that of an investment in many other types of pumps. As a ballpark, for example, evolving from a ±10% level of accuracy to a ±1% level of accuracy might require a 20% additional investment, which, while likely still well under $1000, might fairly be deemed to be "not worth it" for some operations where "good enough" might really be good enough.

Many of the earliest adopters benefitting from the technology, demonstrating higher profits and greater competitive advantage, include those operations involved with under filling printed circuit board assembly components, automotive parts lubrication, encapsulation and potting applications, optical bonding, conformal coating and similar high value electronic, medical, automotive, aerospace and other industrial applications. For these types of applications, the additional upfront investment is quickly returned.

The bottom line, of course, is that it is up to each operation to crunch the numbers for themselves, as only they can accurately predict what, if anything, increased dispensing accuracy and consistency, superior product quality, greater throughout and reduced waste of material and product could mean to the profitability of their operation.

TECHCON SYSTEMS

Can La, Product Manager
10800 Valley View St.
Cypress, CA 90630
(714) 230-2355
cla@techconsystems.com
www.techcon.com