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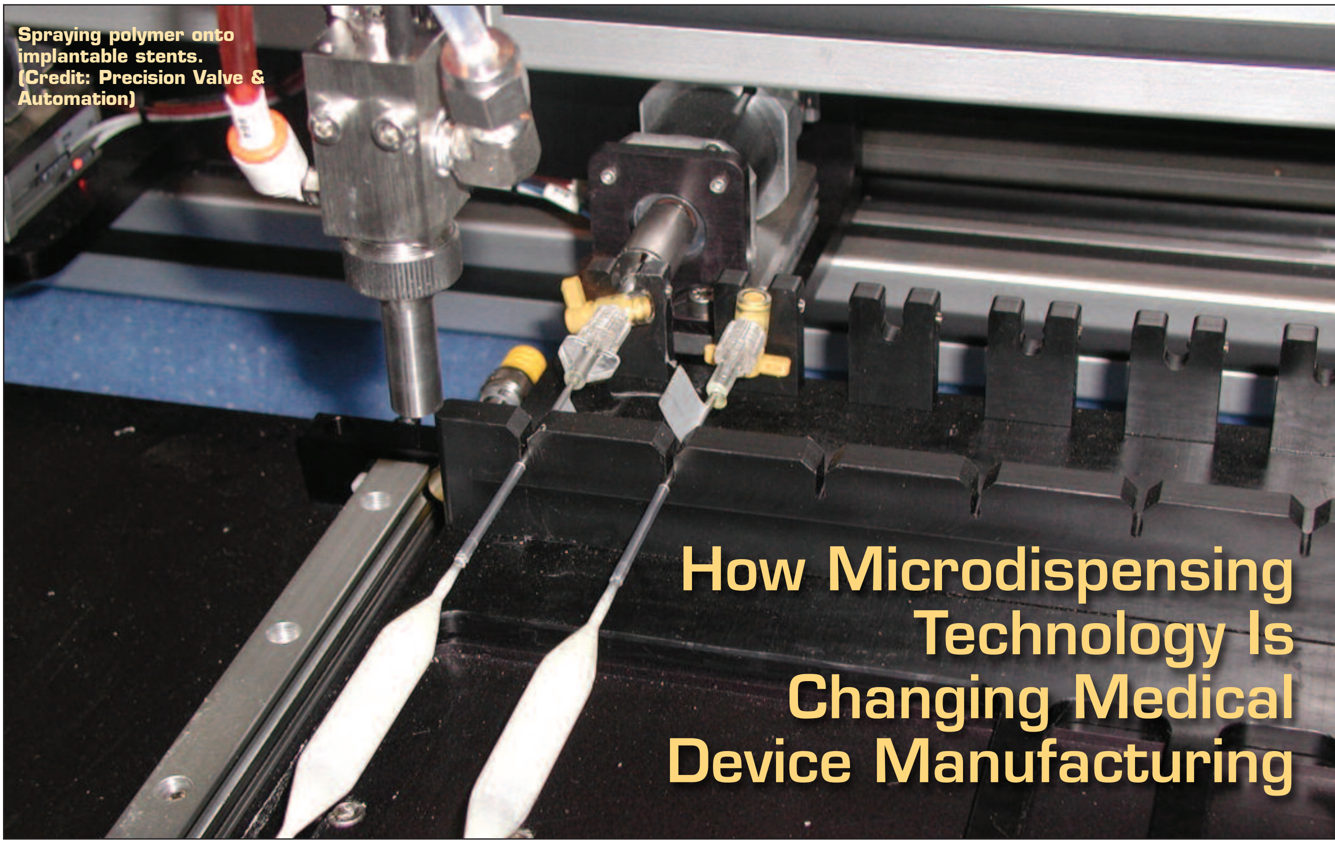


How Microdispensing Technology Is Changing Medical Device Manufacturing

A revolution is upon us. Dispense pump technology innovation is quickly bringing improved accuracy, capability, and versatility to medical device manufacturers. This revolution not only opens the doors to creating production processes that were once unimaginable, but also increases the scope of chemistries that manufacturers can consider for these applications. The end result? Greater flexibility in achieving accurate results for small deposits of fluid with the option to choose rapid curing adhesives that reduce work in progress while improving bond strength.

Manufacturers worldwide are relying on their suppliers to use this updated technology and implement new processes. They are quickly turning in their syringes and the variability present in time and pressure dispensing processes for more accurate alternatives. This is particularly relevant in applications requiring smaller dose volumes. Simple time and pressure dispensing systems typically carry a 5–10 percent variation in volumetric accuracy. As manufacturing demands have required smaller deposits, that level of process variation is often unacceptable and physically unachievable in a manual process. Dispensing technology that can provide 1–2 percent shot-to-shot consistency is becoming the norm. While this technology brings added quality to the manufacturing process, the driver is in demand due to the miniaturization of devices.

Demand for microdispensing technology has led users to seek more accurate applicators. In turn, manufacturers have enjoyed additional benefits of microdispensing pumps. These benefits include a significant reduction in minimum deposit volume, increased speed, better chemical flexibility, improved process capability, and subsequently better part quality and a significant reduction in waste.

Progressive Cavity Pumps

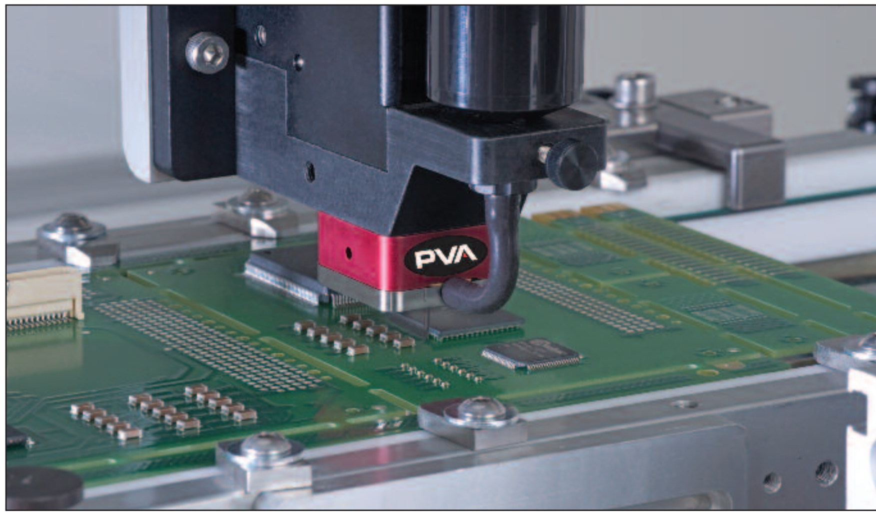
Progressive cavity pumps are positive displacement pumps by design. A helical rotor seals tightly against a molded stator as it is rotated. Once sealed, fixed cavities are formed consisting of the resin to be processed. The rate of rotation directly impacts the pump's flow rate. This relationship is direct; as the rotor rpm doubles, so does the subsequent flow rate.

By design, progressive cavity pumps self-seal as the rotor and stator meet, so that low viscosity fluids can be processed without concern of dripping or leaking. A progressive cavity process is also continuous. As disbursement from each cavity overlaps, there is no necessity to recharge or refill the metering area creating a pulse-free dispensing process. Very little shear is created on the chemistry making sensitive or lightly filled materials acceptable to process.

So what does all of this mean to the end user? Progressive cavity pumps provide tremendous volumetric accuracy for small deposits of material. Dosing rates down to 0.03 ml/min are achievable with sub-2 percent accuracy. Microbonding of medical devices requiring dots or beads can be accomplished easily utilizing this advanced technology. Shot size capability is a fraction of time and pressure processes. This opens the door to adhesive applications that may not have previously been considered.

Multi-component formulations can bring an array of benefits to manufacturers from adhesion and mechanical strength to rapid cure times. Dispensing companies are typically weary of chemistries featuring wide mix ratios (out to 10:1) or large viscosity deltas. Wide variations in these relationships between the resin and hardener can make these chemistries difficult to mix sufficiently. These formulations require such a small amount of hardener that any variation in the mix ratio can change the chemical properties or impact the cure schedule. These issues are often compounded as the deposit sizes get smaller because there is little room for error and even less mix time.

In moving the metering process right to the application point with progressive cavity pumps, users can have a high level of confidence in processing two-component chemistries, even if they have wide mix ratios or viscosity deltas. The resin and hardener are not exposed to each other until they depart the pump body and enter a static mixing tube. Since the mixing tube is disposable, daily maintenance is minimal. The segregation of the A and B components also prevents users from having to conduct any routine purging of the metering pump.



A JDX valve used in underfill of sensitive electronic components. (Credit: Precision Valve & Automation)

The development of progressive cavity technology for 2K materials is driving an increasing number of users to these formulations. Every year there is an increase in 2K materials in the microdispensing market, in particular in the medical device industry. PVA assists those in the medical device field — from the handheld prototyping phase to large-scale production — and ensures that reliable products are perfected. Two-part materials have traditionally been chosen for potting of electrical devices in a housing or a gasket to glue two housings. This was primarily due to limitations in valve technology. Progressive cavity pumps are now the option of choice for valve assembly, implantable devices, and the growing electronics assembly market.

Noncontact Jetting

Jetting technology has been present in the dispensing market for decades. This process brings a myriad of benefits to any manufacturing process. It's fast. Jets can generate up to 300 drops per second allowing for rapid processing of a wide range of fluids. A rapid succession of dots generated quickly over a coverage area results in the formation of small beads of adhesive. Because the droplets are projected out of the jet valve, the processing height can remain fixed. The absence of z-height movements in a robotic application also reduces the processing speed.

Jets are repeatable at very small deposit sizes. Much like progressive cavity pumps, jets should be expected to produce sub-2 percent repeatability. The advantage that jets have over progressive cavity, in addition to the processing speed, is the size of the droplets. Shots as small as 10 nl are achievable with noncontact jets, making these valves an ideal choice as the desired dot or bead size gets smaller.

Jet design concepts can vary widely from sliding valves to pistons to diaphragms. Regardless of the theory of operation, limiting the number of parts that contact the fluid not only reduces the cleaning time, but simplifies the processing of more reactive chemistries that may need to be routinely purged from the dispensing system.

Noncontact jetting systems have a wide range of practical applications for medical device manufacturers. Jets have no equal when combining speed, repeatability, and deposit size. This combination yields less rework and waste while increasing throughput.

Manufacturers can also take advantage of the noncontact nature of jetting valves to help process parts that cannot be successfully dispensed on with traditional needle valves. As beads and dots get smaller in any needle application, the applicator's z-height in correlation to the substrate becomes of greater importance. The gap height and robot speed will be the primary factors in setting the dispense volume in these applications. Let's focus on the gap height. As the distance from the needle tip to the substrate varies, so will a bead's properties. The closer the needle, the flatter or wider the bead will be in relation to its height. As the needle moves further away from the part, the bead will become thinner and taller. These variables can produce inaccurate dispensing of adhesive, a wide range of volume fluctuation, and even voids. This is of particular issue when a flexible part cannot be affixed in a consistent position.

In a manufacturing environment where many medical device applications feature three-dimensional or flexible molded components, the ability to remove z-height variability in needle tip applications is critical to a consistent process. Noncontact jets inherently remove this potential issue with their ability to glide over a part and dispense at a common z-height, even into awkward, hard-to-reach areas. Drops can be dispensed into areas with clearance as small as 300 µm.

Jetting is becoming a constant in medical device manufacturing. The speed, accuracy, and flexibility in processing is in demand, but as bonds and applications continue to get smaller, that is where the jet becomes a necessity. Jets are flexible with higher viscosity chemistries and can often be heated to lower the process viscosity. Many devices are designed without consideration for downstream processes like dispensing. Companies like PVA often take on a consultation role to help develop solutions and implement processes that have never been done before, which is both exciting and challenging.

This article was written by Frank Hart, Sales and Marketing Manager, and Jon Urquhart, Director of Global Application Engineering, for Precision Valve & Automation (Cohoes, NY). For more information, visit ***http://info.hotims.com/65855-163***.

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