



Process Improvements in Fluid Dispensing

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Jetting is the fluid dispensing process where fluid is rapidly ejected through a nozzle and uses the fluid momentum to break free from the nozzle. Jet dispensing has been available in the electronics manufacturing industry since 1993 when jetting technology was first introduced by Nordson ASYMTEK. At the time, it was a revolutionary concept, as fluid dispensing was only being done using a needle that required an up-and-down z-axis motion to dispense the fluid. With the jet, a discrete volume of material is ejected with each jet shot. Jetting greatly increases dispensing speed because z-axis movement isn't needed to overcome fluid cohesion as is required with needle dispensing.

When traveling from one dispense location to the next, jetting is done on-the-fly. High flow rates are achieved, fluid is deposited in tight places with much smaller keep-out areas, and the ability to use a wide range of fluids that are deposited in a vast number of configurations allows for flexibility. Thousands of jets are used in production today.

At NEPCON China last April, a new concept in jet dispensing was introduced. Once again, it is a significant change in dispensing technology, revolu-

tionizing the construction of the jet itself along with the accompanying software, and adding wireless capabilities. Nordson ASYMTEK introduced the patent-pending NexJet™ system which consists of a dispense platform, the NexJet actua-



Genius jet cartridge.

tor, and incorporates the patent-pending Genius™ Jet Cartridge. This cartridge is one piece and is easily removed and replaced without tools. It fits in the palm of one's hand. It contains the fluid and is the only wetted part of the jetted mechanism. An RFID usage tracking system imparts a "smart" feature to the jet cartridge. The NexJet accommodates a wide breadth of fluids, applications, and man-

ufacturing for emerging technologies such as stacked die, precision coating, LEDs, flat panel displays, lab-on-a-chip, MEMS packaging, and others.

Increased Speed and Throughput

Speed and throughput have increased exponentially over the years, yet they are still factors challenging the existing dispensing systems as fast never seems to be fast enough.

However, increasing throughput involves more than just speeding up the actual act of dispensing. Factors that contribute to throughput include conveying and heating the parts, the vision and/or imaging system, and the height sensing, which can ensure consistent dispensing results.

Improvements are constantly being made to these aspects of the dispensing process as well. For example, the NexJet has a high actuation frequency of 300Hz. High actuation frequency means that more dots can be delivered in a period of time. In this case, the jet can deliver 300 shots of fluid in one second, an improvement of 50 percent to help increase units per hour (UPH).

An additional impediment to speed and throughput is the time required to

change and clean the parts of the dispense needle or jet valve. The fluids are often messy, sticky, and difficult to clean. Cleaning is labor-intensive, fluid is often wasted in the process, and production has to be stopped so the valve



Genius jet cartridge cleaner.

can be removed, have its parts cleaned, and be replaced, or have the valve removed and replaced by a back-up clean valve. There are many components to a jetting system. To clean the jet, the entire actuator (or driver) and each piece of the jet must be removed, cleaned, inspected, and replaced. Jets can have as many as 8 to 14 pieces. These parts can include seals, o-rings, seats, nozzles, and needles, and sometimes these parts have parts that have to be disassembled, cleaned, and



Other jet parts (left) vs. Genius jet cartridge (right).

inspected. All these parts come in contact with fluid. It can be a hassle and barrier to high yields if equipment operators have to know how to disassemble and reassemble all these pieces correct-

ly. Down-time is increased if one of the pieces is lost or one of the parts in the system fails or wears out. For contract manufacturers or companies that need to change fluids frequently, this creates a bottleneck or requires the purchase of additional jets to be kept on the shelf and changed out while others are being cleaned.

One Part to Clean

One thing that makes the NexJet system so revolutionary is that in its jetting mechanism there is only one small part that contains fluid and which has to be changed and cleaned. The actuator remains on the dispensing robot. Only the Genius Jet Cartridge needs to be removed, and this can be done without any tools. Each NexJet system comes with two cartridges, so when one is removed to be cleaned or disposed of, the other can be immediately placed in service. To remove the cartridge, the operator simply lifts a lever and squeezes two tabs to release the cartridge from the actuator; the old cartridge is removed from the heater unit and a clean cartridge installed; the retainer tabs are squeezed together and the heater unit is returned to the actuator; the lever is pushed down; and the system is ready to jet. Change-over time is about 30 seconds. Each jet comes with a specially designed off-line cleaning and inspection tool that flushes the jet cartridge, tests the nozzle seal, and provides visual verification that the jet cartridge is clean. No cartridge disassembly or reassembly is required. Extra cartridges are small and easy to store to have ready when needed.

RFID Plays a Part

Wireless communication takes the NexJet to the next level. An RFID transceiver is embedded in the dispense system to communicate with the stored memory on the Genius Jet Cartridge. The number of cycles is wirelessly communicated and the software is programmed to warn the operator when the limit is reached. Custom messages can be written and saved to the jet cartridge and then relayed to the jetting recipe. Once again the operator receives a warning if recipe parameters are not met.

The system ensures that the correct cartridge is installed, checks to see if the cartridge is within life expectancy, and alerts the operator when the cartridge needs replacement. Each cartridge lasts up to 50 million cycles, depending on the type of fluid used and the application. This translates to between a 1- and 3-

month life in high volume production environments. If production rates are low, the jet cartridge can last for much longer. Incorporating RFID capabilities minimizes operator mistakes, eliminates accidental usage and usage longer than recommended, prevents accidental use of incorrect parts, and allows process engineers to evaluate production history.

With smaller devices and components placed in tighter configurations, a challenge has been to maintain speed, while increasing precision, accuracy, and



NexJet System on stand.

reliability — and to accomplish this with many fluid types that have a wide range of viscosities. Fluid has to be dispensed so it is centered in the process window and dot sizes have to be controlled. Process tools and software have played a major role in fine-tuning and controlling the jetting process and the factors that make the process vulnerable to the variations that affect fluid jetting.

Precision software developed for the NexJet has increased jetting capabilities. Fluid ejection and jet dot velocities are adjusted, the process capability index (CpK) is improved, and satellites, accumulation, and splashing are reduced. A wide range of dot sizes are possible. Calibrated process jetting (CPJ) measures the fluid mass and calculates the exact amount of fluid to dispense while compensating for fluid viscosity changes to maintain volumetric repeatability during long production runs.

The new system supports more applications and fluids. Jetting applications include flip chip underfill,



chip scale package underfill, ball grid arrays, package-on-package underfill, precise coating, and adhesive dispensing. The system can accommodate a broader range of fluids and viscosities than previous jets, such as thick and elastic fluids. Tests have been completed successfully with fluids from a broad spectrum of fluid formulators.

Lower Cost of Ownership

An added benefit of the new system is a significant reduction in cost of ownership of about 20 percent. Part of the reduction is simply based on the long life of each cartridge and because a second cartridge comes with the system so a replacement is immediately available and there is no need to purchase a second

jet. Other savings occur because of the fast installation and removal of the cartridge, minimized touch-time for troubleshooting and cleaning, minimal training time, and simplified part stocking and re-ordering frequency. There are also the savings in time, money, labor, and the factors that accompany cleaning a dispensing valve.

Thousands of hours of testing have been conducted on the system to date. Testing is continuing to be done with additional fluids and application parameters. Data is also being collected on the improvement in yield that results from a reduction in factors relating to the production set-up and change-over time derived from using the Genius Jet Cartridge.

However, factors that affect yield include more than just time required for training, cleaning, assembly, and manufacturing. If a jet that has been put together incorrectly is put in production, there can be fluid leaks, incorrect dot sizes, and inaccurate placement. As electronics manufacturers aim for faster time-to-market, reduced costs, and more emphasis on creating quality and brand equity, we will see the evolution of additional types of production equipment.

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