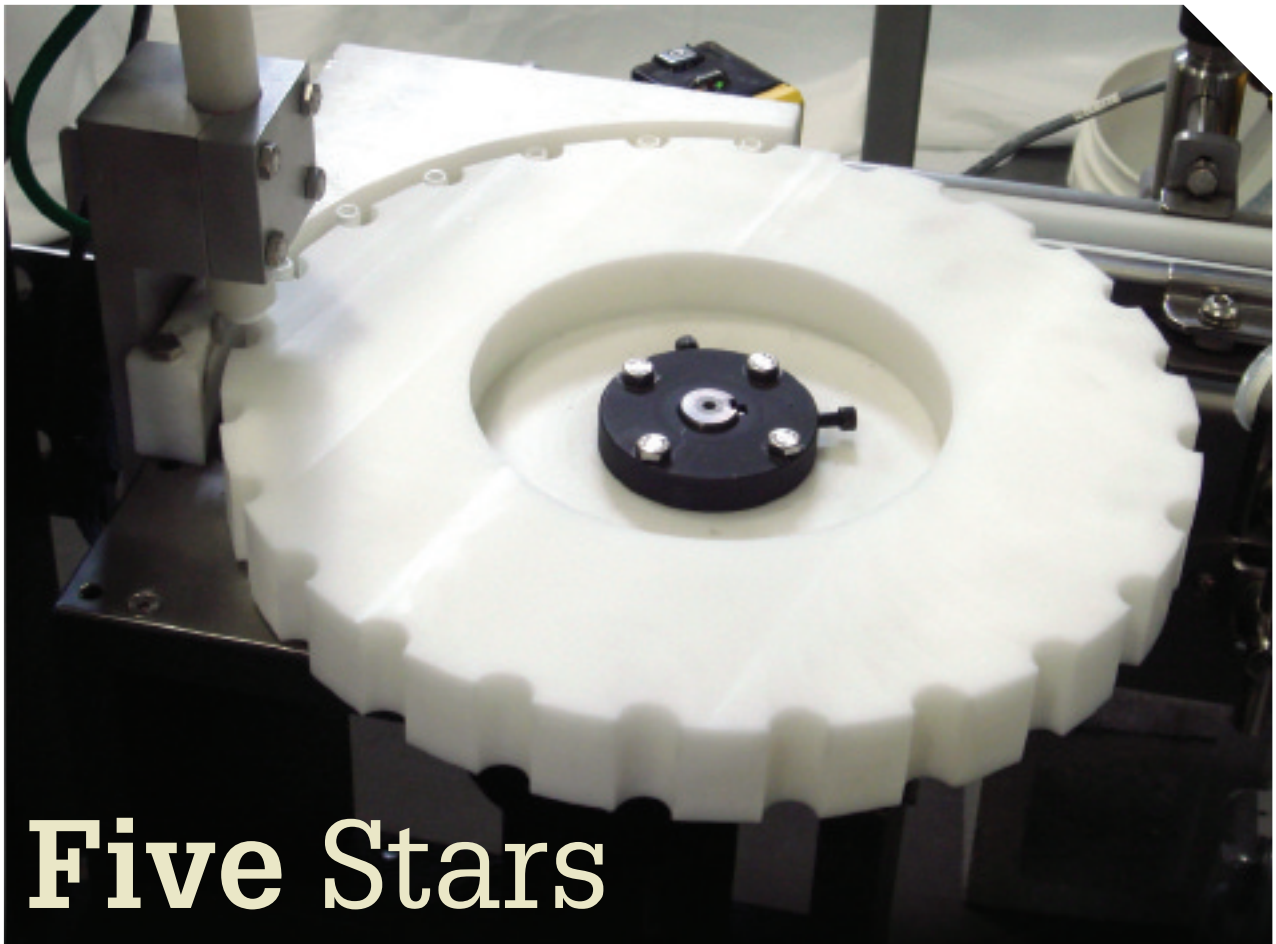

Five Stars

Monoblock fillers/cappers for pharmaceutical production offer a precise solution for exact dosing requirements, and can further be enhanced with a range of innovations on the basic system

Kim Norris at ESS Technologies Inc

Figure 1: Starwheel infeed system for small PET bottles

Pharmaceutical, diagnostics and cosmetics filling applications often require precise control of the container handling, filling and capping processes. Many diagnostic test kits include bottled reagent solutions in small amounts, typically only one to five millilitres. Single dose packages of prescription and over-the-counter products may be dispensed in micro-vials and small PET bottles, and the cosmetics industry has often relied on the precise filling of small bottles for anything from eye drops to breath freshener.

These smaller containers often call for precision feeding, cap handling, plug, wiper, dropper or brush insertion, and precise torque specifications. This precision is not featured on many widely available filling and capping systems and requires an innovative machine design to handle the stringent requirements of these types of application. This article outlines five innovations that create a highly precise system for filling and capping liquids for pharmaceuticals, diagnostics and cosmetics manufacturers.

Innovative Infeed Systems

Correct feeding and placement of bottles, vials, micro-tubes, and so on is essential in order to create a system for reliable high speed filling. The feeding efficiency affects filling speeds, scrap, rework and machine uptime, all of which impact overall productivity. Reliable feeding of very small bottles and vials or micro-tubes has the added challenge of container stability due to the small diameter of the container. For vial filling applications, a unique infeed addresses this by feeding vials from a tube into a precision driven, zero-backlash turret that secures the vials for downstream processing. This infeed design eliminates the need for an infeed conveyor or feed screw, supporting a faster machine changeover.

Images: ESS Technologies Inc

Another innovative infeed system allows controlled handling of small PET bottles. The system incorporates a vibratory bottle feeder that orients the bottles right-side up and drops them into a mini starwheel infeed system. The starwheel carefully discharges the bottles onto an infeed conveyor and into a timing feed screw. The feed screw positions the bottles for filling before moving the bottles into a second starwheel for additional processing, including plug insertion and capping. Both of these innovations permit precise, stable container handling into a monoblock filler/capper without bulky hoppers or additional conveyors.

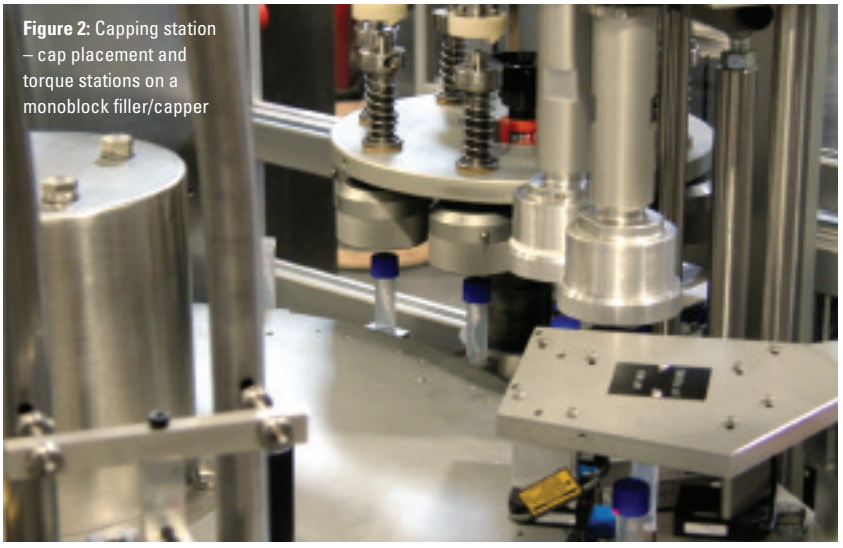

Figure 2: Capping station – cap placement and torque stations on a monoblock filler/capper

Precision Filling with Net Weigh System

Filling systems that integrate net weigh capability offer a very precise process. Monoblock filler/capper machines with integrated scales allow the system to measure and record the weight of the container prior to and again after filling to verify exact fill amounts. The scales provide an accuracy of down to ±20µg to create a very precise filling system for applications with tight tolerances.

A typical monoblock filler/capper with integrated net weigh system performs as follows: bottles, micro-tubes, vials or syringes enter the monoblock starwheel from the container infeed. The empty container is weighed on the tare weight scale, and the data is recorded by the embedded controls. A servo-controlled filling pump provides accurate dispensing, and the container is weighed again by the gross weight scale after being filled. The system records and compares both weights and measures the difference against pre-programmed values that are specific to the application. All containers are capped and torqued, and containers with correct fill weights are tagged to be discharged for further downstream processing. Containers with incorrect weights are automatically rejected, while feedback controls on the system may be configured to automatically adjust the filling nozzles to maintain precise filling volume. Net weigh filling systems are ideal for applications that require filling speeds of up to 60 bottles per minute (bpm).

Precision Plug/Cap Feeding and Placement

All high-speed filling applications require the precise handling of plugs and caps. Servo-driven intermittent motion systems are able to operate at speeds of up to 120bpm. Custom engineered for each application, the unique design allows plugs and caps to be handled with precision to reduce the risk of being dropped or skewed. This is especially true in applications that involve small diameter vials or tubes, which are inherently more difficult to handle.

Plugs are either fed via bowl or a robotic flexible feeding system and oriented into a servo-driven pick-and-place device. Depending on the speed of the application, plugs may be inserted into one or two bottles simultaneously prior to the capping station. This same technology can also be used to provide precise placement of droppers, wipers, brushes, and wands that may be incorporated with the cap itself. In all cases, sensors are used to verify that plugs are fully inserted and that no caps are skewed or dropped. These sensors 'tag' each correct product to be passed on to downstream packaging processes, such as label application and cartoning or pouching to create the final package. The system considers untagged product to be defective and removes it using an automatic reject system.

In a servo-driven capping station, caps are fed and oriented as they enter the capping turret. Depending on the cap design, a servo pick-and-place system may be used to place the cap onto the vial or tube. The capping station may also be designed to accept caps that are pushed up into a capping turret. Caps are then indexed to the bottles and the same turret places the cap onto the bottle. Some speciality caps, such as flip-top caps used to plug test tubes, may not require a torque station as the caps are pushed onto the top of the container. These caps also require precise handling as the cap must first be closed using a pneumatic-driven automated system before it is placed onto the test tube.

Precision Torque Stations

Servo-controlled torquing provides more consistency and accuracy for closing plastic caps and vials with slight tolerance variations. Torque can be critical in some applications such as lab environments where technicians want to have one-hand vial-opening. A monoblock filler/capper with a two-stage torque system can provide the accuracy required for these applications.

At the first stage, the monoblock filler/capper uses a 'doughnut' clamp to place the cap with complete accuracy and applies the first level of torque to secure the cap. The container then indexes to the second stage where the final torque is applied to the exact specification. The use of servos enables the system to apply a precise amount of torque to the cap. This allows packagers and laboratories

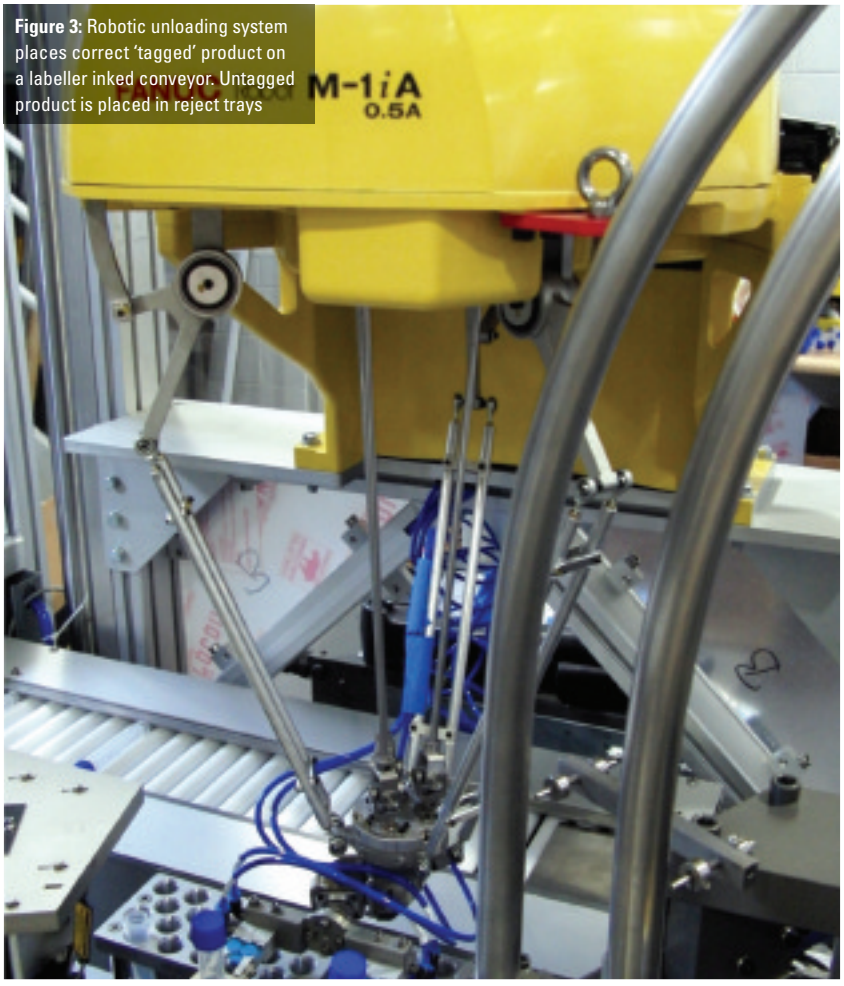

Figure 3: Robotic unloading system places correct 'tagged' product on a labeller inked conveyor. Untagged product is placed in reject trays

to achieve the required seal without making it difficult for the consumer to remove the cap an important criteria for both product quality and consumer assurance of product safety. Further precision can be achieved by specifying a capping system that can be ordered with a feedback loop and charting capabilities to allow for graphing trends and precise control on-the-fly.

Accuracy Ensured by Inspection and Reject Systems

In low-speed semi-automatic and manual filling processes, the production rate makes spotting defective fills or caps relatively simple. However, in automatic medium- and high-speed systems (less than 40bpm), it is impossible for a human to identify fills that fall outside a very strict tolerance, or caps that are skewed or improperly torqued. A well-designed monoblock filler/capper for precise applications will incorporate sensors that allow every step of the process to be inspected. In a net weigh filling system, sensors check the tare weight scale and gross weight scale. If the tare weight scale does not register any weight, the sensor generates a 'no bottle – no fill' condition, which allows that index position to bypass the filling and capping processes altogether. The gross weight scale generates a 'correct fill' condition if the weight is within the programmed tolerance, allowing the container to continue on for downstream processing while untagged bottles are rejected. Sensors are also used to verify the presence of parts such as the plug or the cap. Special cap sensors can also detect skewed or incorrectly torqued caps. Only product that is tagged as 'correct' at all stations is allowed to continue while product that is untagged at any stage in the process is rejected. This programming offers a second level of quality control to the system as a faulty sensor at any stage in the process causes all product to be rejected rather than allowing them to pass uninspected into the production stream with the presumption that the product meets quality standards.

The reject mechanism itself may vary depending on the container and the production speed. In higher speed systems (up to 120bpm), a robot may be integrated to pick untagged rejects from the discharge of machine and place them in a reject bin or tray. Moderate-speed monoblock filler/cappers may incorporate a soft reject option that uses pneumatic pushers to move the untagged bottle onto a separate reject conveyor. Regardless of how it is accomplished, the reject system ensures that only correctly filled and capped product is allowed to remain in the production stream, assuring high quality as well as high precision.

Highly precise filling systems remain challenging to design and commission, but an innovative machine builder can provide the features required to simplify these applications. By choosing a system designed to incorporate exact feeding systems, weigh scales, servo drives and sensors, pharmaceutical, diagnostics and cosmetic manufacturers can realise sustainable high-speed production rates while at the same time incorporating quality control into every step of the process.

About the author

Kim Norris is the Sales Project Coordinator for ESS Technologies. Since joining ESS in 2007, she has written numerous technical articles, white papers and case studies. She also writes the company blog and has recently published technical articles on robotic applications for several industry magazines. Prior to joining ESS, Kim acted as the Editor of the *Fiber Optic Reference Guide*, 2nd edition and *Fiber Optic Video Transmission*. Kim received an MA in English from Virginia Tech, US in 1992.
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