FRAIN INDUSTRIES

COMMON CAPPER PROBLEMS

Getting to closure

A Frain Industries Packaging Equipment Whitepaper

All packaging operations are important but capping is one of the most critical. An improperly capped bottle can leak product out or damage product by leaking air in. This paper will focus on continuous thread (CT) screw caps. It will walk you through some of the issues that arise and how to prevent or resolve them.

In any discussion of screw caps the key parameter is cap torque. On the packaging line, there are two types of torque to be addressed: Application and removal torque. These are sometimes known as “on” and “off” torque. Application torque is a measure of how tightly the cap is screwed down. Removal torque is a measure of how much force is required to remove the cap. In virtually all applications, the removal torque drops to next to nothing once the cap has been loosened by 1/8th turn or less.

If there is too much application torque, the cap can be damaged, threads may strip or the end user may not be able to get it open. Too little and the cap may leak or may vibrate loose in shipping.

Application and removal torque are correlated but not are not necessarily equal. Ten inch-pounds of application torque may be required to provide 5 inch-pounds of removal torque for one cap/bottle combination. For another, ten inch-pounds of application torque may result in 15 pounds of removal torque. Once the relationship is established, a given application torque should consistently result in the same removal torque.

There are several machine and component related issues that can affect capping consistency. Before we get to them we need to discuss some other issues.

Measurement

Capper operation must be monitored by periodically testing the removal torque. If there is variability, it may be the result of improper testing rather than inconsistent capping. Improper testing can cause mechanics to chase problems that don't really exist.

Several types of torque testing instruments are commercially available. Manual testers are effective and relatively inexpensive. Fully automated systems are also available. The bottle is clamped into a base, the operator removes the cap and the meter shows how much removal force was required to loosen the cap. Some models send the reading to a printer or memory for statistical analysis. Digital readouts are generally preferred as they reduce the possibility of operator reading error.

Regardless of type of tester, it must be periodically calibrated to assure that it is reading accurately.

There are a few things to watch out for when using a torque tester:

Bottles must be clamped in the device so that both bottle and tester center of rotation are aligned. Misalignment will cause erroneous readings. Testers usually have bottle clamps designed to automatically center the bottle on the tester. If the bottle has an "F" style or other offset neck the clamps may require manual adjustment and/or special fixturing.

Operator technique can also cause apparent inconsistencies. Generally gradual pressure should be applied to the cap until it breaks free. An alternative technique is to apply a sharp twist to break the cap free. This will usually provide a higher removal torque reading than the slow and steady technique. They key here is training everyone to use the tester in the exact same way every time.

Another issue is **how the force is applied to the cap**. Different operators may grip the cap in different positions, which can change the amount of removal torque registered. Providing a cap chuck with a T or round handle can reduce inconsistent gripping. This forces all operators to grip the cap in the same way.

Needless to say, it is important that removal torque be properly measured prior to making any adjustments to the capper.

Bottles and caps

Cap and bottle materials, design, and tolerances will all effect torque. When these are inconsistent, removal torque will vary through no fault of the capper. Sometimes two caps may be identical except for color. This shouldn't change anything but sometimes does, as one color may be softer or slipperier than the other.

Neck outside diameters (OD) and cap inside diameters (ID) are sized for an appropriate fit assuming no variation from the design dimensions. In the real world no process is perfect and clearances will change as these dimensions change, sometimes dramatically. A cap at the lower end of its specification (minimum diameter) may not even fit on a neck at its upper limit (maximum diameter). A cap at the upper limit of its specification may never tighten on a bottle neck at its lower limit. This can only be corrected with better, more consistent components.

Aging, especially on lighter weight bottles and especially when storage is in an uncontrolled warehouse can cause necks to shrink or expand.

It is important to recognize when the variability comes from testing or from materials rather than from the capper. Failure to do so will result in a mechanic tinkering with the capper all day trying to get it right and failing to do so. In most cases they will amplify rather than minimize torque inconsistency.

Missing liners

Many caps use paper, plastic or composite liners to provide the seal between cap and bottle. These liners are applied at the converter and held in place by either a dab of glue or by locking under the cap thread. Either way, they can fall out of the cap during handling at the converter, shipping or on the line at the cap orienter. This causes two problems: First, the linerless cap will not seal properly. Second, the liner, mixed with the caps can cause jams, especially in the cap feeding chute. If liner caps are used, there should be a detection mechanism to detect when liners are missing. There should also be a relatively easy, preferably automatic, way to remove loose liners from the orienting and feeding system.

Cap placement

The first step in capping is getting the cap onto the bottle. The trend toward lightweighting caps makes getting this right more critical than ever. The reduced rigidity and depth of some lightweight caps makes them more prone to deformation in the cap sorter. Caps that are out of round and/or warped will not go over the bottle neck correctly.

If this is a frequent occurrence it may be necessary to run a lower level of caps in the sorter. Sorters may be run at higher speeds than actually necessary to keep up with the capper. Reducing the speed to the minimum required may also help reduce deformation by reducing churn. This is less of a problem in chuck style cappers. The chuck, in picking up the cap prior to placement, tends to overcome any deformities. It is critical in inline cappers and other style cappers where the bottle itself is used to pull the cap from an escapement. If the cap is deformed, the bottle may not catch the leading edge. If it does catch the leading edge, the cap will not sit flat on the neck. When the first pair of spinning disks engage the cap, there may not be enough downforce to force the threads to engage correctly. This can result in the cap falling off creating a possible jam. It can also result in cross threading, where the cap seems to be on the bottle and may even achieve correct application torque but is not sealed.

Torque control

There are several technologies in common use to control application torque.

Mechanical disk clutches are one common technique. These use a series of alternating metal and fiber plates forced together by spring or air pressure. Adjusting the pressure on the clutch plates controls torque. When the desired torque is reached, the plates slip, preventing further tightening. Chuck speed can be an issue because, once the clutch plates do begin to slip, residual inertia in the chuck can keep applying torque. Tachometers can avoid this problem by assuring that each chuck or wheel always spins at the proper speed.

Disk clutches are sensitive to contamination. If they begin giving inconsistent torque, a possible cause is that they have gotten soapy water from washdown or an oily product between the disks, reducing the friction. Some sugar-based products, if they get into the disks, can cause them to lock up, resulting in overtorquing the caps.

Magnetic clutches have no sliding or contact parts, which give them an advantage over disk clutches. A female magnet is mounted on the drive shaft and the chuck is mounted on a corresponding male magnet. The two parts couple magnetically and remain coupled until the desired cap torque is reached. Once the coupling force (application torque) has been overcome the magnets spin freely preventing a further torque application. The depth of insertion of the male into the female magnet is adjustable and is used to control the application torque. Magnetic clutches are highly repeatable and, with no contact or wear parts, not generally susceptible to problems caused by wetting.

Servo motors eliminate the clutch entirely. Application torque is controlled electronically by the motor, so that it stall stops when the proper torque is achieved. An advantage of the servo drive is not only that it controls the torque precisely, it can also measure and record the torque applied to each cap. If insufficient torque is applied, because of stripped cap threads for example, the system will record that as a trigger and automatic rejection.

Compressed air motors are sometimes used similarly. The amount of air pressure controls the torque at which the motor stalls.

Proper clutch operation can often be verified by observation. Whether disk or magnetic clutch or servo motor, the cap chuck should be observed to pause momentarily at the end of tightening. In the case of a friction wheel capper the only the last pair of wheels will pause. When the chuck or wheels do not, it is a sign that the cap has not been completely tightened, or that the cap or bottle are slipping.

An alternative to clutches is a spring actuated chuck. These chucks have jaws which grip the cap firmly during application. When correct torque is they snap open to release their grip. The chuck continues to spin but, with no contact between jaw and cap, no further torqueing occurs.

Chucks

The simplest chucks are aluminum shells with an elastomeric insert tapered to fit over the upper rim of the cap. One issue with these chucks is that they can require considerable downforce to prevent slippage between cap and chuck. If the bottle is insufficiently rigid, it may collapse causing the chuck to slip against the cap. If the bottle has a neck ring, a support underneath may solve this problem.

Insufficient downforce, whatever the reason, allows uncontrolled slippage between cap and chuck to determine torque rather than controlled slippage in the clutch. Slippage between cap and chuck also causes scuffing of the cap and generation of particulates. These particulates can cling to a plastic bottle and wind up as lumps under the label. Other styles of chuck are serrated to match serrations on the cap. These serrations are designed to match and positively engage the cap. If the cap serration pattern changes, it is necessary to change the chucks, or at least the serrated inserts, as well.

Bottle holding

It's not enough to hold the cap firmly during capping. The bottle mustn't slip either. Square and rectangular bottles are relatively easy to hold due to their shape. The side belts of an inline capper or a center-column starwheel and guide rail on a rotary capper, will keep them from rotating. Round bottles will need to have the side belts adjusted tightly enough so they can't rotate. Rotary labelers commonly have semi-circular grippers or other mechanisms to prevent rotation.

It is important not to grip the bottle so tightly as to cause deformation. If the bottle is deformed in holding, it will remain deformed after the cap has been tightened. To avoid this, multiple or wider side belts or belts with a softer material can distribute the force over a greater area reducing deformation. If mechanical grippers are used, more gripping area and/or softer pads can prevent rotation while avoiding deformation.

Capping inspection systems

Detection systems are particularly critical when using foil liners that will be induction sealed. No liner means no security seal. Fortunately foil liners are easily detected with a capacitance sensor that reacts to the foil. This sensor, along with a reject system, should normally be mounted at the discharge of the capper.

Twenty years ago it might have been necessary to rely on human operators to detect cap problems but that is so case today. A simple missing cap detection system can be built with two photoeyes and a smart relay for a few hundred dollars. Camera based systems that can identify cross-threaded caps, loose caps, or other conditions are not only easily affordable, but they have also become simple enough that most plants can effectively use them.

As with any inspection system, these should be designed to operate in a fail-safe mode. It is far better to reject a properly capped bottle than let an improperly capped one get out into the market place. One way to do this is to trigger a delayed rejection for every bottle as it is inspected. If there is no defect, the rejection is cancelled. If the cap fails the inspection, the reject is allowed to take place.

Conclusion

Good quality caps and a well-maintained capper, properly set up, should produce few problems. The key to consistent outputs is consistent inputs. If the inputs vary—for example, inconsistent setup adjustments or variable cap dimensions—the output will vary as well. Consistency is quality, and quality is consistency.

About the Author: John Henry

John Henry is the Changeover Wizard at **www.changeover.com** and the author of multiple books on packaging machinery including *Machinery Matters: John Henry on Troubleshooting, Packaging, Machinery, the Packaging Machinery Handbook, Secrets of Buying Packaging Machinery* (with Rich Frain) and *Achieving Lean Changeover: Putting SMED to Work*.

He can be contacted at **john@changeover.com** or **787-550-9650**

Get to know Frain Industries

Frain Industries is the world's largest provider of high quality pre-owned packaging and processing machinery. Frain buys, sells, rents and leases USED equipment and has over 30,000 machinery listings in our database, as well as over 8,000 quality used machines immediately available for 2 day shipping. We also provide the ability to retool, add a PLC or provide complete line integration on any machine.

Our skilled team of technicians and engineers can improve your machinery's productivity as well as provide emergency field service. Come visit us at our new facility in Carol Stream to find the right piece at the right price.