John Goff offers solutions to poor screw tip performance and discusses trends in screw tip designs in his latest article in the series on how to achieve optimum injection cycles

Solving screw tip assembly problems

Troubleshooting related to screw tip assemblies encompasses a variety of approaches. The more popular ones are described here.

An indication that there is a problem can be the absence of a melt cushion value (screw bottoming out), which suggests that the seal between the sleeve and pressure back ring is defective. Increasing the changeover and screw stop positions by the same value will give the same shot volume with more material in front of the screw before it bottoms out. This needs to be monitored and if a melt cushion now occurs, the holding pressure time should be increased and monitoring continued. Achieving the same melt cushion value will indicate that the problem is within the area from which the screw tip assembly had been operating. If, on increasing the holding pressure time, the screw continues to move forwards leaving a zero or minimal cushion, then the seal between the sleeve and pressure back ring is defective and the molten material continues to be forced backwards along the metering section of the screw.

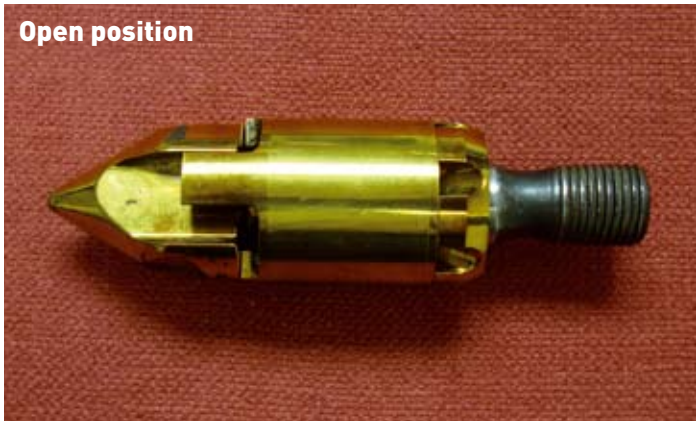
The presence of molten plastic in the feed or material intake section of the Archimedean screw also suggests that the screw tip is defective so that material is being forced backwards from the compression section.

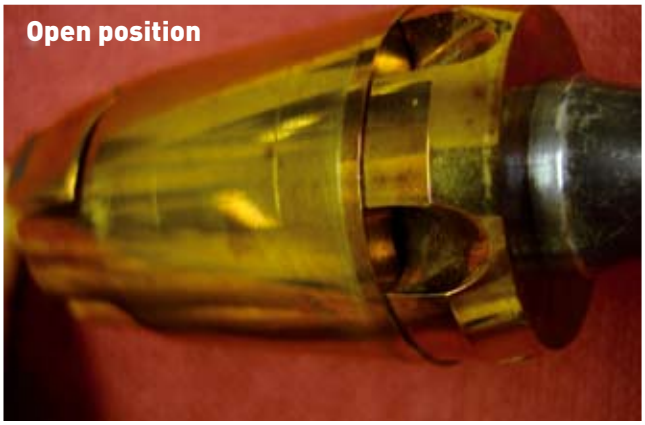
Another indication of poor screw tip performance is when the moulding machine allows reverse (clockwise) screw rotation. When the screw tip is defective during the injection stroke, reverse rotation becomes visually evident as a result of a defective seal and the molten material being forced backwards along the Archimedean channel of the screw.

Often, maintenance engineers remove the screw tip

The ball check valve offers a fast response to closure with high accuracy. Photo supplied by Nickerson Europe

A reverse rotation of the screw motor, just prior to injection, closes the ring assembly and forms a hermetic seal





The castellation design and the incorporation of servo motor technology has given up to a four fold improvement in machine performance

assembly following requests from processing personnel and on inspection, the screw tip assembly is found to be in good condition with the sealing faces showing no damage. Also, there is an absence of inclusions or foreign material within the screw tip assembly. Based on this, the screw tip and screw are reinstalled with the comment "no problems, looked very clean". Yet, on reinstallation and a further trial, the melt cushion value still varies and the screw continues to bottom out. The screw tip is then reluctantly removed again and with more thorough inspection, a hairline crack is detected in the sleeve.

Detection of a fine crack can be simply ascertained by heating the cleaned sleeve and looking for a polymer film present on the outside and inside diameters of the sleeve. When a defective ring is under pressure, the crack opens to allow molten plastic to become entrapped and prevent sealing. When pressure is reduced, the crack then closes on the molten plastic, squeezing out the excess. On heating the cleaned sleeve, the presence of the polymer film highlights the formation of the crack. Inspection of the sleeve under a microscope will also confirm the crack.

Screw tip performance is often questioned with large diameter screw tips of 60 mm upwards. As a result of too much decompression stroke, usually associated with mould tools containing a single hot bushing, the presence of surface splay occurs. Reducing the stroke overcomes this, however, flashed mouldings are intermittently produced. They are insufficient to necessitate a detailed investigation, but enough to affect the expected productivity requirements (OEE values) and reject values, because the comprised decompression stroke leads to a variation in the actual position of the sleeve. The distance for closure and subsequently the rate, therefore, sometimes changes, which prevents the same amount of material from being lost each cycle; the additional amount is transferred into the mould cavity/cavities and causes flashing. It is the stroke of the sleeve that needs to be physically shortened to achieve both objectives.

Screw tip designs

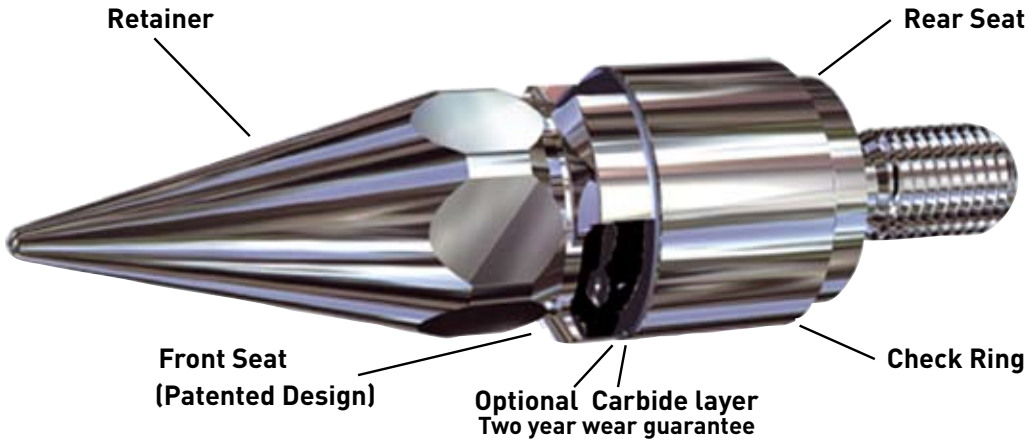
Screw tip design and configuration has, and still is, a subject for examination. Each design or concept professes to overcome the common issues of inconsistent operation (closure), longevity of performance and conciseness of shot weight delivery each cycle.

Castellation design. With the introduction of servo-electric direct drive machine technology applicable to the reciprocating screw, the acceleration time of the screw to its set velocity has greatly reduced, which means that the time taken for the screw tip to seal has become extremely important. Conventional three-part screw tip technology has difficulty in coping with this issue, especially if the sliding fit between the outer diameter of the sleeve and inner diameter of the barrel varies as a result of manufacturing tolerances and the presence of wear. To combat this issue, servo electric moulding machine manufacturers have developed a design that incorporates castellations.

This design readily utilises the characteristics of servo motor technology whereby instead of the ring closing/seating by the sliding sleeve, a reverse rotation of the screw motor just prior to injection closes the ring assembly. This forms a hermetic seal by blocking the passage of molten material to the front of the screw tip by means of the circular holes. On normal screw rotation, the screw tip assembly reverses its position to allow the molten material to pass through the coincident holes to the front of the screw.

The effective operation of this design has allowed servo motor technology to achieve highly consistent component manufacture relatively easily compared with the performance of the conventional sliding ring design. In fact, the synergism of the castellation design and the incorporation of servo motor technology has led to up to

THE FOUR PIECE SCREW TIP ASSEMBLY ALLOWS FREE FLOW OF THE MATERIAL WITHIN THE SEAT AND SELF-CLEANING



a four fold improvement in shot-to-shot consistency and machine performance compared with hydraulically activated machines that possess conventional screw tip technology. Because of the unique opportunity to close the screw tip prior to the forward movement of the screw, a hermetic seal is created, which results in consistent delivery of shot volume each cycle.

Ball check valve. Another common type of screw tip design that has recently made a popular return to use is the ball check. This type of screw tip offers an extremely fast response to closure and gives high accuracy because the small movement of the hardened ball being forced against its seating becomes concise and extremely efficient. The main reason why processors moved away from using this type of valve was its limitations in achieving fast screw recovery times, issues of contamination when changing colours and the concerns of material degradation because of the limited passage for the molten material to pass through the circumferentially machines holes.

Developments have been implemented to address these issues, hence its popularity has considerably increased over the past few years. The use of heat sensitive and flame retardant materials in addition to PEEK still remains an issue, but viscous materials such as PC, PMMA, PES, PSU, PEI can now be suitably processed.

Z4 screw tip valve. The other designs of screw tip regularly used are the Zeiger Z4, formerly the Mallard design, and the Z3. The four piece screw tip assembly is shown above. The inclusion of the front seat and the difference in steels, as well as surface hardnesses between the retainer and the front seat, have enabled longevity of service life. Its design caters for free flow of the material within the seat as well as for self-cleaning and achieving a more positive seal. The rear seat can be tuned by its overall length to accommodate the processing of different materials.

There are, of course, other designs of screw tips assemblies, each with their own merits. The most important consideration is shot-to-shot consistency.

More information

This is the eighth article in the Moulding Masterclass series, which discusses the fundamental issues that prevent optimal injection cycles. Recent articles can be accessed, **here**, **here** and **here**, respectively.

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