PHOTO: MÄNNER

In the latest instalment in his Moulding Masterclass series, processing expert **John Goff** looks at selection of holding pressure and timing for hot runner fed moulds

# Get more from your hot runner

In the previous instalment in this series, we looked at selection of holding pressure and time values for cold runner moulds. In this article, we will consider selection to reap the benefits of hot runners. It is important to understand that the manner in which holding pressure and holding time values are selected for hot runner moulds differs from cold runner types and varies according to hot runner system employed.

Furthermore, it must be considered that the design and complexity of the moulding, its end use, the type of thermoplastic material, and the manufacturing costs can often dictate the pressure and time values used. For instance, the holding pressure time value used for the manufacture of caps and closures may be selected to achieve the minimum time value necessary to obtain a stable, dimensionally and visually compliant moulding.

Any unnecessary extension of holding time value will have repercussions on the overall piece part cost and resultant output rates, particularly when the mould tool is expected to produce millions of parts per annum. So the same objective that might be applied to closure production might not, however, be applied to components for the assembly of medical or pharmaceutical devices, where accurate dosage of a drug or medicine is required. These mouldings would, of course, need to be produced economically but the emphasis would be on the maintenance of the micron tolerances required to achieve the specified performance of the dispensing device rather than cost of manufacturing.

For similar reasons, the manufacture of an automotive headlight assembly, where optical clarity and transmission of light is vital to provide optimum performance, may require a completely different approach to avoid the creation of high levels of internal stress.

In the determination and selection of holding pressure and holding pressure time values, the use of hot runner technology offers significant advantages over conventional cold runners as it allows a wider scope for optimisation as the temperature of the molten material reduces in the gate area. The processor can, in effect, determine both the holding pressure and holding pressure time values to suit the particular moulding or application.

Quite often mouldings can be produced using a combination of higher holding pressure value and an associated shorter holding pressure time, while achieving the same attributes as if the optimally determined lower pressure and longer time values were used. However, it is advisable to be careful if adopting this approach. As stated in the previous article, the use of high holding pressure induces more stress within

**Hot runner moulds provide wider scope for process optimisation than cold fed types but are more complex to get right**

the moulding, and this can lead in certain circumstances to service failure of the part. So if higher holding pressures are used, then the moulded parts should be subjected to vigorous testing to ensure that premature failure does not occur.

Valve gated hot runner systems provide an additional advantage over static or fixed probe/thermal types as the valve pin can be prematurely actuated, allowing the gate to be closed earlier than the designated time value. By closing the gate early, the applied holding pressure within the moulding – and in particular within the gate area – can be uniformly distributed to prevent over-packing and to reduce the level of inherent stress while still achieving a stable, visually and dimensionally compliant moulding. This can also result in a cycle time gain.

For thermal/static probe type gates an extended holding pressure time value can be used without damage to the probe itself. However, with a valve gate type an extended holding pressure time of more than 5 seconds, particularly when using valve pins of 1.1 mm diameter or less, may cause the material within the gate aperture to become compacted and the valve pin may be forced sideways upon closing. This will eventually wear the gate aperture, leading to flash on the moulding. In extreme circumstances, the valve pin may be bent causing catastrophic damage to the cavity or mould tool. For this reason, the inclusion of a replaceable powdered metallic insert is often recommended when using small valve pin diameters, see Figure One.

For edge gated hot runner systems the time value needs to be quite short, as too long a time value will cause a cold slug to form within the gate. This will restrict the flow of molten material into the cavity and result in short shots. In such circumstances, the cause is often attributed to too low a temperature rather than too long a holding time value. With certain side gated systems, a semi-solid slug can be forced into the cavity upon commencement of the next cycle.

For hot runner systems that can achieve gate freeze off by fast removal of heat, optimisation of the pressure and time values can be carried out in accordance with the principles applied to both cold and conventional hot runner systems. A major advantage with this system is the ability to optimise the rate of heat removal in accordance with the pressure and time selection.

A further issue often arising when optimising the holding pressure and holding pressure time value is the presence of stringing (fibres of fine hairs) from the gate/feed point, as shown in Figure 2. In such circumstances, the cause is often attributed to the effect of temperature rather than over-pressurising of the gate.

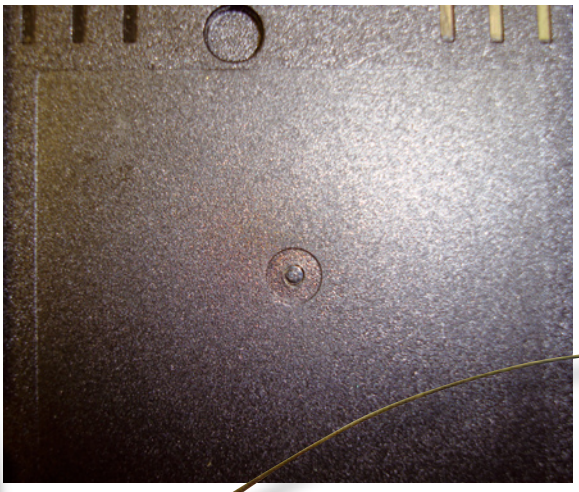

**Figure 1 Evidence of an anti-wear insert around a small valve pin gate**

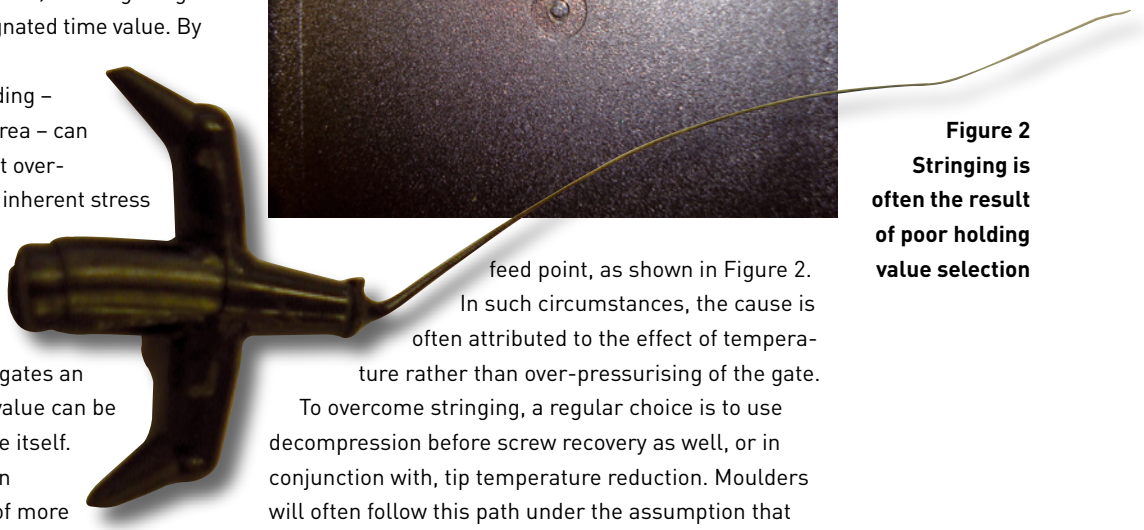

**Figure 2 Stringing is often the result of poor holding value selection**

To overcome stringing, a regular choice is to use decompression before screw recovery as well, or in conjunction with, tip temperature reduction. Moulders will often follow this path under the assumption that residual high temperatures are present in the area of the gate. Where such actions do not overcome the problem, further extension of the cooling time or a temperature reduction of the cavity plate takes place. Typically, one of the last considerations is how the holding pressure and holding pressure time values are derived.

However, the presence of fibres is very often also related to the visco-elastic behaviour of the molten polymer, particularly thermoplastic materials that exhibit the greatest visco-elastic behaviour. Semi-crystalline materials, particularly those of the polyolefin family, tend to be more problematic with stringing.

The holding phase of the injection moulding cycle also contributes to the manner in which the heat energy contained in the molten core is dissipated through the frozen layer and into the adjacent metal surface of the core and cavity. When selecting the cooling time value to ensure effective removal of the moulding in a distortion free condition, reference should therefore be made to the actual values derived for the holding phase, as such heat energy removal takes place during both phases.

## More information

John Goff is managing director of G&A Moulding Technology. This is the seventeenth in his Moulding Masterclass series. Recent articles can be viewed **here**, **here** and **here**.

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