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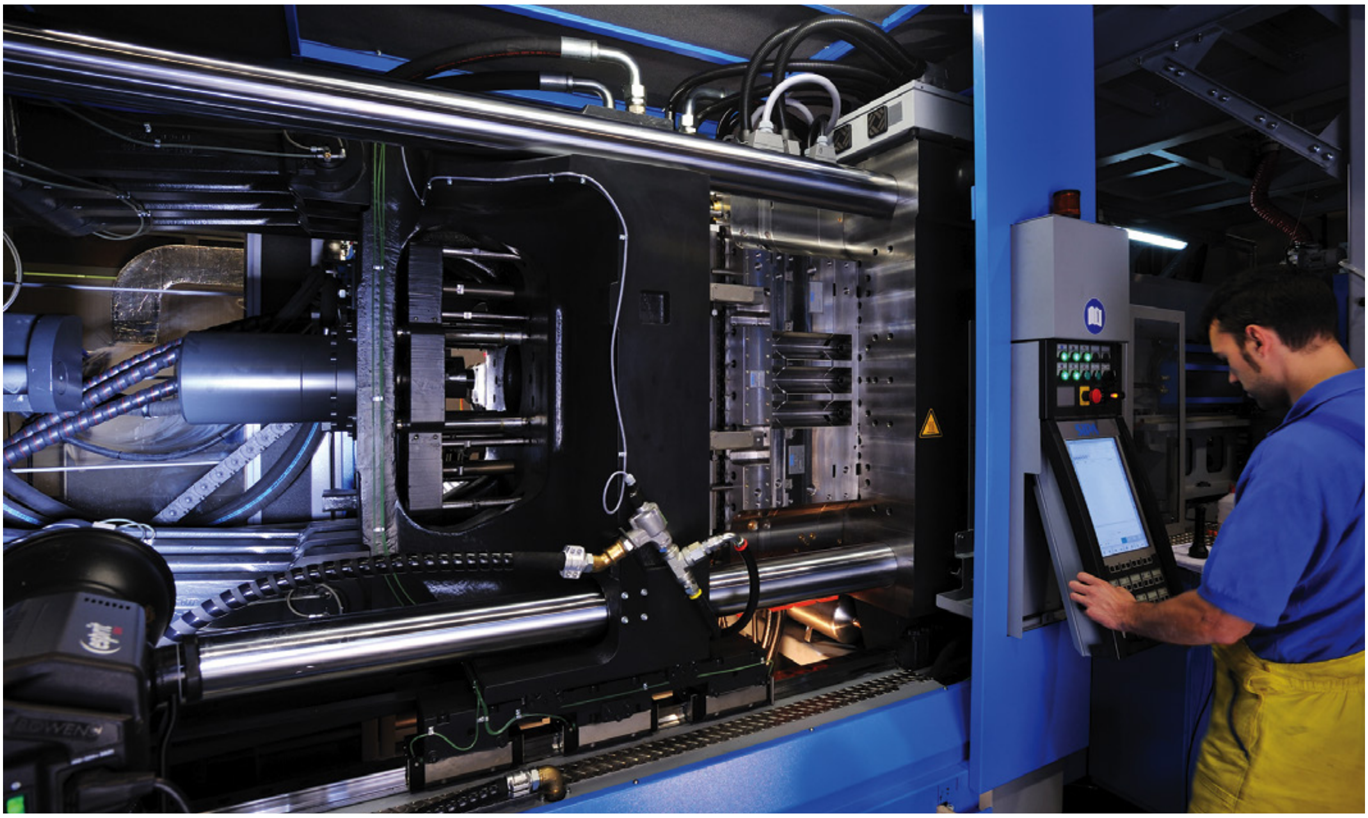

Making clamping force effective

In the second part of his discussion on effective clamping force, moulding expert John Goff explains how incorrect selection impacts on part quality

The use of an incorrect clamping force – whether too low or too high – has a detrimental impact on the quality of injection moulded parts, making it important to give its selection proper consideration during process setting and optimisation.

The use of too low a clamping force results in flash on the resultant moulding. From a mould tooling viewpoint the presence of flash should be avoided at all cost, especially if the mould cavities/cores are produced from a pre-toughened steel or aluminium. The presence of flash will cause the edge at the split line of the mould tool to become blunt and lose its integrity/sharpness so the edge of the moulding becomes less defined. This problem increases with each occurrence.

A common practice within the injection moulding industry is to reduce the clamping force value until slight flashing occurs on the moulding and then to increase the value again until flashing disappears. However, this is not recommended as it will often reduce the life of the mould tool.

The surface hardness of the shut-out faces of the mould tool is a critical consideration during design and manufacture. The selection of a clamping force which is sufficient to prevent flashing or visually poor mouldings but which may be inadequate for consistent component manufacture is not always noticed in the initial stages of a production run. Sometimes it is only during or upon completion that dimensional problems, visual issues (surface imperfections, ripples, gloss, surface flatness and non-uniformity of surface texture) and overall weight changes are noticed. By this time, machine production hours have been wasted, material used and labour expended in investigating the problems, resulting in additional costs and loss of productivity.

However, selecting too high a clamping force (often more typical) can also cause problems as it can mask the extent of inherent variation within an unstable moulding process. This usually results in inconsistent part quality, which may often go undetected until parts fail in service or have been running in production for an extended time period. Too high a clamping force can accommodate overpacking and overfilling of the mould cavity, resulting in overstressed parts. This may typically show as cracking of components and/or breakages of bosses, location spigots and poor output yield after decoration.

Another common problem is the presence of air/gas within the mould. Upon application of clamping force, air is contained within the sprue, runner and gate system (as well as in the cavity) in a cold runner mould tool, or only in the cavity within a hot runner mould tool. This needs to be able to escape as the cavity is filled by molten plastic. The most common technique to achieve this is to use vents strategically positioned in and around the cavity to ensure effective escape of air. A lack of good venting often results in burn marks (caused by ignition of trapped volatiles under compression), short shots or bubbles in the moulding. Volatiles ignition attacks the surface of the metal cavity and core to cause erosion. Such erosion is more prevalent with mould tools made of pre-toughened steel or soft metals.

Selection of too high a clamping force reduces the effectiveness of air removal. The size and depth of venting on a mould tool is important as it allows air/volatiles to freely escape from the cavity at the extremities of the material flow. Too deep a vent can result in flash occurring on the moulding, so caution should be employed during mould tool manufacture to prevent the need for rebuilding or welding. The use of too high a clamping force can often cause excessive compression that, over a period of time, reduces the initial vent depths and prevents a free unrestrictive passage for the air to escape. Such compression, therefore, will cause damage to the mould tool through erosion due to air/volatiles being trapped and "crushing" of the venting due to the high compressive forces being applied to the vent areas.

A simple and short term solution adopted by many moulders is to reduce the velocity at which the molten material enters the cavity by reducing the injection speed, which also increases the injection time. This speed reduction reduces the likelihood of combustion, eliminating black burn marks. The potential problem is that it also induces product variability, as previously explained in discussions on selecting the most effective injection time earlier in this series of articles. Furthermore, reducing the injection speed does not eradicate entrapped air/volatiles but can force the pocket of air into the bulk of the moulding. If the moulding is opaque, the presence of air bubbles would not be detected. Porosity in the structure of the moulding could cause failure if an external load was applied to the component during, say, a drop test, or if an impact is sustained in the area of the small pocket of trapped air/gas.

High clamping forces also provide the basis for using high holding pressures. In certain circumstances, these are necessary to achieve correct dimensional, visual and functioning of the component. However, the higher the compression, the greater the inherent stress and the risk of component failure. As stated earlier in this series of articles, the lower the holding pressure employed the more stable and effective the resultant moulding. Values of less than 20% of injection pressure, in particular, need interrogating to ensure sufficient pressure within the cavity.

High holding pressures are sometimes used for components possessing a textured or etched surface (VDI or grained) to ensure a consistent surface - the pressure forces the frozen layer into the resident grained structure within the cavity. Too high a holding pressure, however, can and will erode the etched surface through friction, causing the depth of the VDI or grained finish to reduce over a period of cycles (typically 200,000 to 1,000,000 cycles). This will necessitate the mould tool surfaces being re-textured/refurbished at some point. The time span for this to occur is often wholly dependent upon the holding pressure value used.

The use of too high a clamping force can also result in wasted energy. The application of clamping force by the injection moulding machine needs both electrical and physical energy. Savings in power consumption of up to 25% can be made, especially when operating larger injection moulding machines of 800 metric tonnes and above, by using the most effective clamping force.

This discussion of clamping forces will be continued in the next Moulding Masterclass instalment.

Correction: The third paragraph in the July/August instalment of Moulding Masterclass referring to measurement of clamping force was misprinted and may have confused some readers. It should have read: "The clamping force is usually measured in metric tonnes (imperial tons in the US) or kiloNewtons (kN) and is the amount of force used to keep the mould closed and so oppose the opening force."

About the author:

John Goff is a chartered engineer, a Fellow of IoM3 (Institute of Materials, Mining and Metallurgy) and managing director of injection moulding process consultancy G&A Moulding Technology (**www.gandamoulding.co.uk**). This is the 23rd instalment in his Moulding Masterclass series of injection moulding process optimisation articles. You can read the most recent instalments **here**, **here**, and **here**.

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