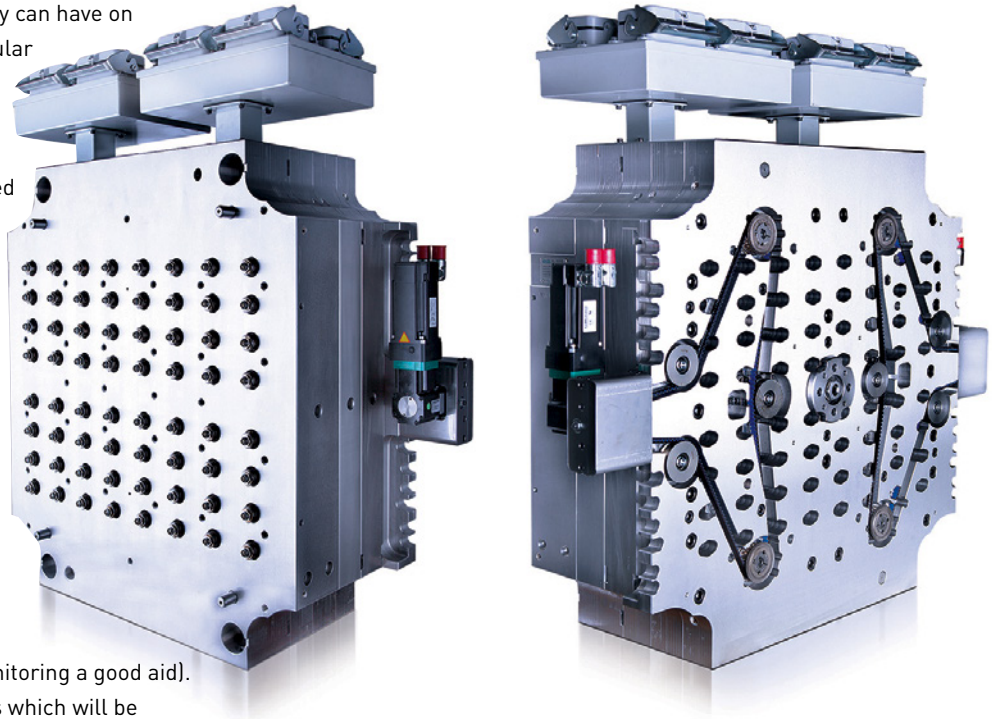
Continuing his discussion of process control, in this month's instalment **John Goff** takes a look at some of the challenges involved in setting and controlling hot runners

Optimising hot runner control

In the previous instalment in this series we discussed the impact that plant cooling capacity can have on the moulding process, paying particular attention to hydraulic circuit cooling.

Control and/or stabilisation of oil temperature in hydraulically-actuated moulding machines has, as it was stated in last month's instalment, regularly proved to be the Achilles heel of the moulding process when producing high precision components to micron tolerances. This is especially the case where multi-cavity mould tools and semi-crystalline engineering polymers are used. It is not that this cannot be achieved, but sustaining the process over a long production period can be highly challenging (although many companies have found real time monitoring a good aid).



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Above: It is essential that multi-cavity hot runner systems are correctly set-up to gain the maximum performance benefit

For this reason, along with others which will be discussed in a later article, the servo-electric motor technology found in all-electric moulding machinery is increasing in popularity worldwide. Most significantly, cycle-to-cycle repeatability, as well as reduced variability between mould impressions, is more readily achieved upon production start-up, enabling more effective use of production hours.

Consistent performance

The plant cooling requirements for consistent moulding performance mentioned in the previous article present an obvious and tangible issue that requires objective financial decisions. Sometimes essential changes cannot be made due to infrastructure and location of the moulding division, the significant costs involved, or due to lack of space and prioritisation of available funds. However, where the cooling system is properly designed and implemented the processor will benefit from a reduction or elimination of inherent temperature variability, allowing increased profitability and a faster return on investment.

A further and extremely important temperature variable that has a significant influence on the overall productivity of the moulding division – but which is very often given little or no attention – is the control of the hot runner system within the mould tool. Given the increasing popularity of hot runner systems in modern plastics production, their operation and control should not be overlooked. This is of particular importance when running large cavitation moulds or moulds consuming high volumes of molten polymer on each cycle.

The manner in which the hot runner entry bushing, manifold segments and drops are controlled will significantly affect the overall performance of the production cell. Many processors simply set the temperatures on the hot runner control module and then rely on those values being correct and stable throughout a production run. However, inconsistent or ineffective hot

runner temperature control can lead to poor mould performance, manifold or hot runner leakages, and/or distortion of the manifold and supporting plates.

Hot runner controllers of all types, zone capacities and cost are used within moulding shops around the world, with many varieties often found even within an individual moulding division. Whatever type is used, the ultimate objective of the hot runner controller is to initially record the temperature of the metallic mass by means of its heat sensing element (usually a thermo-couple type J or K), to compare it to that set on the hot runner control module (or moulding machine control page in the case of integrated control), and then to correct any temperature deviation by altering the power supplied to the electrical resistance elements.

Individual control

Each section of the hot runner system, from the entry bushing, through the manifold block and the nozzles/probes, needs to be separately controlled to minimise overall temperature variance, which has an influence on process stability. A spontaneous response at each section of the hot runner controller is essential.

As maintenance of these temperatures is imperative for process stability it is not unusual for a hot runner controller to be calibrated to tune the response to the individual requirements for each section. It is important to remember, however, that the temperature being controlled is that of the metal mass and not the actual melt. The temperature values recorded for both the inlet bushing and probes/nozzles may be relatively close (within 2-10°C) to the melt temperature, but the manifold temperature may differ by up to 20-25°C.

The manner in which the hot runner controller attains the set temperatures and the responsiveness of the power supply is very much taken for granted. Furthermore, the same mould tool may be run using different types of hot runner controllers. Various philosophies may be employed across the moulding plant, including:

- Mould tool and bespoke hot runner controller as a total unit;
- A mould tool where the same make of hot runner controller is used from a range of controllers;
- A mould tool used in association with the integrated hot runner control system within the moulding machine;
- A mould tool used in association with a range of different makes of moulding machine, each having its own integrated hot runner system;
- A mould tool used in association with different types and makes of hot runner controllers.

The author has found it is not uncommon for performance variability and inconsistency to be traced to inadequate and/or inconsistent hot runner controller temperature control. It has also been found that the filling pattern and overall percentage imbalance of a mould tool can be dramatically altered by changing the type/make of hot runner controller.

Such risks can be avoided if the moulder steers clear of the trap of simply setting the temperatures on the hot runner controller and allowing the process to run by itself with no monitoring. Hot runner technology is now an integral part of the injection moulding portfolio for plastics component manufacture, making it a necessity to optimise temperature values for each element of the hot runner system.

This discussion will be continued.

About the author:

John Goff is a chartered engineer (CEng), a Fellow of the Institute of Materials, Mining and Metallurgy (FIMMM), and CEO of injection moulding process consultancy and moulding process optimisation software developer G&A Moulding Technology (**www.gandamoulding.co.uk**), which provides consultancy services on all aspects of process setting, optimisation and control, including hot runner technology. This is the 28th instalment in his Moulding Masterclass series. You can read the most recent instalments in this series **here**, **here** and **here**.

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Right: Modern hot runner controllers are powerful tools providing the ability to optimise performance and enhance process stability