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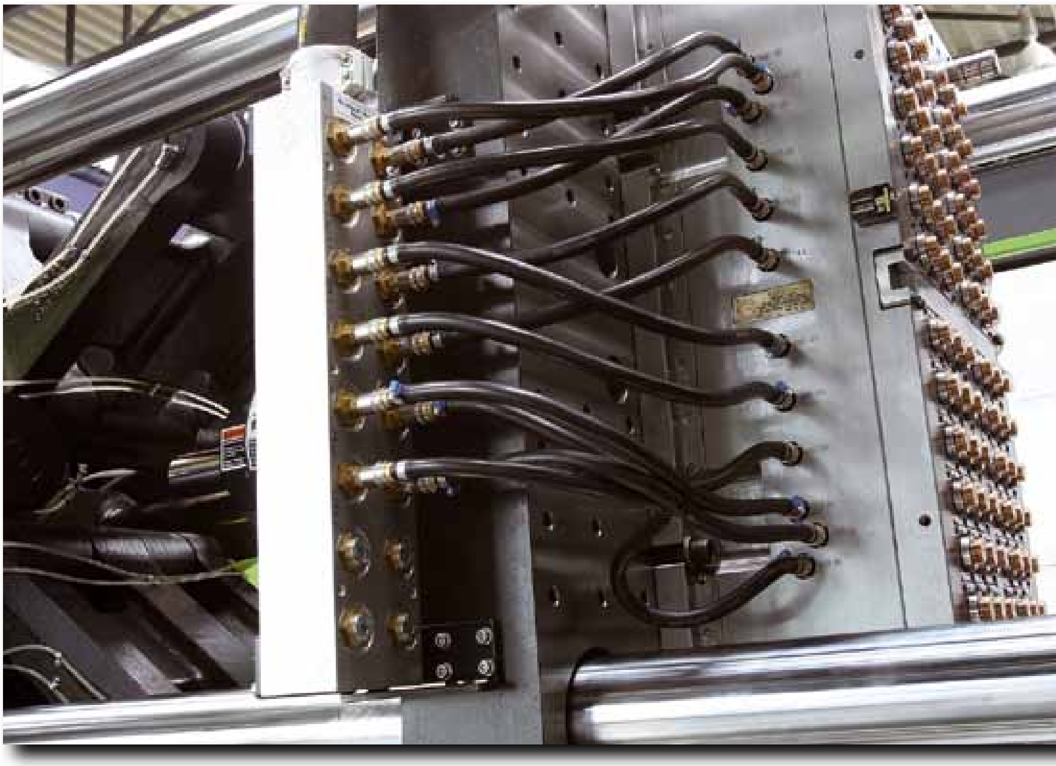

The best mould cooling channel layout can be compromised on mould installation. Moulding expert **John Goff** explains why

# Effective mould cooling means making the right connection

**Above: Careful cooling circuit connection can pay big benefits in final part quality**

The best efforts of the tool designer in placing the correct number of cooling channels in the mould and to locate the inlet and outlet ports at the optimum positions can so easily be undone when the mould is placed in the machine if appropriate consideration is not paid to how those channels are connected.

In the previous instalment we considered how poor selection and sizing of connectors can restrict the rate of cooling medium flow into the mould's cooling circuits. In this instalment we will take a detailed look at how those circuits should be connected to achieve the optimum results in terms of part quality and production efficiency. This is an important issue, particularly when it is necessary to achieve the maximum performance from the mould.

The two main options available to moulders are the use of looped circuits or independent circuits. The latter option, where each cooling circuit connects to a distribution manifold or flow regulator, is the most effective. Unfortunately, it is far more common to see looped circuitry used – installations where external loops are fitted to create a single path of coolant that cascades through the mould – and this is even more likely in the case of large mould tools weighing in excess of one tonne.

There are a number of reasons why looped circuit connections continue to be so widely used:

- Ease of mould tool set-up
- Insufficient time for mould changeovers
- Lack of available inlet/outlet ports on distribution manifolds
- Shortage of connecting hoses
- Established practice employed within the moulding division.

However, whatever the reason, it must be understood that the effectiveness of heat energy removal from within the mould is greatly impaired, especially as the number of looped circuits increases.

Figure 1 highlights a typical set up that often results in cycle time and moulding quality issues. The mould tool shown has been well designed, providing the ability to effectively remove residual heat energy through the numerous cooling circuits in the mould tool. However, the majority of the individual circuits are looped, which prevents the residual energy from being uniformly and effectively removed.

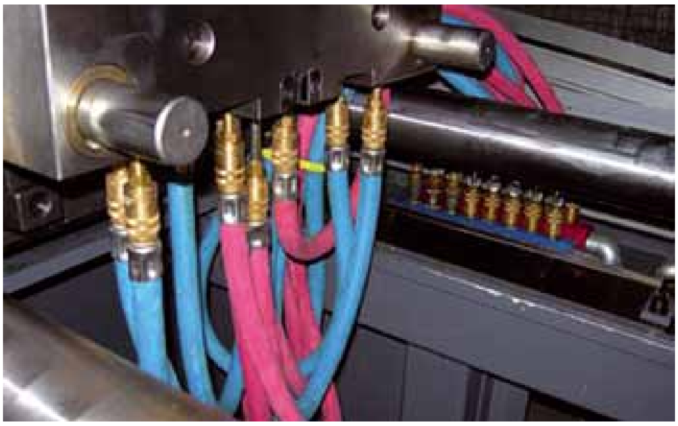

**Figure 1 (above left) shows a looped mould set-up against Figure 2 (right) which uses a more effective independent solution**

This scenario will very often result in moulding quality issues such as dimensional inconsistency across different impressions within a multi-cavity mould tool, surface finish variations, and poor shape retention of moulded parts. These issues will differ according to the polymeric material being used and the wall thickness distribution within the component.

In the case of processing a semi-crystalline material, the presence of looped circuits will often dictate the extent of crystallinity created within sections of the moulding where there is a non-conformity or sharp change in wall section, resulting in warpage or change in shape or dimension of the part after it has been produced.

Where an amorphous material is being processed, however, the use of looped circuits may result in an extension of the time required to cool the part to below its heat distortion temperature (HDT), particularly within thicker sections of the moulding. This will result in an unnecessary extension of the cooling time in order to overcome possible shape and dimensional changes on removal from the mould. Such a shape change is termed "distortion".

Very often, the cooling circuits within a mould tool are machined to accommodate a manifold that is permanently secured to one of its faces. Such techniques have evolved to accommodate the need to increase the surface temperature in certain parts of the mould tool, such as to improve polymer flow when producing larger components with long flow length to wall thickness ratios.

As stated earlier, for effective heat removal to take place the use of independent circuits is preferred. However, the choice of whether flow regulators or distributor manifolds are employed can often also influence the ultimate outcome.

Flow regulators are sometimes supplied with the moulding machine and therefore tend to be more popular (Figure 3). Aside from the availability, they are often preferred by users as they readily display the flow rate value and temperature of the cooling medium. Distribution manifolds are supplied in pairs or zones, where all the respective inlet/outlet circuits are connected to a designated manifold or zoned section.

Traditionally, distribution manifolds relied upon part quality indicatiors to assess the flow rate - where a lack of coolant flow rate caused the mould surface temperature to increase this would often be reflected in changes in part quality. Today, the use of electronic or ultrasonic flow meters, in association with a distribution manifold, is becoming more popular and in such situations output values can be accurately measured without flow rate restriction/reduction.

Good moulding practice entails the use of distribution manifolds with the appropriate flow meters or suitably sized flow regulators. In addition, the position of flow regulators on the moulding machine is also important. Common problems that can occur include:

- Over lengthy pipe runs from the mould tool to the regulator
- Flow restrictions within the area around the control valve
- Poor visibility of flow rate values due to discoloration of flow tubes
- Lack of resolution of the scale on the flow tube necessitating the use of flow markers
- Leakages between flow tube and control valves
- Staining of flow tubes due to dirty or untreated water
- Blockages due to the presence of sediment or silt in the cooling medium
- Incorrect tube and float sizing restricting flow rate

**Figure 3 (right) shows a typical flow regulator, in this case by Wittmann**


through mould tool
- Restricted temperature range for cooling medium due to plastic flow tubes.

Figure 4 highlights the type of flow meters available for flow rate measurement. Various meters now offer an electronic output which is received by a central data collection facility enabling both the temperature of the cooling medium and the flow rate to be displayed either on the process data collection page on the moulding machine or at an independent central display.

With the mould cooling system connectors and the cooling circuitry and flow regulation optimised, we can now turn our attention to the performance of the mould temperature controller and/or chiller. This third element in optimising mould cooling – mould temperature controller selection – will be discussed in the next instalment in this series.

**Figure 4 (left) shows a number of different flow meters installed on a test rig**

### About the author

John Goff is managing director of G&A Moulding Technology. This is the 20th instalment in the Moulding Masterclass series of articles. You can read the most recent instalments **here**, **here**, and **here**.