In this month's Moulding Masterclass, injection moulding expert **John Goff** discusses how the machine architecture itself can affect the consistency of the production process

PHOTO: RALPH BIJKER

Inside the machine

So far this series has considered how the fundamental elements for consistent component manufacture are created, looking at how we can achieve good melt homogeneity, how we can deliver a consistent melt volume each cycle using the most efficient injection time, and how we can make sure the mould tool has the correct attributes to accommodate such cavity filling times.

Later in this series of articles we will continue to develop this overall strategy of achieving optimum moulding performance in association with good mould tool practices. This article will, however, make a brief departure by explaining how the injection moulding machine itself can influence consistent component manufacture.

The injection moulding industry today uses a wide range of moulding machines that utilise differing technologies, each of which has a significant influence on the ability to achieve consistent component manufacture. The newer technologies, most notably servo-electric motor systems, have clearly demonstrated their ability to deliver more consistent shot volume control on a cycle-by-cycle basis.

In fact, investigations carried out by many processors – including G&A Moulding Technology – have found that use of servo-electric machinery can result in up to four times better performance in terms of consistency. The reason for this improvement in consistency comes from the ability to better control and maintain the forward movement (or velocity) of the screw from its stationery screw stop position to the changeover point.

Servo-electric machines and some hybrid hydraulic servo-electric combinations are highly capable in terms of their ability to reproduce the same acceleration and deceleration profiles within the screw forward movement and accurately maintain the selected speed value to achieve optimised injection times. By contrast, the performance of hydraulically-actuated machines can be highly dependent upon oil temperature and its viscosity, on the purity of the oil in the system, and the manner in which the designated volume of oil is delivered to the

Figure 1: INJECTION SPEED CONTROL: Test A – slow-fast-slow

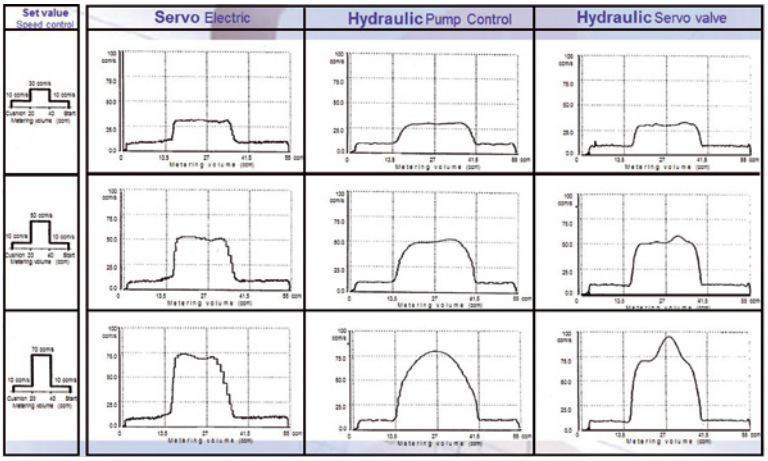

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Figure 2: INJECTION SPEED CONTROL

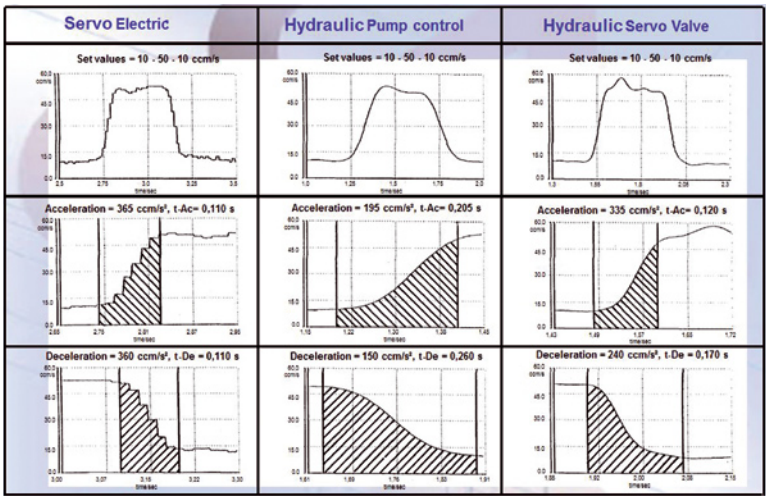

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Figure 1 and 2 above contrast injection speed profiles of different injection machine types

injection cylinder in order to propel the screw forward to achieve the selected velocity.

Hydraulic accumulators, fast acting hydraulic servo valves and computer control technology have been incorporated within the hydraulic injection machine hardware and software control systems to speed up communication and to improve repeatability and minimise variability. Even so, servo-electric technology retains the edge, as demonstrated in Figure 1 above, which highlights the differences in the speed profiles generated for servo-electric and hydraulically-actuated machines.

When parts are produced on hydraulically-actuated machines we see naturally inherent (hysteresis) variation, typically related to oil temperature control. Figure 2 shows a comparison of injection speed control on servo-electric and hydraulic machines producing the same part.

Due to ever increasing energy costs, servo-electric injection machines are more prominent in the thoughts of processors when purchasing new plant today. Aside from energy savings, component consistency and precision is becoming increasingly essential in industries such as medical, pharmaceutical, optical and teletronics.

The speed and accuracy with which the moulding machine makes the control changeover from filling to packing significantly affects component repeatability. Some makes of injection moulding machinery now provide the ability to control the speed at which holding pressure is applied. This is a valuable control option. It is widely accepted that the holding pressure application rate must be very fast for thin walled components so that applied pressure is delivered to the end of filling before the molten core solidifies. Meanwhile, holding pressure application rates must be much slower and more controlled for thick walled components to avoid penetration of the frozen layer by the molten material, which would result in split line flashing.

Injection moulding machines are highly adaptable and can be successfully applied to a wide range of products and materials. However, they need to be fully understood by the persons operating them to achieve optimised production. Where machines are purchased solely for one particular product, optimisation of holding pressure application should be undertaken as part of the process optimisation protocol.

Performance capability assessment prior to purchasing an injection moulding machine now tends to be the norm. Such assessments create a baseline upon which various types and makes can be compared. Although the hydraulically-actuated machine has limitations, it is still the most popular type being purchased. Not every part demands the accuracy of servo-electric technology, while for some production projects features such as core pulling, core back and coining may be key requirements.

Ultimately individuals are influenced in their purchase of a moulding machine for performance and many other reasons: familiarity of use and ease of maintenance; in-plant knowledge of machine operation; personal preference; technical support; availability; and cost of spares and delivery times.

We will return to the topic of injection machine performance later in this series of articles.

More information

John Goff is managing director of G&A Moulding Technology. This is the fourteenth article in the Moulding Masterclass series. Recent articles can be accessed in the Injection World archives, **here**, **here** and **here**.

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