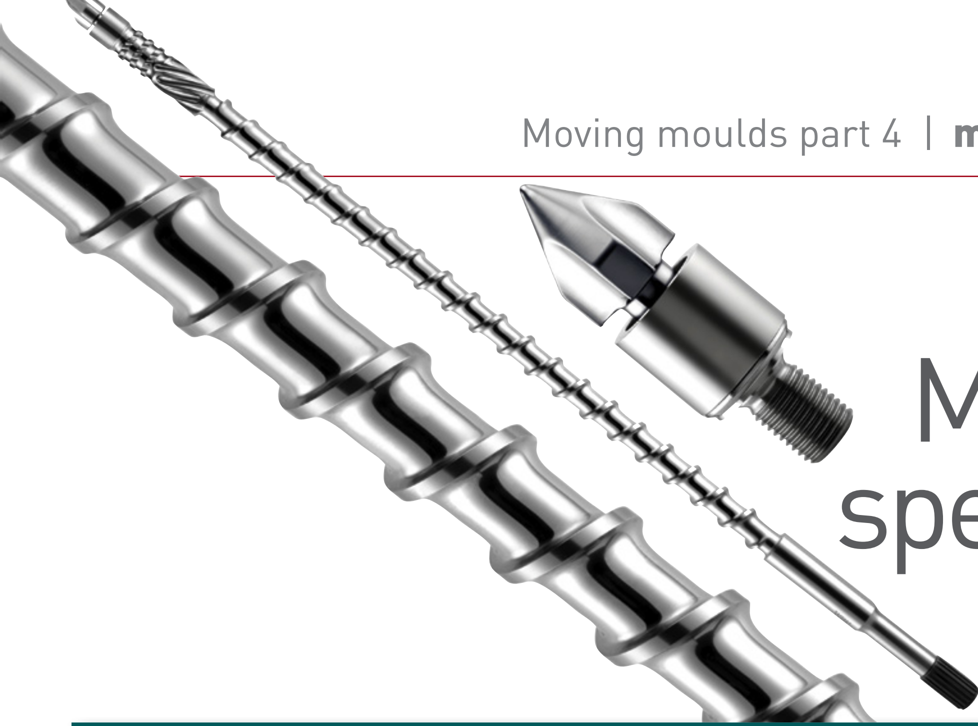

Make use of specifications

Moulding expert John Goff rounds off his tips on moving moulds between machines with an explanation of how to use manufacturers' specifications to ensure precise process replication

Moving moulds between different machines is a task every moulder needs to deal with. Over the previous three instalments (Part 1, Part 2 and Part 3) we considered some of the basic considerations, then looked in detail at the example of a moulder with two four-cavity tools for production of a PP box and lid. We previously considered the transfer of the box tool between two machines (A and B), which had the same clamp force and screw size but different injection unit classifications, and saw that the processing parameters could not be replicated. In this final instalment we will look at the lid moulding.

The basic injection unit specifications for machines A and B are shown in Figure 1. When we consider the manufacture of the lid component using Machine B, the inherently shorter melt flow length to fill the component results in an injection time of 0.36 seconds to correspond with the injection pressure of 118 bar hydraulic. Converting the 118 bar hydraulic pressure into the corresponding specific pressure value gives 1,588 bar.

The maximum available specific injection pressure for Machine A is 2025 bar, meaning that the actual pressure needed to produce the lid component is well within its capability. To achieve the required 1,588 bar specific pressure on Machine A, a hydraulic value of 141 bar must be selected.

So we can see that both Machine A and B are capable of achieving the same quality standards and output requirements for the lid component, whereas we had previously determined that the box component could only be produced on Machine B if we wished to avoid quality and productivity issues.

Naturally, the process parameters selected for Machine A will need to be referenced to the 1.196 : 1 ratio for the other hydraulic pressure settings, as demonstrated above for the injection pressures. Furthermore, the injection speed settings for both Machine A and Machine B will require adjustment in accordance with their corresponding available injection rate values to achieve an identical fill time of 0.36s. The plasticising rate will also need adjustment, as the rate for Machine A is 32 g/s in PS and the corresponding rate for Machine B is 52 g/s. The PP material used for the lid and box components has a lower melt density than PS, therefore, the actual plasticising rate for each machine is reduced by approximately 14%. This means Machine A has a reduced plasticising rate of 27.43g/s.

Knowing that the total shot weight for the four lid components is 36.32g, with the derived cooling time of 3.6s and the screw recovery time of 2.8s, an equivalent plasticising rate value of 12.97g/s is needed. Reviewing the data for Machines A and B shows both can achieve the required rate, even though there is a large disparity between machines.

Returning to the scenario of our processor, we can see the company has a dilemma. It has acquired two perfectly good 2,100kN moulding machines, but only one of them has the specification flexibility required to produce both the lid and box components.

We will now consider the consequences when the same two mould tools are to be used in a moulding machine of a completely different make but with the same screw diameter. Machine C is a 2,000kN clamping force machine with a 40mm diameter screw and barrel assembly (the specification is detailed in Figure 1). The attributes of Machine C will allow both the lid and box components to be readily moulded to the desired visual,

Above: Manufacturer's plasticising system data can be used to accurately replicate process settings on a different machine

Figure 1: Key specification data for three moulding machines, A, B and C

		Machine A	Machine B	Machine C
Clamp capacity	kN	2,100	2,100	2,000
Injection unit classification		430	600	750
Screw diameter	mm	40	40	40
Screw geometry		Standard	Standard	-
L/D ratio		20	20	25.2
Specific injection pressure	bar	2,025	2,423	2,500
Maximum cylinder head volume	cm^3	231	231	251
Maximum shot weight (PS)	g	210	210	228
Maximum injection rate	cm^3/s	224	187	153
Plasticising rate (PS)	g/s	52	32	39.4
Maximum screw stroke	mm	184	184	-
Nozzle sealing force	kN	80	80	50
Number of heating zones		4	4	5
Screw cylinder heating capacity	kW	11.1	11.1	15.54

Source: Data from Sumitomo SHI Demag (Machine A: Systec 210/580-430; Machine B: Systec 210/580-600) and KraussMaffei (Machine C: KM CX200-750)

flatness and dimensional requirements.

The differences between Machines A & B (2,100kN) and C (2,000kN) are quite apparent from the specification data. It is, therefore, important for the process setter to have a good knowledge and understanding of each machine's attributes by having at least a hard copy of the specifications for reference prior to attempting to transpose process settings derived in Machines A & B, or before optimising moulding parameters to replicate performance from both box and lid mould tools.

Naturally, the processing conditions selected for Machine C will be somewhat different to those employed for either the box or lid mould tools in Machines A and B due to the differences in shot capacity, screw stroke, injection rate, injection pressure availability, and hydraulic pump pressure. Another notable difference is the L:D ratio of the 40 mm screw for Machine C compared to the value for both Machines A & B. Such a difference will affect both the melt homogeneity and resultant melt temperature.

Another scenario, might be to consider a fourth machine of different make or type possessing a dissimilar screw diameter. Certain process parameters will be transferrable from Machines A and B – for example injection time, holding pressure, holding pressure time, screw surface speed – whereas others will have to be determined to accommodate the attributes of the specific plasticising unit.

Put simply, replication of the original processing conditions will not reproduce base and lid components to the previous quality and output rates. In certain circumstances, for example where the screw diameter is larger than that in either Machine A or B but provides a comparable injection pressure, then an increase in output rates can sometimes be achieved. More often than not, however, the melt homogeneity and maintenance of a consistent shot volume is necessary together with other process parameter changes to ensure comparability of performance.

Previous articles in this series have stressed the importance of fully scoping original conditions so that replication of component quality and cycle time can be achieved and, as demonstrated above, this is particularly important where different moulding machines and screw diameters are involved. In conclusion, when moving a mould tool from one machine to another – regardless of the make and type – it is extremely important that full details of the process are taken from the original machine for replication. Generally the process setter will not have to hand the required specification so, to enable greater vision, a comprehensive chart showing the important attributes of all machines in the workshop is often derived (an example is shown in Figure 2).

About the author:

Moulding Masterclass series author John Goff is a chartered engineer (CEng), Fellow of the Institute of Materials, Mining and Metallurgy (FIMMM), and CEO of injection moulding process consultancy and 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, and developed and markets its own Pro-Op process optimisation software tool. You can read the most recent instalments in this series **here**, **here** and **here**.

Figure 2: A process setting chart bringing together key specification data for all machines in the plant will help achieve smooth mould transfers

Injection Moulding Machine No		1	2	3	4	5	6	7	8
Injection Moulding MachineType		Hydraulic	Servo Electric	Hydraulic	Hydraulic	Hydraulic	Hydraulic	Servo Electric	Servo Electric
Clamping Unit		Direct Thrust	Toggle	Toggle	Toggle	Toggle	Toggle	Toggle	Toggle
Maximum Clamping Force	KN	800	1250	1500	1500	1350	3000	1000	500
Mould Opening Stroke	mm	500	350	500	500	450	675	350	250
Minimum Mould Height	mm	250	150	250	250	250	330	345	250
Maximum Mould Height	mm	350	450	560	560	480	710	575	350
Maximum Daylight Between Platens	mm	750	800	1060	1060	930	1385	960	700
Maximum Mould Weight	Kg	-	650	1700	1700	-	-	-	-
Platen Size (H x W)	mm	670 x 670	610 x 610	750 x 750	750 x 750	700 x 700	950 x 950	650 x 600	500 x 450
Distance Between Tie Bars (H x W)	mm	420 x 420	410 x 410	490 x 490	490 x 490	475 x 475	630 x 630	460 x 410	310 x 360
Minimum Mould Diameter	mm			300	300		400		
Location Ring Diameter	mm	125	125	160	160	125	160	125	125
Maximum Ejector Stroke	mm	150	100	160	160	140	200	100	70
Core Circuits Available	qty	2	0	2	1	2	2	2 with core pack	2 with core pack
Air Blast	qty	2	2	2	2	2	4	4	4

Injection Unit	Size	180	200	320	320	430	1450		250		160	
Screw Cylinder Type		Standard	Standard	Special	Standard	Standard	Standard		Standard	Special	Special	Standard
Screw Diameter	mm	30	26	25	35	40	60		28	22	22	25
Maximum Injection Pressure	bar	2025	2600	3100	1877	2025	1905		2900	2800	2800	2800
Maximum Injection Speed	mm/sec	120	330	683	617	200	300		300	300	400	400
Maximum Screw Speed	mm/sec	750	613	734	1028	670	1257		587	461	461	524
Cylinder Head Volume	cm^3	85	50	85	168	231	86		86	40	40	51
Maximum Shot Weight (Polystyrene)	gms	77	46	74	150	210	83		83	36	36	49
Maximum Rate of Injection	cm^3/sec	85	125	332	592	224	241		185	116	154	196
Maximum Plasticising Rate	Kg/h	72				28	53		37			26
Maximum Screw Stroke	mm	120	95	175	175	184	160		140	104	104	104
Robot		Yes	Yes	Yes	Yes	No	Yes		Yes		Yes	
Valve Gate Control		Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes