How to select Plastic Injection Moulding Machine 5

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2.11 Accumulator

Some PIMMs have an accumulator as an option to boost injection speed. An accumulator is an energy storing device that stores up pressurized hydraulic oil in a phase of low demand to be used in the injection (high demand) phase. It evens out the load on the electric motor and reduces its overloading. While increasing the electric motor and hydraulic pump sizes (available as an alternative by some manufacturers) does increase injection speed by about 25%, an accumulator does so with about three times increase. Figure 3. Accumulator

2.12 Injection rate

As an alternative to injection speed, some PIMM specifications use injection rate. Injection rate is the maximum volume swept out by the screw per second during injection. It is expressed in cm3/s.

Injection rate = injection speed * 3.1416 * (d/2)2,
where d = screw diameter in cm.

Note that injection speed is independent of screw diameter, but injection rate is.

2.13 Screw rotary speed

Screw rotary speed is specified as a range in rpm. Screw rotary speed by itself is not as critical as screw surface speed. The two are related by the screw diameter.

Screw surface speed (mm/s)
= 3.1416 * screw diameter (mm) * screw rotary speed (rpm) / 60

Each plastic material has a recommended maximum screw surface speed which must not be exceeded. For example, UPVC should not experience a screw surface speed of higher than 200 mm/s. AbbreviationOptimum surface speed (mm/s)Maximum surface speed (mm/s)GPPS (PS)800950HIPS850900ABS550650AS (SAN)400450LDPE700750HDPE750800PP750850PPVC150200UPVC150200PA-6400500PA-66400500PMMA350400PC400500POM (Copolymer)200500POM (Homopolymer)100300PET300400PBT300350CA400500PPO-M400500PPS200300Table 7. Optimum and maximum surface speed of resins

Example 12: What is the maximum rpm for a 60 mm diameter screw injecting UPVC?
Maximum rpm = 60 * 200 / (3.1416 * 60) = 64.

2.14 Screw motor torque

The hydraulic motor that turns the screw has a rated torque, expressed in Newton-meter (Nm) in SI unit. It represents the maximum amount of turning moment the motor can produce at the specified hydraulic pressure. A viscous material needs a high torque and a low rotary speed, vice versa for an easy-flowing material.

A higher torque is needed for screw C (large diameter) than screw A (small diameter). The proportional pressure valve is used to adjust the motor torque to the needed value during feeding.

2.15 Plasticizing capacity

Plasticizing capacity is the amount of PS that a PIMM can uniformly plasticize, or raise to a uniform moulding temperature, in one hour at maximum screw rotary speed and zero back pressure. Since it is rated in PS, an amorphous material, a higher plasticizing capacity is needed for semi-crystalline materials. Although the barrel heaters also contribute to melt the plastic, their capacities are not counted in plasticizing capacity.

To check if the plasticizing capacity of a PIMM is not being exceeded, calculate the weight of component and sprue per shot W (g) divided by screw rotation time t (s), and convert the quotient to kg/hour:

W * 3600/(t * 1000).

This must be less than the plasticizing capacity of the machine.

Since cycle time is longer than screw rotation time, the shot weight S (g) of a machine and its plasticizing capacity G (kg/hr) set a lower limit on cycle time Tmin (s) as follows.

$T_{min} = S * 3600/(G * 1000)$.

It is particularly important to match shot weight and plasticizing capacity in the case of fast cycling machines producing thin walled or closed tolerance components.

Plasticizing capacity could be increased by a larger electric motor and hydraulic pump.

Section 2.16 to 2.27 describe other attributes of the clamping unit.

The next five attributes relates to the dimensions of the mould the machine could accommodate. They indirectly relate to the maximum dimension of the moulded part.

2.16 Mould opening stroke

Mould opening stroke is the displacement of the moving platen from mould close to mould open. Mould opening stroke determines the maximum height H of the moulded part the machine is capable of. The relationship is mould opening stroke >= 2H + sprue length L

In a hot runner system, L = 0.

The inequality allows for a clearance for gravity, the robot arm or human hand to remove the part. Figure 4. Mould opening stroke

2.17 Mould height (thickness)

Mould height is left over from the days when presses are vertical. In a horizontal press, a more appropriate description is mould thickness. Figure 5. Mould height, width and length

In a toggle clamp PIMM specification, mould height is expressed as a range, from the minimum to the maximum mould height the machine could accommodate. The difference is the mould height adjustment the machine is capable of.

In a direct hydraulic clamp PIMM specification, mould height is expressed as a number, the minimum mould height the machine could accommodate.

The actual mould height must be bigger than the machine minimum mould height for the mould to be closed and clamped. Otherwise, a smaller machine (to be exact, a smaller clamping unit) is called for.

The actual mould height must be less than the machine maximum mould height for the mould to fit in. Otherwise, a bigger machine is called for. Figure 6. Mould height

2.18 Maximum daylight

The maximum opening between the fixed and moving platens when the clamp is wide open. It is related to mould opening stroke and minimum/maximum mould height as follows.

For a toggle clamp machine,
maximum daylight = mould opening stroke + maximum mould height.

For a direct hydraulic clamp machine,
maximum daylight = mould opening stroke + minimum mould height.

2.19 Space between tiebars

The mould must fit within the space between tiebars. This space is expressed in horizontal and vertical dimensions.

Refer to Figures 5 and 7. The mould width must fit within the horizontal space between tiebars if the mould is lowered from above. The mould length must fit within the vertical space between tiebars if the mould is slit in from the side. It is advised that there is a clearance of 25 mm on each side for a small mould, and 50 mm for a big mould. This is to avoid banging of the heavy mould against the tiebars during loading, denting them and subsequently affecting the bearing in the moving platen which travels over them. Figure 7. Space between tiebars Tiebarless PIMMs do not have this restriction.