How to select Plastic Injection Moulding Machine 6

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2.20 Platen size

The platens are thick steel plates to back up the moulds with. It is advisable that the moulds do not protrude beyond the platen limits to avoid bending the moulds during injection. Too small a mould would put undue bending stress on the platens, breaking them in the extreme case. Some manufacturers offer a choice of platen sizes for machine of a given clamping force. A car bumper is an example where a very wide platen is needed.

2.21 Platen thickness

The moving platen and fixed platen must have sufficient stiffness to transmit the forces of the tiebars to the mould with minimum deflection. For a given geometry, a flat platen¯ deflection is proportional to the cube of its thickness. Especially for the moving platen, a compromise has to be struck between weight and thickness.

Space between tiebars is related to platen size. If this space is increased without increasing the platen thickness, the platen under the same load deflects more . In short, one must not consider space between tiebars alone, but must consider it together with platen stiffness.

Platen deflection causes the mould to deflect which in turn changes the shape and dimensions of the moulded article. Figure 8. Platen deflection is affected by platen thickness and size

Some machine makers put ribs on a platen to increase its stiffness while minimizing its weight. Since there is no standard rib patterns, comparison of platen stiffness across manufactures is not easy. Figure 9 Ribbed stationary platen

2.22 Tiebar diameter

Most PIMMs with tiebars have four of them, except small machines below about 20 tonnes, which have two. Together, their tension forces hold the mould halves together against cavity pressure during injection.

If the tiebar tensions are even, the stress in each of them is given by stress = clamping force * 1000/(3.1416 * (d2/4) * 4) = clamping force * 1000/(3.1416 * d2),where stress is in kg/mm2 clamping force is in tonnes, diameter d in mm.

High tensile steel has a breaking stress of more than 90kg/mm2. Mild steel has a breaking stress of 20kg/mm2. A tiebar breaks if its stress exceeds the breaking stress.

More often then not, a tiebar breakage is due to uneven tensions among them. This is caused by a. non-parallel mould faces, b. non-symmetrical cavity with respect to the sprue, c. misadjustment of the mould height adjustment mechanism of a toggle clamp machine.

When the mould expands due to higher temperature, it stretches the tiebars more than when the mould was set up when it was at room temperature.

Example 13: Tat Ming's ME125 has four tiebars, each with diameter 75 mm. The clamping force is 125 tonnes. High tensile steel is used. What is the safety factor built into tiebars of this machine?

Assuming even tension, each tiebar has
stress = 125 * 1000/(3.1416 * 752) = 7.07 kg/mm2.

The safety factor is 90/7.07 = 12.7.

Usually a safety factor of 10 or more is common in an industrial design. An example is the stress in the cables hauling a fully loaded lift up and down. Tiebar breakage occurs at the root of a thread where the radius is smaller and there is stress concentration.

Please see section 3.11.8 on tiebar tension measurement.

2.23 Ejector stroke

The ejector moves forward to eject the article from the mould. A long part requires a long ejector stroke.

2.24 Ejector force

When a part cools, it shrinks around the mould and may need a big force to eject. This is especially so for a container with a small slanting angle. Sometimes, a (smaller) retraction force is also quoted.

2.25 Carriage stroke

The carriage moves back to allow servicing of the nozzle, nozzle heater and the front end of the barrel. Sufficient space behind the screw motor must be allowed for.

2.26 Carriage force

The carriage moves forward so the nozzle press against the sprue bush. Carriage force seals the interface from melt dripping. It is also called nozzle contact force.

2.27 Dry cycle time

plasticizing. Dry cycle time is the mould closing time plus mould opening time plus idle time. It is defined by EUROMAP 6 recommendation. Dry cycle time is the ultimate cycle time as there is no cooling period. An alternative expression is cycle rate, the number of cycles per minute.

Running a machine at the maximum possible cycle rate is not desirable if the machine is not running smooth and stable. This is another example why an attribute should not be evaluated by itself alone.

2.28 Electric motor rating

The hydraulic system is driven by an electric motor. It converts electrical energy to mechanical energy at a certain efficiency. An electrical motor is rated in terms of kW or hp which denotes its maximum power delivery under the specified conditions like temperature of its windings. Some manufacturers offer a bigger pump size as an alternative. The motor size is also increased.

It is important not to confuse the power rating of the electric motor to energy efficiency. A lower power does not by itself mean a PIMM is more energy efficient than another with a higher rating. It means it is overloaded more during the moulding cycle. A three-phase motor is about 90% efficient over a wide range of power rating.

The moulding cycle demands widely varying hydraulic power in its different phases. At the electric motor, this translates to a similar demand in electrical power. Usually, the injection phase is the most demanding phase of the cycle. An electric motor is rated at below that power, requiring it to run above its rating in the injection phase.

For a PIMM without an accumulator, the injection phase presents an overload to the electric motor. Most motors could be overloaded to two times its rated torque for short periods. Since a three phase motor runs at a relatively constant speed, even at overload, the extra power comes from increased torque. Because power = rotary speed * torque, the extra power comes from increased torque. Since motor current is proportional to torque, an overloaded motor heats up (proportional to the square of current) more than it is rated at, reducing its long-term reliability. A motor with a higher power is overloaded less.

The story is different if the PIMM has an accumulator which does allow the electric motor to have a lower rating. Hydraulic energy is stored into the accumulator in phases of low demand to be used in the injection phase. In short, it evens out the motor loading during the cycle and reduces its overloading.

A motor with a high rating does not use up more energy. How much energy is used depends on the load (the work to be done) which in turn depends on the electric drive, hydraulic drive and hydraulic circuit design. See section 3.12.

The current per phase drawn by a three phase motor at its rated power is

im (A)
= motor power rating (kW)*1000 / (3*single phase power voltage(V)
*efficiency*power factor)
= motor power rating (hp)*746 / (3*single phase power voltage(V)
*efficiency*power factor)

For most three phase motors,
efficiency = 0.88 - 0.91,
power factor = 0.84 - 0.88.

Example 14: Tat Ming's ME175 is driven by a 30 hp three phase motor. Find the current per phase it draws when the single phase power voltage is 220 V.

Assume an efficiency of 0.91 and a power factor of 0.88. The current drawn per phase at the rated power of 30 hp is im = 30*746/(3*220*0.91*0.88) = 42.3 A. Figure 10 Power demand during the moulding cycle