# How to select Plastic Injection Moulding Machine 4

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f2.3 EUROMAP size rating

EUROMAP size rating is a standard way for specifying the size of the clamping unit and the injection unit of a machine. EUROMAP is a the European Committee of Machinery Manufacturers for Plastics and Rubber Industries. It publishes a number of recommendations.

The rating is made up of two numbers: xxx-yyy. xxx is the clamping force of the clamping unit in kN. yyy is the product of injection pressure (in kbar) and injection volume (in cm3). Hence, xxx is the rating of the clamping unit, yyy is that of the injection unit. For a given injection unit, yyy is constant with respect to the choice of screw diameter.

Some manufacturers provides several injection units for a machine of a certain clamping force. The different injection units are specified by their yyy rating. The higher is yyy, the more powerful is the injection unit.

Example 9: Tat Ming's ME75 has the following specifications.
Clamping force 75 tonnes,
Injection pressure (screw B) 1264 kg/cm2,
Injection volume (screw B) 215 cm3.

xxx = 75 * 9.807 = 736,
yyy = 1264/(1.02*1000) * 215 = 266.

The ME75's EUROMAP size rating is 736-266. Using the approximation that 1 tonne = 10 kN, and 1 kg/cm2 = 1 bar, the EUROMAP size rating is 750-272. See section 5.3 for unit conversion.

2.4 International size rating

In the Far East where kN and kbar are less well-known than tonne and kg/cm2, an alternative size rating is used instead of that by EUROMAP. It is made up of two numbers: aaa/bbb. aaa is the product of injection pressure (in kg/cm2) and injection volume (in cm3) divided by 1000. bbb is the clamping force of the clamping unit in tonnes. Note the order of the two numbers are reversed from those in the EUROMAP counterpart.

Example 10: Find the International size rating of ME75.

aaa = 1264 * 215 /1000 = 272,
bbb = 75.

ME75's International size rating is 272/75.

2.5 Screw diameter

For a given injection unit, most manufacturers offer a choice of screw diameters. The screw diameter directly affects the L/D ratio, and the injection volume (and hence the shot weight.)

2.6 Screw L/D ratio

For machines that provide a choice of screws, the screw diameter and hence the L/D ratio is an important attribute in the selection process.

A high L/D ratio of 22:1 or above provides better mixing and more uniform heating due to compression in the transition section of the screw. It is selected for moulding parts with high requirement, e.g. moulding engineering thermoplastics, or high precision, e.g. within 0.01mm dimension tolerance. For a given L, a higher L/D ratio translates to a smaller screw diameter. The injection pressure is increased, the injection volume and the shot weight are reduced.

A medium L/D ratio of 20:1 is used for general applications with medium requirement.

A low L/D ratio of 18:1 or lower is used for low requirement where shot weight is the more dominant selection criterion. The injection pressure is low.

2.7 Injection pressure

As stated in a PIMM specification, injection pressure means the maximum pressure in the barrel during injection, not the maximum hydraulic pressure. The two are related by the ratio of the screw cross section area to the injection cylinders area. Usually, injection pressure is higher than the maximum hydraulic pressure by about 10 times. Where there is a choice of screws for a given injection unit, the smaller diameter screw produces the higher injection pressure. A high injection pressure helps in moulding engineering thermoplastics. Material manufacturers publish minimum and maximum injection pressures in the specification of the materials.

2.8 Injection stroke

For a given screw diameter, injection volume (see next section) could be increased by injection stroke. Increasing injection stroke, however, lengthens the injection time and hence the cycle time. It also reduces the effective screw length and hence the effective L/D ratio. Hence, the advantages of a high L/D ratio is lost.

From the statistics of machine specifications for L/D ratio of 18:1, injection stroke is about 4 diameters.

Example 11: The data for screw C in the three injection units of Tat Ming's ME series are tabulated below. Injection unit rating272 860 1603 Screw C diameter (mm)43 60 70 Screw C L/D ratio18:1 18:1 18:1 Injection stroke (mm)180 250 300 Injection stroke/diameter4.19 4.17 4.29 Table 5. Injection stroke/diameter ratios of Tat Ming's ME series

One should watch out for excessive injection stroke for the purpose of increasing injection volume and hence shot weight, at the expense of injection time and L/D ratio.

2.9 Injection volume

Injection volume is theoretical. It equals the cross section area of the screw times the injection stroke. Injection volume (cm3) = 3.1416 * (d2 / 4) * iwhere d = diameter of screw , in cm (~= diameter of barrel) i = injection stroke, in cm

Due to leakage pass the screw tip and the backward movement of the non-return valve, the actual injection volume is about 90% of the theoretical injection volume. To convert the actual injection volume to shot weight, the resin S.G. at plasticizing temperature is used. See Table 6. ResinAbbreviationS.G. at plast. temperatureGeneral Purpose PolystyreneGPPS (PS)0.886 - 0.901High Impact PolystyreneHIPS0.895 - 0.917Acrylonitrile Butadiene StyreneABS0.895 - 0.908Acrylonitrile StyreneAS (SAN)0.907 - 0.917Low Density PolyethyleneLDPE0.730 - 0.740High Density PolyethyleneHDPE0.752 - 0.772PolypropylenePP0.712 - 0.737Plasticized Polyvinyl Chloride (soft)PPVC1.050 - 1.389Unplasticized Polyvinyl Chloride (rigid)UPVC1.134 - 1.219Polyamide-6PA-60.958 - 0.995Polyamide-66PA-660.958 - 0.995Polymethyl MethacrylatePMMA0.996 - 1.012PolycarbonatePC1.018 - 1.037Polyoxymethylene (Polyacetal)POM1.187 - 1.214Polyethylene TerephthalatePET1.129 - 1.172Polybutylene TerephthalatePBT1.102 - 1.113Cellulose AcetateCA1.074 - 1.104Polyphenylene Oxide, modifiedPPO-M0.873 - 0.890Polyphenylene SulfidePPS1.075 - 1.109 Table 6. Specific gravity of resins at plasticizing temperature

Instead of using shot weight and the 35% to 85% rule in selecting a PIMM, some manufacturers recommend using injection volume and the following rule.

For low requirement moulding, use between 20% to 80% of the injection unit injection volume. For high requirement, use between 40% to 60%.

2.10 Injection speed

As stated in a PIMM specification, injection speed is the maximum speed of the screw the machine is capable of during injection. It is expressed in cm/s.

Injection speed affects the injection time. Moulding thin-walled articles requires high injection speed so that the melt does not solidify before the cavity is completely filled. Through controlling hydraulic oil flow, some machines have multiple injection speeds available during injection. The constant melt front theory stipulates the best moulding occurs when the leading edge of the melt (the melt front) moves in the cavity at constant speed. Since the mould cavity varies in cross sectional area, this requires multiple injection speeds during injection. Some machines have as many as ten.