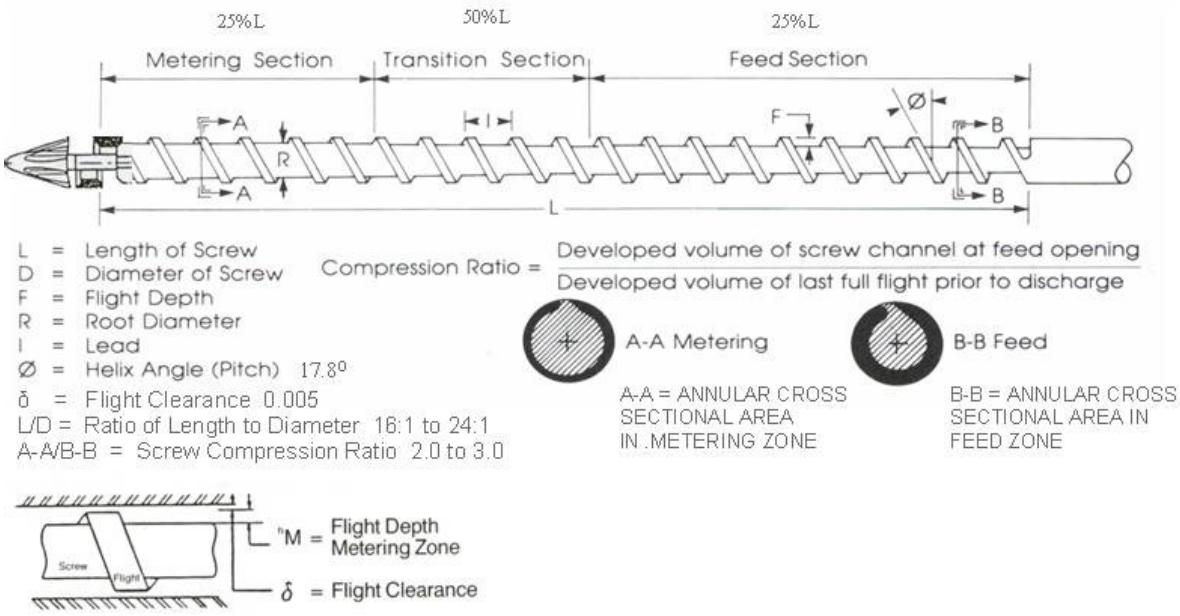
INJECTION MOULD DESIGN: MARPLEX PVC RESINS

- **MACHINE RECCOMENDATIONS**
- PVC requires reciprocating screw injection moulding machine with a plasticising screw to produce homogeneous melt.
- It is recommended that a shot weight of the part should take two thirds of the rated barrel capacity to reduce melt exposure to residence time during part cooling phase. This also enables processing at higher temperatures while avoiding degradation.
- Clamp force required for PVC is 300 - 400kg/cm^2 (2 - 3ton/square inch) of projected part area, including runners.

Typical Injection Moulding Screw for PVC



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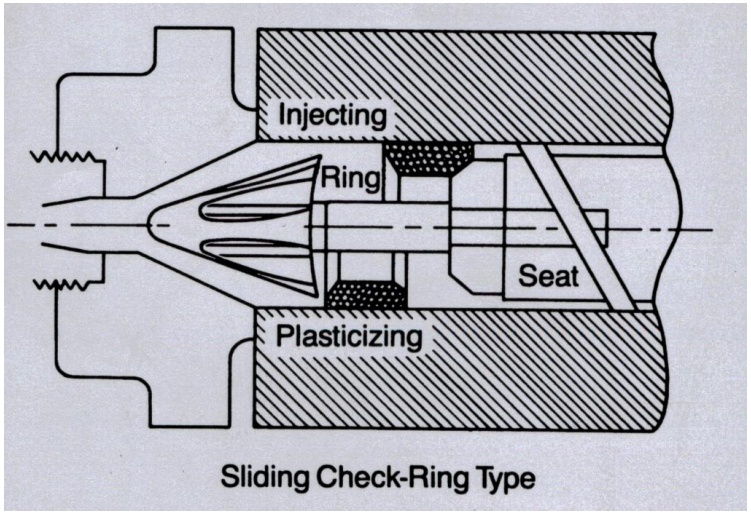
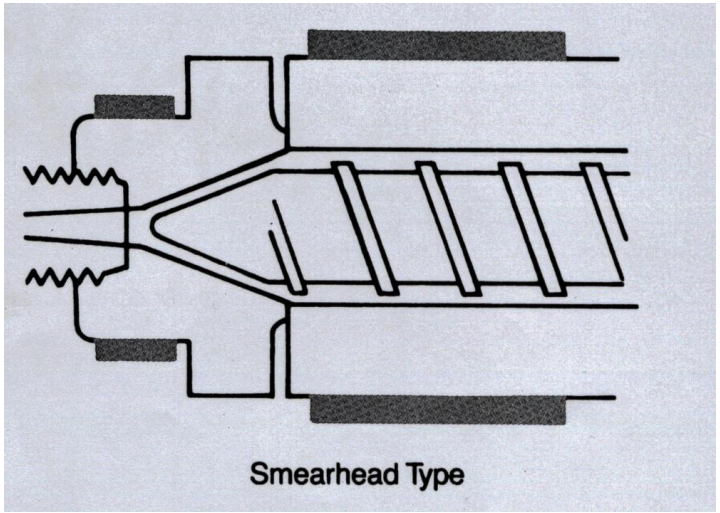
- **SCREW DESIGN**
- Compression ratios of 2.0/0.1 to 3.0/0.1 and L/D ratio of 16/1 to 24/1.

- To reduce PVC degrading or adhering to the screw surface and to protect against chemical attack, screws must be deep nitrided to 67 Rockwell C. Flame hardened screws should be chrome plated and polished but are not as resistant to wear.

- Two types of screw tips are recommended, for large thin walled parts a sliding check ring type with easy flow material. For mid flow material a smear head tip is preferred.



Sliding Check-Ring Type


Smearhead Type

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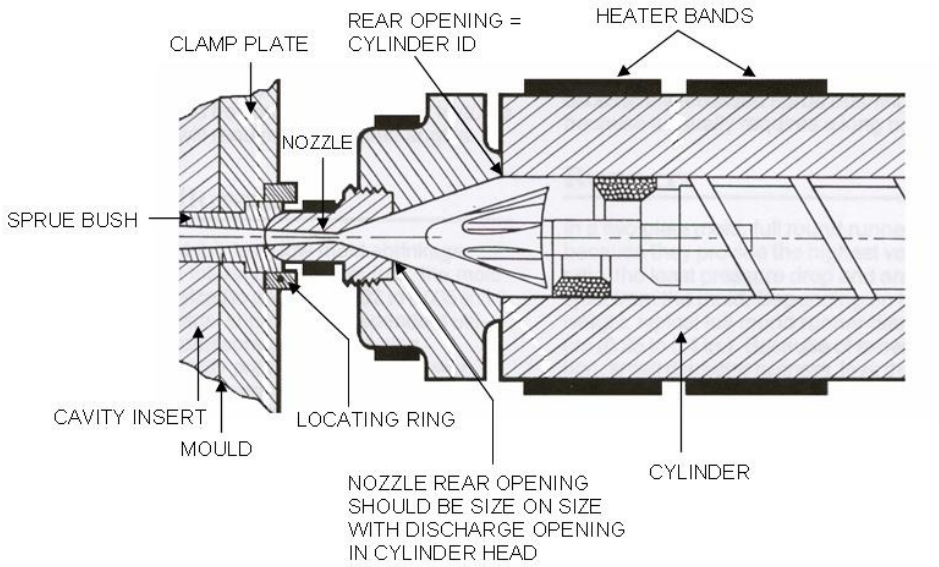
- **NOZZLE**
- Short as possible nozzle length.
- Own temperature control.
- Thermocouple monitoring nozzle temperature.
- Solid state, temperature controllers.
- Reverse taper nozzle highly recommended with zero land to reduce shear.
- Reverse taper nozzle promotes sprue break off in nozzle, preventing site for degraded material.
- Nozzle orifice diameter should be 6mm minimum. Generous orifice, runners and gates prevent short shots and shear burn.
- No shear edges should be formed at the nozzle rear opening or orifice / sprue bushing.

NOZZLE SIZING



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INJECTION MOULD DESIGN: MARPLEX PVC RESINS

- **MOULD DESIGN**
- 420 stainless steel is recommended for mould core and cavities. Moving parts should be made of hardened steel and plated.
- Prehardened and conventional hardened steel can be used if material contact areas are plated.
- Multiple layer chrome plating has good resistance to hydrochloric acid.
- Conventional two and three plate mould can be used.
- Draft of $0.5^0 - 1^0$ per side per 0.001". Harder plastic may require more draft.
- Tool should be cut with shrinkage of 0.002-0.005cm/cm. Actual shrinkage is dependant on cavity pressure.
- PVC moulds must be vented, otherwise trapped air, gas or moisture can become super heated under compression causing burning.
- Vent sizes generally 6mm – 13mm wide by 0.01mm -0.03mm deep, located on the mating surface of the mould halves.

- **SPRUE AND RUNNERS**
- Sprue bush with 2.5^0 and approximately 42mm taper per meter.
- The exit diameter of the sprue should be larger than the diameter of the main runner
- Two-plate moulds, full round runners are preferred due to lowest pressure drop. Diameter usually 6mm – 10mm depending on part size.
- Smaller diameters should be avoided and the same with larger due to little advantage and have longer cycle times.
- Three-plate moulds, full runners preferred, however trapezoidal and half-round runner can be used. Rectangular runners are not recommended.
- Multiple cavity tools should have balance flow to all cavities, secondary runners should be the same size as main runner. Secondary runners should be radiused and polished at the runner junction (main to secondary).
- Cold slug wells should be used used with PVC before the material is allowed to enter the cavity.

- ***HOT RUNNER SYSTEMS MUST NOT BE USED WITH MARPLEX PVC***
- ***UNDER ANY CIRCUMSTANCE***

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INJECTION MOULD DESIGN: MARPLEX PVC RESINS

- **GATE DESIGN**
- All gates with generous cross-sectional area work well with PVC. This allows the material to flow freely with minimum pressure loss and shear build up. The gates should be polished smooth with all rough edges and sharp corners removed.
- The land length of the gate should be keep as short as possible.
- Typical gate designs that work well are low restrictive gates such as direct sprue, fan, tab, chisel, reverse chisel, diaphragm gates.
- Sub, pin, flash gates are not recommended due to the high viscosity nature of PVC and the sensitivity to shear. If these designs are needed please consult MARPLEX technical service department.

INJECTION MOULD DESIGN: MARPLEX PVC RESINS

- **PROCESSING CONDTIONS**
- PVC has a low moisture sensitivity, however better result can be seen when PVC is dried for 2 hours in a dehumidified dryer at 65-75^{O}C.
- Mould temperature should be tightly controlled between 21-38^{O}C with good water flow. The ejector side of the mould is generally 5^{O}C lower than the stationary side of the mould to help with part removal. If parts are thick chilled water of below 21^{O}C can be used.
- Melt Temperature is critical in moulding PVC. Melt temperature is different from heater band temperature. To measure melt temperature a needle-probe pyrometer must be used.
- The recommended melt temperature of PVC is 199-210^{O}C but should never exceed 216^{O}C.
- To find these readings using a pyrometer, undertake some air shots onto some cardboard and place the probe into the melt. This will give a reading of about 10^{O}C below actual melt temperature.
- Heater band temperature may be as follows: Nozzle 185^{O}C, Zone 1 170^{O}C, Zone 2 160^{O}C, Zone 3 150^{O}C. This would give a melt temperature of approximately 200^{O}C. The extra heat from the material comes from shear, back pressure and screw RPM.
- Screw back pressure will vary from machine to machine, usually between 0.3 – 0.7MPa range.
- Screw RPM is generally 40 to 50 RPM with larger machines requiring less.
- Injection speed should be slow to moderate to prevent excessive frictional heat.
- Injection pressure is in the range of 50-75% of the maximum available then when the part is full switches to holding pressure which is 0.5 – 0.75 of the injection pressure. Over packing the part increases moulded in stress and should be avoided.
- Sink marks opposite the gate indicate more injection pressure/time is needed, sink marks near the gate indicate more hold pressure/time.

INJECTION MOULD DESIGN: MARPLEX PVC RESINS

- **PURGING**
- It is important to purge barrel of injection moulder with GP ABS, Acrylic, Polystyrene before and after the use of PVC compounds.
- The injection moulding machine must not be shut down with PVC in the barrel.
- If material is left in the barrel it will degrade and the screw and barrel will have to be removed and cleaned mechanically.
- The use of Polyethylene and polypropylene and not recommended due to they are immiscible with PVC.
- **Warning**
- PVC must never come into contact with Acetal copolymers within an extruder or moulding machine. The two material will rapidly degrade. Traces quantities will be enough to cause degradation.

- The content of this report is based on test methods and results we believe reliable, but any results or recommendations contained should not be construed as a guarantee of final product performance by Marplex Australia Pty Ltd.

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