INJECTION MOUDLING RIGID PVC

CJP QUICK GUIDE

GENERAL
UPVC-Un-Plastersized Polyvinyl Chloride

Rigid PVC comes in a number of formulation types for moulding applications. All are highly stable and suited for processing on standard screw and barrel injection moulding machines. This material is safe to use and this information will help you the operator achieve a good quality moulding in a safe and controlled manner.

Two impression tool using Natural PVC and Vynacol Masterbatch on a BOY 50T

CONSISTENCY

PVC when melted has the consistency of paste. It's very much like tooth paste being squeezed from a tube. Un-like other polymers the Melt Flow Rate (MFI) are not measured on conventional laboratory equipment because the method is to put pellets into a heated cylinder with a piston. When a weight is placed on top of the material it becomes free flowing and exits a hole in the base of the cylinder. The extruded material is weighed and measured by the amount of grams extruded in 10 mins. The heat stability of PVC is very poor if it is left to stand for a long period of time, this makes it not suitable or MFI testing.

EQUIPMENT

This is without doubt the deciding factor in establishing whether a good quality moulding can be produced in a production run. Most general purpose injection moulding machines can be used for processing PVC.

SIZE

This is critical as an extended barrel residence time can cause stability issues. Finding the balance between opening stroke and clamp force can be difficult, this needs to be taken into consideration when designing the tool or when considering taking on new tools.

BARREL CAPACITY

The barrel capacity and residence time are critical factors in selecting the correct machine for processing PVC. In order to ensure that the residence time or dwell time is reduced it is important that the cycle time and shot weight are in harmony.

Typical Residence Time – Barrel Capacity

Machine	50 te	80 te	130 te	200 te	500te
Barrel Capacity (PS)	135g	238g	300g	530g	1500g
Shot Weight	23.5g	209g	140g	340g	900g
Cycle Time	45 sec	44 sec	37 sec	60 sec	60 sec
Maximum Residence Time	245 sec	65 sec	79 sec	93 sec	100sec

SCREW AND TIPS

General Purpose Screws

With high flow calcium zinc UPVC grades a general purpose screw with a 2:1 compression ratio is suitable and most commonly used.

PVC SCREWS

PVC specific screws can be used if fitted, these types of screws offer a constant compression as they don't have the feed, compression and metering zones.

SCREW TIPS

Sliding check rings are suitable providing they offer plenty of clearance of at least 1.6mm, the sliding valve must be free moving and provide at least one screw flight of back and forward motion.

SMEAR TIPS

These are more suited to the very high viscosity grade which is less inclined to flow back. The higher flow grades have become more standard.

SCREW SPEED

The screw speed will be dependent on the compression of the screw. The greater the compression the slower the screw speed should be. The aim is to bring the screw back at a slow steady rate so the PVC is moving for as long as possible which will reduce the shear heat build-up. Also the larger the machines, the slower the screw speed.

NOZZLES AND SPRUE BUSH

Nozzles for PVC should be as short as possible and be heated with specific heater band and thermo couple to control the heat. The nozzle opening should be as large as possible but smaller than the sprue bush to avoid any restriction in flow. The tip should be tapered.

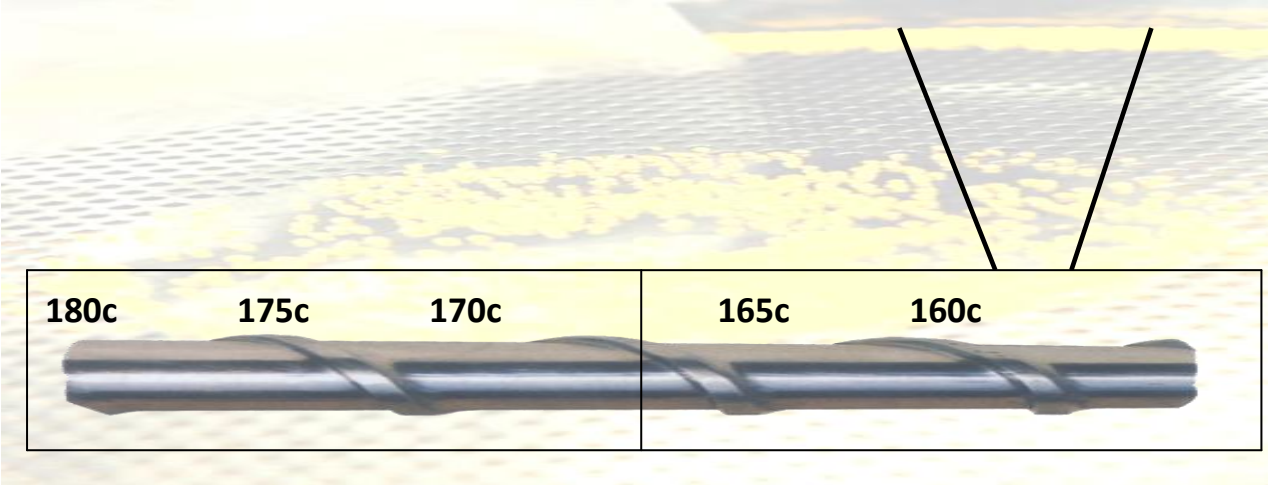
MELTING PVC

Formulations for PVC are very specific but there are many co-variants to consider. A rigid moulding formulation contains several substances all of which are blended together to produce a compound. These compounds are made in a batch process and are very dependent on the level of work applied during the manufacture process. Lubricants are added as process aids and stabilizers are added to stop degradation and allow melting in the barrel. Typically we would want to achieve a melting temperature of 180 degrees c when an air shot is taken. Because of the PVC's paste consistency the viscosity is high which in turn does become prone to the build up of frictional heat. To monitor this, it is important to measure the temperature with an air shot and expect the purge to be within 10 degrees c of the actual barrel setting. It is necessary to monitor the barrel temps actual figure against the settings. Any over ride needs to be identified. The objective is to balance these two readings where possible.

BARREL SETTINGS

There are a number of things to consider when setting your machine. When the PVC melts it will become a paste, this is referred to as gellation. To achieve consistent mouldings free from gas marks, gellation needs to accrue as far down the barrel as possible so the shot is ahead of the screw, is as free from gas as possible. As a result a steadily increasing profile is required:-

Machine Size	50te	80te	130te	200te	500te
Barrel Range	165c-190c	165c-180c	160c-180c	160c-175c	160c-175c



Screw Speed – The screw Speed needs to be slow and timed as a close as possible to the cooling time. Keep the material moving slowly.

Back Pressure – Keep the back pressure low 1-5bar.

MATERIAL MELT

When purged the material should have a smooth glossy finish. If it is foamed and expanding then it has gassed and the impact will be affected.

INJECTION SPEED

The injection speed should be slow and steady; it can be profiled if there are any blooms or marks around the gate. Start with a medium speed and reduce if splays are visible.

INJECTION PRESSURE

The machine and the melt viscosity will dictate the amount of pressure required to fill the tool, where possible the pressure needs to be kept low.

TOOLING AND FILLING THE CAVITY

Tool design is critical to ensure a good quality moulding. At the sampling stage there is little that can be done about the tool design but there are points to consider that can be altered.

TOOL TEMPERATURE

Lower mould temperatures are recommended. The best results, cycle time and surface finish are when the mould temperatures are around 20c. If mould filling becomes an issue on thin sections, this can be increased.

Typically

1-2mm 30c

2-5mm 20c

5-7mm 10c

The lower the temperature the faster the cycle time and there will be an increased possibility of sinking on thick section and ribs and distortion if the mouldings are ejected soft and warm.

GATES AND RUNNERS

The gates need to be as large as possible without affecting the part and the runners fully round with a little land length as possible. Hot runners and direct fed hot tips are suitable for UPVC.

SHRINKAGE

The shrinkage of UPVC is the same as ABS based on wall thickness as below:-

1-2mm 0.30%
2-4mm 0.45%
4-5mm 0.45%

IMPACT STRENGTH

High flow injection moulding grades do contain an impact modifier but are classified as a medium impact. High impact grades are available if specified.

Impact is affected by a number of factors including melt temperature, tool temperature, injection speed and tool design.

MELT TEMPERATURE

As stated earlier the gellation of the material is fundamental to the impact properties. If there is a high level of gas in the melt, this will have a smooth skin and a honey-combed centre. This is cause by overheating die to frictional heat build-up. You would need to go back to the “Melting PVC section”.

TOOL TEMPERATURE

If the tool is too cold the moulding can be shocked cooled to make it brittle.

INJECTION SPEED

The lower the injection speed the better the impact.

START UP & SHUT DOWN

PVC is a temperature sensitive material and prone to degradation being left for long periods of time static in the barrel can start the degradation proves. As a result it is good housekeeping practice to use Dyna-Purge ®V, K or M to clear out the PVC between runs.

SAMPLING

During the sampling process the material does tend to sit in the barrel for longer periods of time while mouldings are examined and condition settings programmed. During these periods it is advisable to empty the barrel. Always empty the barrel and measure the temperature of the purge and visually inspect the consistency of the melt. When the tool is finished with it should be sprayed with an anti-oxidant spray before it is taken out of the press. This will help prevent possible rust build up and pitting.