



Thermoset Injection Molding

Injection molding of thermoset materials is the most automatic method of processing these materials and has become the most common. The main difference between injection and transfer molding is reduced material handling. With injection molding, the material is fed directly into the hopper of the molding press, eliminating preforming, preform storage, and preheating.

An **injection molding press** consists of two major sections, which are the **clamping section** and the **material processing section**. The **clamping section**, which is similar to a compression press, is basically a hydraulic cylinder that closes the mold halves and holds them together under pressure. In the case of a toggle press, there is a cylinder and linkage mechanism that closes the mold halves and holds them together under pressure. In addition to the clamping mechanism, this part of the press also provides the mechanism for removing the parts from the mold.

The minimum press size is determined by, the pressure required to clamp the mold during the molding cycle. PLENCO typically suggests that the clamping force equal 1,816 Kg (4,000 lbs) per square inch of projected area at the parting line.

The mold consists of a cavity side with one or more cavities and a force side. The sprue bushing is the channel that connects the nozzle of the injection cylinder with the runner system of the mold. It is tapered to facilitate the removal of the sprue from the mold. The cavities are connected to the sprue by way of runners and gates. The mold is heated by either electric cartridge heaters, steam or hot oil to a temperature range of 165°C - 182°C (330°F - 360°F) for phenolic molding compounds, 150°C - 177°C (300°F - 350°F) for melamine-phenolic molding compounds, 163°C - 182°C (325°F - 360°F) for PLENCO granular polyester molding compounds, or 143°C - 171°C (290°F - 340°F) for PLENCO BMC polyester molding compounds.

The material processing section includes the barrel, the reciprocating screw or sometimes a plunger for BMC materials and the material hopper which is normally replaced with a stuffer when molding BMC. A reciprocating screw is always used to process phenolics, melamine-phenolics and granular polyesters. BMC molding compounds are usually processed using a reciprocating screw but they can also be run on plunger presses.

The reciprocating screw aids in the processing of thermoset materials in a number of ways. The rotational motion advances the material down the screw to where it is plasticized (changed from a solid to a semi-viscous state) and then injected into the mold. At the same time that the screw rotation is advancing the material, the screw is being forced backward. This "backing up" of the screw allows the plasticized material to move in front of the screw so it can then be injected into

the mold. Once the pre-determined amount of material is plasticized in front of the screw, the screw is pushed forward, forcing the material out of the barrel and into the mold.

The processing of a thermoset molding compound is controlled by three items which are temperature, pressure and time. In injection molding, each of these is affected by a number of variables that need to be controlled.

Temperature - The melt temperature of the molding material (stock temperature) is controlled by the barrel temperatures, screw speed, injection speed and back pressure. The water jackets around the barrel regulate the point at which the material will start to plasticize. The screw speed, injection speed and back pressure create frictional heat. To maintain a consistent and workable melt temperature, all of these variables must be coordinated and adjusted. The stock temperature cannot be so hot that the material cures before it is able to fill the parts, nor so cold that the cycle times have to be extended in order for acceptable parts to be produced from the mold.

Pressure - The pressure on the material is controlled by the primary pressure, which moves the screw forward at a rapid speed to fill the cavities. The secondary pressure (holding pressure) finishes the filling of the cavities and maintains pressure on the material until it is sufficiently cured to allow the screw to return and plasticize the next shot.

Time - The time required for each phase of the process should be established and optimized. The high pressure injection phase should be controlled by a limit switch that changes the pressure on the injection cylinder from the primary to the secondary. The primary or high pressure timer should be used to insure that the switch is made from primary to secondary injection pressure, if for some reason the limit switch fails to carry out this function.

What are the advantages of Injection Molding?

- Material handling is reduced because the press hopper will usually hold sufficient material to mold parts for an extended period of time.
- Longer and smaller diameter core pins may be used because they can be supported on both ends.
- With the mold being closed before any material is injected into it, parts containing metal inserts can be molded without having material flash the inserts.
- Relatively tighter tolerances across parting lines are possible.
- Parting line flash can be held to a minimal thickness if the mold is designed properly and well maintained.
- Injection molding of thermoset materials lends itself to automating the process which can result in lower piece costs.

What are the disadvantages of Injection Molding?

- Warpage can be a problem in injection molding because injection materials have softer flows and higher shrinkages. The forcing of the material through a sprue, runner and gate, can orient the material producing non-uniform shrinkage.
- The filling of the parts through one or two gates produces parts that have knit lines. These knit lines are usually the weakest areas on the part.
- The total amount of scrap produced during injection molding will usually be higher than that for compression molding because of the additional scrap created by the sprue and runner. In the past, thermoset scrap had to be disposed of in a landfill. However, some thermoset materials are now being successfully recycled. **Note:** The use of “cold manifolds” can reduce the amount of sprue and runner scrap and have been very successful in the molding of granular and BMC polyester materials.

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This information is suggested as a guide to those interested in processing Plenco Thermoset molding materials. The information presented is for your evaluation and may or may not be compatible for all mold designs, runner systems, press configurations, and material rheology. Please feel free to call Plenco with any questions about PLENCO molding materials or processing and a Technical Service Representative will assist you.