Injection Molding Startup Procedure for BMC Polyester Molding Compounds

Prior to setting a mold into a press, it is necessary to determine first that the mold will fit in between the tie bars of the intended press. Once this is determined and before installation begins, the minimum clamp tonnage for the mold must be calculated. A couple reasons for the need to determine proper clamp tonnage are:

- Insufficient clamping force may lead to parts having unacceptable dimensions such as being too thick because the press may not have sufficient clamp force to force the material throughout the cavity(s)
- Potential mold damage from installing a mold that is too small for a press. Example: A mold that requires only 75T of clamp force is installed into a 400T press with non-adjustable clamp force may be damaged from too high of clamp pressure.

To determine the correct tonnage, multiply the projected area of the part at the parting line by 2,000psi ($1T/in^2$) - 4,000psi ($2T/in^2$).

Example: A part having a 12" diameter, requires a minimum clamp pressure of 113T ($1T/in^2$)

This can be calculated from the following formula:

Clamp tonnage required = $r^2 * \pi * T/in^2$

$6''^2 * 3.1416 * 1(T/in^2)$ = 113 tons of clamp pressure

In addition to reviewing the physical size of the mold, it should be determined if the shot size is within the press capacities. Typically, PLENCO suggests using between 20% and 80% of the total shot capacity of the injection barrel. Typically, under 20% utilization can lead to inconsistent processing while utilization over 80% can result in not enough shot capacity.

Once a mold has been matched with a press and is installed in that press, a standard procedure should be followed to begin molding parts. Following a written procedure each time a mold is installed makes it easier for the press operators by helping to minimize the omission of any procedural steps. After the mold is set, the following startup procedure can be implemented.

1. Be sure the mold when clamped up has no tonnage set. Having the mold closed and tonnage set while the mold is heating may cause issues with opening the mold due to thermal expansion. A good practice is to leave a ¼" – ½' visible gap while heating the mold.

2. Turn on the heat and frequently check the temperature of the molding surfaces with a calibrated pyrometer and surface probe. Typically start with a mold temperature of 290°F - 340°F (143°C - 171°C). It is desirable to have as little temperature variance (typically within 10F) across the mold surface as possible.

3. Set the temperatures of the barrel heaters. Typically, the front zone should start at 80°F - 110°F (27°C - 44°C) and the rear zone should start at 80°F - 110°F (27°C - 44°C).

4. With the pyrometer and surface probe, check the "in" and "out" connections of each zone of the water temperature controllers to confirm that the actual water temperatures are close to the set temperature. There can be some variance from the set temperature, but a difference of 10°F - 20°F (5°C - 10°C) should be investigated. The problem may be calibration or something more serious such as a blocked water line. Of particular concern would be a situation where the "in" and "out" connections of the same zone are significantly different in temperature. This could be an indication that there is a blockage in the water jacket or possibly corrosion in the jacket.

5. The next step in the setup is to set the mold opening distance. This distance is important because if a mold opens too far, it can slow the overall cycle resulting in lost production. When the press is running in Automatic cycle, the mold must open far enough to allow the parts, sprue and runner system to fall freely into a box, or onto a conveyor. When the press is running in Semi-Automatic cycle, the open distance must be adequate to allow the operator to safely remove the parts, sprue and runner system.

6. At the same time that the mold open distance is being established the ejector stroke length should also be set. The ejection stroke should be long enough to ensure that the parts are ejected from the cavity. A full ejection stroke that extends to the stops is not necessary or suggested.

7. Set the screw speed to match the output rate of a screw type stuffer. Be sure to adjust the stuffers screw speeds to match the speed of the injection screw.

8. Set the back pressure for 0 psi (0 MPa) and air purge a couple shots. Check the stock temperature of the purged material from the third shot with a calibrated pyrometer and needle probe. The stock temperature is measured by air purging a shot of material and forming it into a ball, which is then checked after probing it 2 or 3 times using the needle probe of a calibrated pyrometer. The temperature should be 90°F - 120°F (32°C - 49°C). **NOTE:** At this point, the stock temperature may be lower than the desired temperature since you are just starting the process. It will take several molding cycles before it actually reaches between 90°F - 120°F (32°C - 49°C).

9. Before injecting the material for the first shot, the throttle or injection speed should be completely open. The amount of vacuum being pulled in the mold should be checked to ensure it is at least 21"Hg and then set the amount of injection delay time needed to allow the vacuum system to achieve it. The shot size should be adjusted so there will be less than a complete shot. The primary and holding pressure should also be set so the material will fill the cavities in 1 - 3 seconds. It normally is better to begin with a less than a full shot (about ¾ to ⅞ of a complete shot) and gradually work up to full shots. By starting with short shots, the mold will not be flashed, any vacuum ports will not be blocked, and the fill pattern of the mold is easily observable.

10. Just prior to injecting the first shot, the mold should be waxed. Carnauba wax or Zinc Stearate Spray Mold Release works well for this purpose. To wax a mold, melt the wax on the molding surface and with the aid of a small natural bristle paintbrush, spread it over the entire molding surface, getting it into every pocket and corner. Remove any excess wax from the mold surface and do not hesitate to start molding parts as the wax may burn on the surface of the tool and create other issues. Liberally spray the Zinc Stearate Mold Release over molding surfaces.

11. The molding parameters should be adjusted to produce good parts from all cavities. Typically, the injection time should be 1 - 3 seconds. The primary pressure should be in the range of 400 - 900 psi (2.8 - 6.2 MPa) while the holding pressure should be set at ½ to ⅔ of the primary pressure. After an acceptable molding process is established, it should be capable of continuing without change for many hours.

12. When gate cutters **are not being used**, it is a good practice to use a cushion when injection molding thermoset materials to help ensure well packed parts. To establish a cushion, 1/8" (3 mm) is added to the injection stroke and at the same time the transfer to secondary pressure or holding pressure is set at 1/4" – 3/8" (6mm - 10mm) from the end of the stroke. The cushion helps ensure that the screw is packing against material, not just bottoming the screw out.

13. When gate cutters **are being used**, the use of a cushion is not good practice. This because the gate cutters are engaged immediately after holding pressure is de-activated. The cushion would serve no purpose, as the holding pressure is deactivated and the gate cutters are now blocking the gates and cavities.

14. After the material has been injected into the cavities, holding pressure may be held for approximately 2-5 seconds. Only hold the holding pressure until the gates are frozen off.

15. Upon ejection from the mold, the sprue should have a soft bulbous tip. If it does not, try the following

    - Adjust barrel, cold manifold, or water-cooled nozzle temperatures lower.
    - Insert a piece of **corrugated** cardboard between the nozzle and sprue bushing to insulate the nozzle.

    Please note we do not generally encourage the use of a sprue break, as it does not pull the tip and can lead to other processing problems.