



Participant Handbook



Sector
Rubber

Sub-Sector
1. Tyre 2. Non-Tyre

Occupation
Moulding/Curing

Reference ID: **RSC/Q0207, Version 1.0**
NSQF Level 4

**Injection Moulding
Operator**

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2. Preparing Injection Moulding Machine



Unit 2.1 - Equipment Readiness

Unit 2.2 - Raw Material Appropriateness



UNIT 2.1: Preparing Injection Moulding Machine

Unit Objectives

At the end of the unit, you will be able to:

1. Identify machines used in moulding process
2. Familiarise with injection moulding process
3. Identify raw material used
4. Ensure safety and cleanliness of the work area

2.1.1 Introduction

Injection moulding is a polymer process in which the polymer is heated to a highly plastic state and forced to flow under high pressure into a mould cavity, where it solidifies. The process produces discrete components that are always net shape. Complex and intricate shapes are possible to produce, however the challenge is to design mould so that the part can be ejected successfully.

It evolved from metal die casting, however, unlike molten metals; polymer melts have a high viscosity and cannot simply be poured into a mould. Instead a large force has to be utilized to inject the polymer into the hollow mould cavity. Higher amount of melt has also to be packed into the mould during solidification to avoid shrinkage in the mould. The injection moulding process is basically a sequential operation that results in the transformation of plastic pellets into a moulded part. Identical parts are produced through a cyclic process involving the melting of a pellet or powder resin followed by the injection of the polymer melt into the hollow mould cavity under high pressure.

Injection moulding of rubber was originally an offshoot from the plastics industry in the early 1960s. After overcoming the initial issues of temperature, (plastics are cooled when moulding and rubber is heated) and pressure (rubber injection moulding requires significantly more pressure per square inch of cavity surface), the process has become an efficient way to mould rubber in many case.

There are 3 main types of rubber injection moulding

1. **Organic Rubber Injection:** Organic rubber injection starts with more efficient material preparation. The material is mixed, and then stripped into continuous strips and fed into a screw which charges a barrel as needed with a pre-defined amount of material. When the mould is closed, the material in the barrel is injected into the mould cavities and cured. Benefits of injection moulding include:
 - » Complete elimination of operator placement of pre-forms
 - » The injection screw pre-heats the material before forcing it into the cavities. This decreases the viscosity of the material, allowing it to flow more easily into the cavities.
 - » Moderately quicker cycle times than compression and transfer moulding
2. **Liquid Injection Moulding (LIM) or (LSR):** LIM Injection is the process where a two part liquid silicone compound (A & B parts) is delivered at a fixed ratio into a static mixer. The LSR mixture blends with a platinum cure system and is delivered into the injection unit where it is injected through a runner and gate system into the closed mould until cured. At the end of the cycle the parts are removed or ejected from the cavities and the next cycle begins. Benefits of LIM moulding include:

2.1.3 Nozzles, Runners and Gates

These are among the most important parts of an injection moulding machine.

Nozzles

The rubber is injected into the mould through the nozzle and, obviously, with multi-station systems, its shape and outside dimensions have to be such that it mates positively with each mould. As the inside nozzle diameter is increased, the pressure drop, injection time, and temperature rise, decrease. Nozzle diameters are chosen to provide a temperature rise of - 15 °C and an injection time of 5 to 10 s. This balance is adjusted, if important, to avoid scorch during mould filling. Nozzle diameters may range from 3 mm for a shot volume of 500 cm³, to 10 mm for a 4,000 cm³ shot volume. Nozzles generally have a reverse taper of 4 to 5 degrees and as short a land as possible. The nozzle bushing on the mould also has reverse taper and an inlet bore the same or slightly smaller than the nozzle.

Runners

These are the channels offered to convey the rubber from the injection point, the sprue, to the mould cavities; in cross section, they are generally trapezoidal, half-round, or round. They must be as short and direct as possible, and streamlined to reduce pressure loss [8]. The thickness of the moulding at the gating point governs the cross-section size of the runner. For multi-cavity moulds, the lengths of runner channel between the sprue and each cavity must be the same so that all cavities are filled at the same rate and have the same effective pressure. If the product has to meet close tolerances, this requirement becomes important. Where the flow branches there must always be a blind wall at 90°, this gives balanced flow as the leading edge of the flowing rubber hits the wall and divides equally. If the runner system is extensive, venting the runners is advisable, to help reduce the volume of air and gases which have to be removed via the cavity vents and flashlines.

A reduction in scrap can be achieved by using a "cold" runner system. This depends on having a temperature-controlled platen containing the runners, which are constantly full of rubber at a temperature below that at which it will cure. From here, it is injected into the rest of the mould, from which the cold channel platen is effectively insulated. Obviously adequate heat has to be generated in the hot channel run to raise the rubber temperature to the needed level for curing.

Gates

These are restrictive passageways from the runner to cavity which are sized to allow easy flow of the rubber into the cavity and at the same time raise its temperature to the final desired level. Usually they are full-round, fanned, with a bore one-half of that of the feed runner and as short as possible. The final sizing of gates is generally done by carrying out a practical moulding test. The gate position is often more essential than the size or type of gate. It must be positioned so that it feeds the thickest section of the moulding, preferably in the non-stressed area of the moulding. If weld lines are likely to be a problem, the gate position is important.

2.1.4 Setting Machine Process Parameters

Before setting process conditions, you must make sure the moulding machine is in proper working order, and that the mould you plan to utilize was designed for the particular machine you plan to use. Follow the step-by-step procedure given below to control the settings on your machine.

Most melting of the resin occurs because of the frictional heating from the screw rotation inside the barrel. The barrel heater bands serve mainly to keep the resin at the appropriate temperature. Generally there are three to five temperature zones or heater bands on the cylinder. The rules for setting the heater band temperatures are as follows: