

Lecture 4.4: Transfer Molding and Compression Molding

Transfer Molding

Transfer molding process combines the principle of compression and transfer of the polymer charge. In the transfer molding, polymer charge is transferred from the transfer pot to the mold. The mold is cooled and molded part is ejected. The schematic of transfer molding process is shown in figure1.

In this process, the required amount of polymer charge is weighted and inserted into the transfer pot before the molding process. The transfer pot is heated by the heating element above the melting temperature of the polymer charge. The liquid charge is gravity filled through the sprue to the mold cavity. A “piston and cylinder” arrangement is built in the transfer pot so that the resin is squirted into the mold cavity through a sprue. The plunger is also preheated in the transfer pot. The plunger is used to push the liquid polymer charge from the transfer pot into the mold cavity under pressure. The mold cavity remains closed as the polymer charge is inserted. The mold cavity is held closed until the resin gets cured. The mold cavity is opened and the molded part can be removed once it has hardened with the help of ejector pin. The sprue and gate attached to the molded part have to be trimmed after the process has been completed.

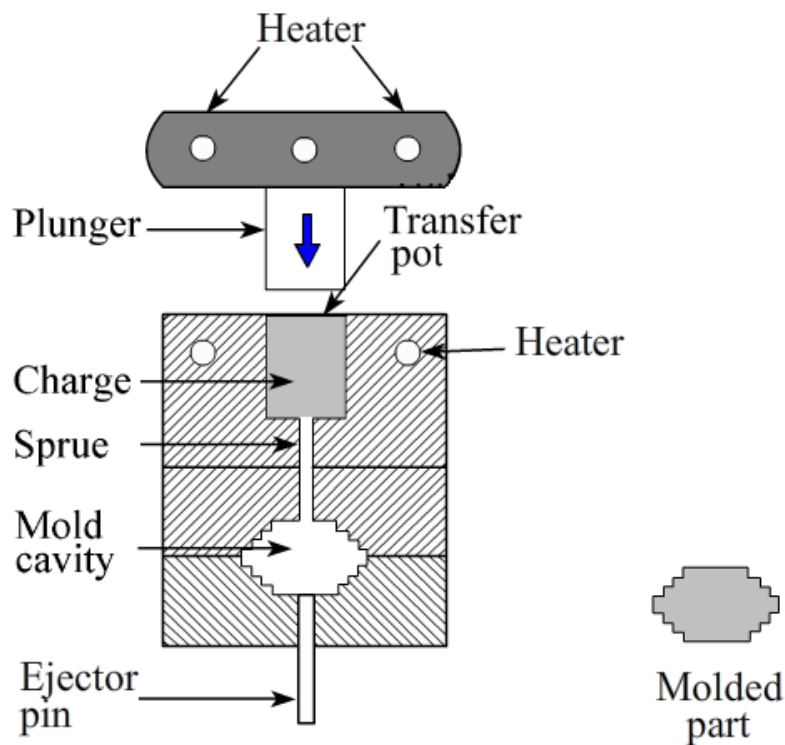


Figure 1 Transfer molding process

This is used for mass production. It has short production cycle and smaller tolerances and more intricate parts can be achieved. It produces more waste material; therefore it is the more expensive process. The mold cavity can be made from metals such as aluminum or steel for larger production.

Process Parameters

- Heating time
- Melting temperature of the charge
- Applied pressure
- Cooling time

Materials Used

Generally, thermoset plastics (such as epoxy, polyester, phenol-formaldehyde, vinyl ester, silicone) are processed by transfer molding process, but certain thermoplastic materials can also be processed.

Applications

This process is widely used to encapsulate items such as integrated circuits, plugs, connectors, pins, coils, and studs. It is suitable for molding with ceramic or metallic inserts which are placed in the mold cavity. When the heated polymer fills the mold it forms bonding with the insert surface. Transfer molding is also used for manufacturing radio and television cabinets and car body shells.

Advantages

- Fast setup time and lower setup costs
- Low maintenance cost
- Plastic parts with metal inserts can be made
- Design flexibility
- Dimensionally stable

- Uniform thickness of parts
- Large production rate

Disadvantage:

- Wastage of material
- Production rate lower than injection molding
- Air can be trapped in the mold

Compression Molding

Compression molding process is one of the low cost molding methods as compared to injection molding and transfer molding. It is a high pressure forming process in which the molten plastic material is squeezed directly into a mould cavity by the application of heat and pressure to conform to the shape of the mold. The schematic of compression molding process is shown in figure 2.

Working Principle

In this process, the predetermined amount of charge of plastic material is placed in the lower half of a heated mold cavity. The plastic material is preheated before inserting into the mold cavity to reduce the temperature difference between the material and the mold cavity. The mold cavity is closed with upper movable half mold and pressure is applied to compress the material in to the mold cavity. This causes the raw material to be squeezed out to take the shape of the mold cavity. The application of the heat and pressure increases the polymerization process. Hence, plastic material is cured. The temperature of the mold cavity is usually in the range of 130-200°C. Generally, the hydraulic pressure is required in the range of 7-25 MPa to squeeze the plastic material. The mold cavity is then cooled for sometimes so that molded plastic part gets solidified. The mould cavity is then opened and the final product is taken out with the help of ejector pin. The molded part may require the finishing operation.

In compression molding, the charge of plastic material may be inserted into the mold cavity either as a powder, granules or as a preformed. The manufacturing cycle time (heating, cooling,

and part ejection) may be long (about 1-6 minutes). For high production rate, it is desirable to have multi cavity molds. Compression mold cavity can also be available in a wide variety of shapes and sizes; therefore plastic products can be manufactured into different shapes and sizes.

There are four important factors to be considered before compression molding process:

- Amount of plastic material (charge)
- Heating time and melting temperature of plastic material
- Pressure required to squeeze the material in to the mold cavity
- Cooling time

Two different types of molding compounds i.e. bulk molding compound (BMC) and sheet molding compound (SMC) are commonly used in compression molding process.

In bulk molding compound, the plastic materials are blended with fillers and short fibers and placed into the mold cavity. In SMC, the long fiber sheet is usually cut according to the mold cavity and placed into the mold surface. The resin is placed on the fiber sheet. It is a layer by layer making process. The process is completed until desired thickness is obtained. The long fiber sheet results in better mechanical properties as compared with the bulk molding compound products. In both the molding compounds (BMC and SMC), the plastic materials are conformed to the mold cavity, with the application of heat and pressure.

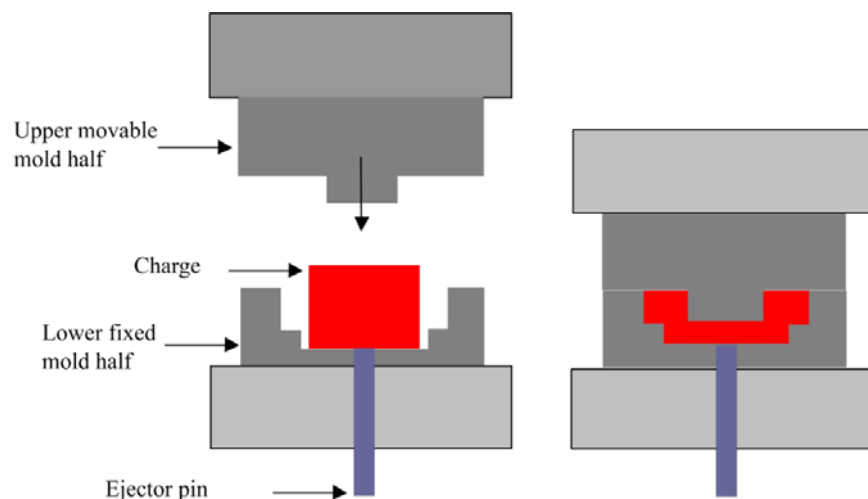


Figure 2 Compression molding setup

Materials Used

Different types of thermosets and thermoplastics materials can be used for compression molding process. For example: Epoxies, Urea formaldehyde (UF), Melamine formaldehyde (MF), Phenolics (PF), Polyester, Polyamide (PI), Polyamide-imide (PAI), Polyphenylene sulfide (PPS), Polyetheretherketone (PEEK), Torlon, and Vespel.

Applications

Compression molding process is used for manufacturing electrical and electronic equipments (electrical wall receptacles, circuit breakers, television cabinets, radio cases, electric plugs and sockets, electrical switch, fuse box, electricity meter housing), brush and mirror handles, trays, cookware knobs, clothes dryer blower fan blade, cooking utensils, milling machine adjustment wheel, water testing equipment buttons, dinnerware, appliance housings, aircraft main power terminal housing, pot handles, dinnerware plates, automotive parts (such as hoods, fenders, scoops, spoilers, gears), flatware, buttons, buckles, and large container. Compression molding is also suitable for heavy molding applications.

Advantages

The advantages of the compression molding process are as following:

- Low initial setup costs and fast setup time
- Heavy plastic parts can be molded
- Complex intricate parts can be made
- Good surface finish of the molded parts
- Wastes relatively little material as compared with other methods
- The molding process is cheaper as compared to injection molding

Disadvantages

The disadvantages of the compression molding process are as following:

- Low production rate
- Limited largely to flat or moderately curved parts with no undercuts