



**Department of Science and Humanities
Applied Chemistry Laboratory**

Subject: Engineering Chemistry

CO: 2 (Demonstrate and analyze the knowledge of polymeric for futuristic engineering applications.)

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Date: 30/11/2021

**Experiment No. 6
Compression Moulding**

Title: To study the construction and working of compression molding.

Aim: To study the construction and working of compression molding.

Theory:

Compression molding is a process that involves the exposure of thermosetting materials to a particular temperature to soften it which results in high strength articles. It can be employed to develop a variety of thermoplastic, thermosetting, rubber and composite products such as bottle caps, sheets, gaskets, O-rings, seals, electrical components, automotive components etc. It uses compressive force and heat to shape a raw material by using a shaped metal mold.

Process

The compression molding process includes following stages:

1. Opening of mold and application of mold releasing agent:

This step is required to free the mold from any impurity or contamination adsorbed inside of the mold cavity to achieve good surface finished product. The mold releasing agents are used to kick out the contamination generated during the cycle. The releasing agents creates invisible layer over the mold surface and reduces friction in the contact of polymer with mold surface which gives the easy removal of finished product.

2. Loading raw material in the mold cavity:

The next step is to load the charge or raw material in the mold cavity for molding. Plastics are generally heat-insulators in nature which creates a problem of uneven heat distribution. The raw material is in direct contact with mold first and then the heat is transferred through the other section by conduction. Due to the heat-insulating nature, the curing reaction will start at the surface of the material which is in direct contact with mold. However, the lack of temperature in the bulk material results in restriction of the curing. Preheating of raw material is done which results in the reduction of the curing time of the material and hence this

increases frequency of molding. The preheating also removes the moisture or other volatile components prior to molding and reduces mold shrinkage. Though preheating is beneficial in many ways, care must be taken as excessive preheating can cure the material before it reaches the mold cavities.

3. Closing of Mold:

After loading of the raw material or charge the mold is closed by using the hydraulic compression system. To reduce wear between meeting surfaces, the mold is initially closed rapidly till both halves of mold touches each other and the speed is reduced.

4. Breathing cycle:

The evolution of volatile gases during crosslinking reaction happening in the closed mold is important and has to be considered while compression molding operation. These gases must be removed from the closed mold to avoid any defects in the molded article. The trapping of these gases in the product reduces the cross linking density and can cause blisters or ruptures. To avoid this, a breathing cycle has to be given during mold closing to allow easy escape of volatile gases from the molding compound as the raw material experiences heating from the mold and from the exothermic reaction of the resin and catalyst during cure. Hence, the breathing time is the time interval between the opening and closing of mold for removal of volatile gases.

5. Compression Cycle:

After the completion of breathing cycle, the material is held under desired temperature and pressure for certain time to complete the molding/curing (thermosetting) process which is called dwell time for curing. The curing time can be decided based on the materials used and their composition and characteristics to evaluate the curing time required for the material.

6: Opening of mold and ejection of article:

After the completion of curing step, the mold opens up and the finished article is ejected out from the mold either by automatic ejection system or by manual intervention. In some cases, if the product achieved desired stiffness for the ejection, product/s can be removed from the mold before the completion of curing reaction. The curing will continue for the next several minutes as its temperature gradually returns to ambient temperature (cooling). After the completion of this cycle the mold is again filled with a fresh set of raw material and the molding process repeated.

Temperature and Bulk Density of Compression molded raw materials:

The temperature and bulk density for some common polymeric materials (in different forms) that can be compression molded are given as follows:

Sr No Name of the polymer Range of Temperature for compression molding (°C)

1.	Phenol Formaldehyde	160-180
2.	Urea Formaldehyde	145-155
3.	General Purpose Polyester	150-160
4.	Polypropylene	160-175
5.	Phenol Formaldehyde	160-180
6.	Tetrafluoroethylene	160-180

Sr No Name of the polymer Bulk Density (gm/cm³)

1.	Urea Formaldehyde (Powder)	0.577
2.	Polyamide	0.497
3.	Polyethylene (Powder)	0.581
4.	Polyvinyl chloride	0.657
5.	Phenol Formaldehyde	0.481
6.	Melamine formaldehyde (Liquid)	1.2
7.	Urea Formaldehyde (Liquid)	1.22
8.	Polypropylene (Powder)	0.519
9.	Polystyrene (Powder)	0.529

Applications

Some of the products that can be manufactured commercially from this process are: large containers, automobile panels, battery trays, fenders, hoods, kitchen bowls and trays, dinnerware, buttons, switches, seals, gaskets, footwear sole, toy parts, hair brush handles, plates, energy meter casing, bushes, O-rings, bottle caps, recreational vehicle body panels etc.

Advantages of Compression Molding

1. Can process a wide range of polymers such as thermoplastic, thermosetting plastics and rubbers easily.
2. Multidirectional flow of the material enabling reduction of internal stresses.
3. Processing waste generation such as runner, gate, sprue, culls etc avoided.
4. Multicavity molding fairly easy in comparison with other processing.

5. Thin walled products molding is very popular with compression molding process since it leads to very little or no warpage.
6. Relatively inexpensive for large parts molding.
7. Less expensive process due to lower machine and mold costs.

Disadvantages of Compression molding

1. Not used for processing of complex articles with undercuts, small holes and side draws.
2. High Cycle time.
3. High processing cost.
4. Required high manpower with respect to other processing operations.
5. Limitations in mold depth.
6. Trimming of flash is compulsory and acts as a secondary process.

Important Formula:

Charge of Raw material in the cavity(grams) = Volume of cavity (cm³) * Bulk density of polymer raw material (gm/cm³)

Clamping pressure requirement for compression molding (Tonnes) = Projected area of article (inch²) * y (tonnes/inch²)

where y is in the range of 1.78-2.67 Tonnes/in²

Procedure:

Step 1: Open Simulator tab.

Step 2: Click on "Start" button.

Compression Molding

Start Simulation

Start

Step 3: A question will appear on the screen, read and answer the question by clicking on any of the given options. Press submit after the option selection.

Compression Molding

Which of the following is the Thermoplastic?

- ☐ a) Urea formaldehyde
- ☐ b) Unsaturated Polyester
- ☐ c) Polypropylene
- ☐ d) None of the above

Submit

Step 4: If correct answer is provided, the next question will appear. Select appropriate answer from the dropdown list. Click submit after options selection.

Compression Molding

Label the following by selecting the options from given dropdown menu.

1) Polymeric materials that can be remoulded upon application of heat are known as.....

Select ▼

2) is made using Phenol Formaldehyde

Select ▼

3) Electrical junction boxes are made using.....

Select ▼

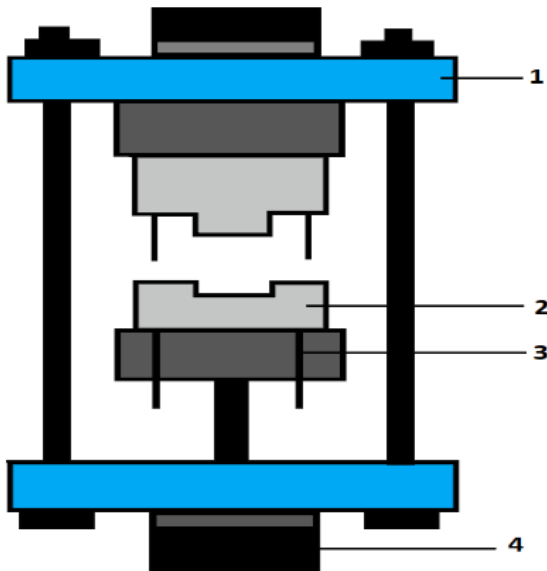
4) Polypropylene and polystyrene are examples of.....

Select ▼

Submit

Step 5: if correct answers are provided, next question will appear. Now match the experimental setup with the given options from the dropdown menu. Click submit after options selection.

Compression Molding



Label the numbered compression molding machine parts choosing the right option from the drop down menu.

1.

2.

3.

4.

Step 6: If all the answers are correct, it will move to next question. Click on one option and press

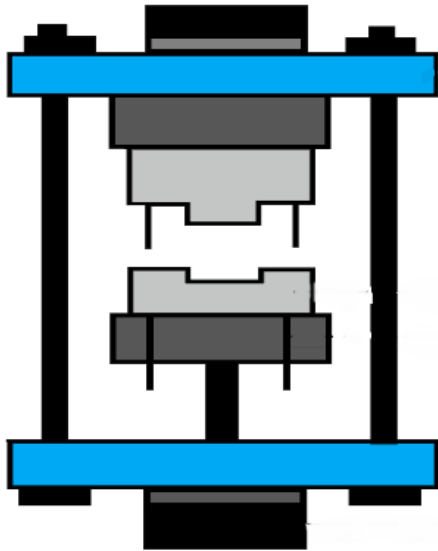
Compression Molding

Which part of the equipment is responsible to provide compressive pressure to the mold platen?

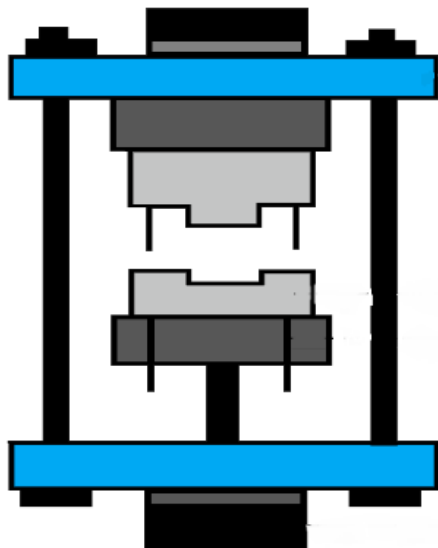
- ☐ a) Mold Platen
- ☐ b) Hydraulic Pump
- ☐ c) Guiding pins
- ☐ d) Ejector Pin
- ☐ e) Mold
- ☐ f) Mold Cavity

submit.

Step 7. Select the raw material from the dropdown menu.



Step 8: Enter the Raw material weight.



Step 9: Switch the Main switch On.

Compression Molding of sheet (10*10*3 cm)

Select raw material

Weight of the raw material

Main switch ☐ OFF

Temperature ☐ OFF

Pump ☐ OFF

Mode:

Compression Molding of sheet (10*10*3 cm)

Select raw material

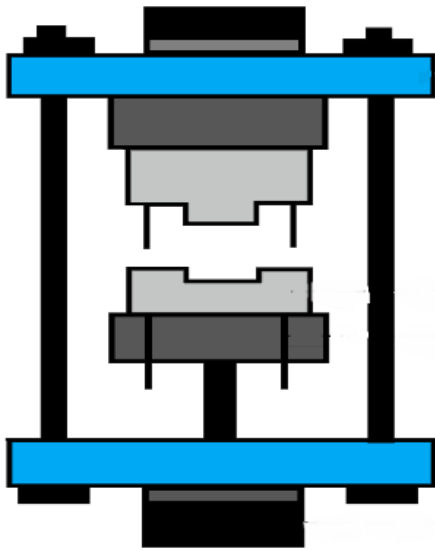
Weight of the raw material

Main switch ☐ OFF

Temperature ☐ OFF

Pump ☐ OFF

Mode:



Compression Molding of sheet (10*10*3 cm)

Select raw material

Weight of the raw material

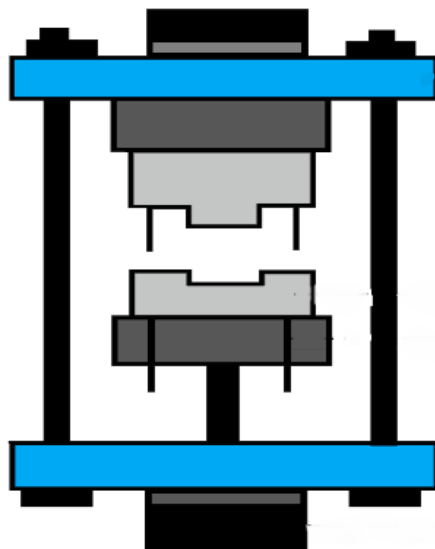
Main switch ☒ OFF

Temperature ☒ OFF

Pump ☒ OFF

Mode:

Step 10: Input the temperature value in °C.



Compression Molding of sheet (10*10*3 cm)

Select raw material

Weight of the raw material

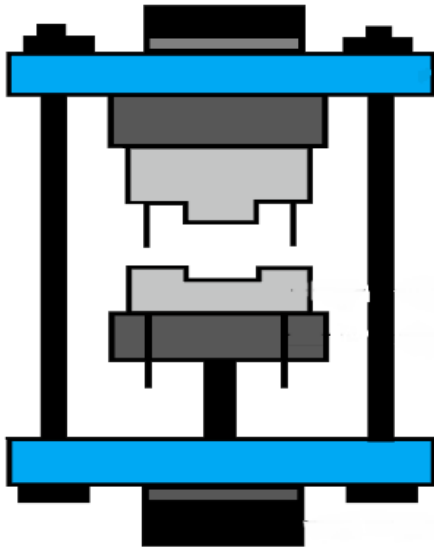
Main switch ☐ OFF

Temperature ☒ OFF

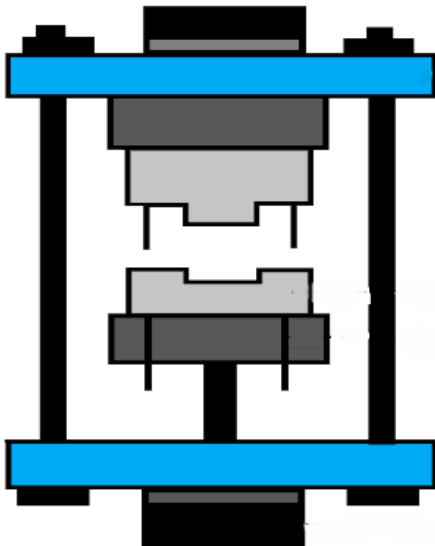
Pump ☒ OFF

Mode:

Step 11: Click and start the temperature button.



Step 12: Input the clamping pressure value.



Step 13: Click and start the pump button.

Compression Molding of sheet (10*10*3 cm)

Select raw material

Weight of the raw material

Main switch ☐

Temperature

☐

Pump

☐

Mode:

Compression Molding of sheet (10*10*3 cm)

Select raw material

Weight of the raw material

Main switch ☐

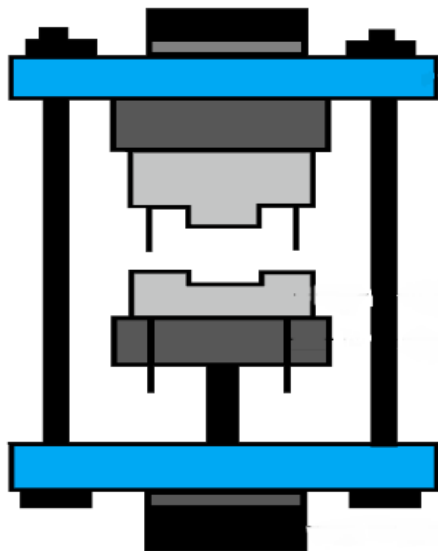
Temperature

☐

Pump

☐

Mode:



Compression Molding of sheet (10*10*3 cm)

Select raw material

Weight of the raw material

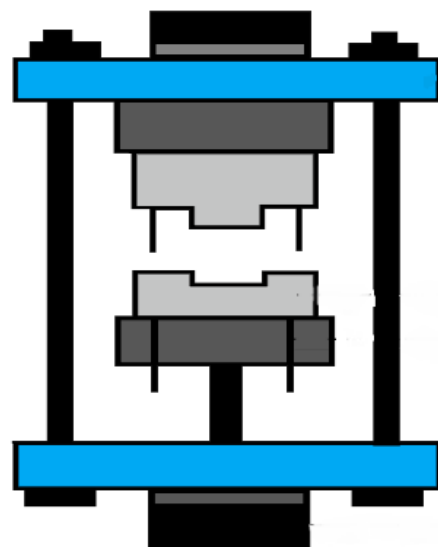
Main switch ☐ OFF

Temperature ☐ OFF

Pump ☐ OFF

Mode:

Step 14: Click and start semi-automatic operation.



Compression Molding of sheet (10*10*3 cm)

Select raw material

Weight of the raw material

Main switch ☐ OFF

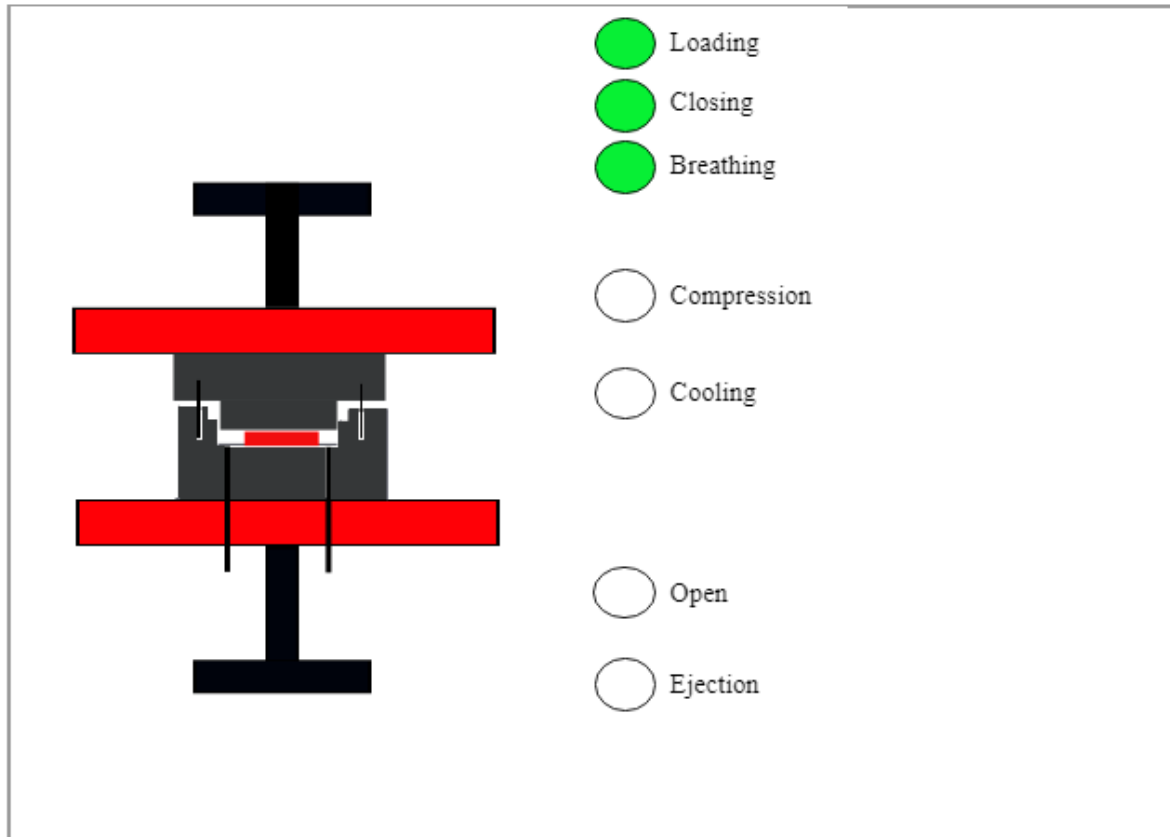
Temperature ☐ OFF

Pump ☐ OFF

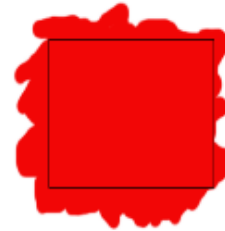
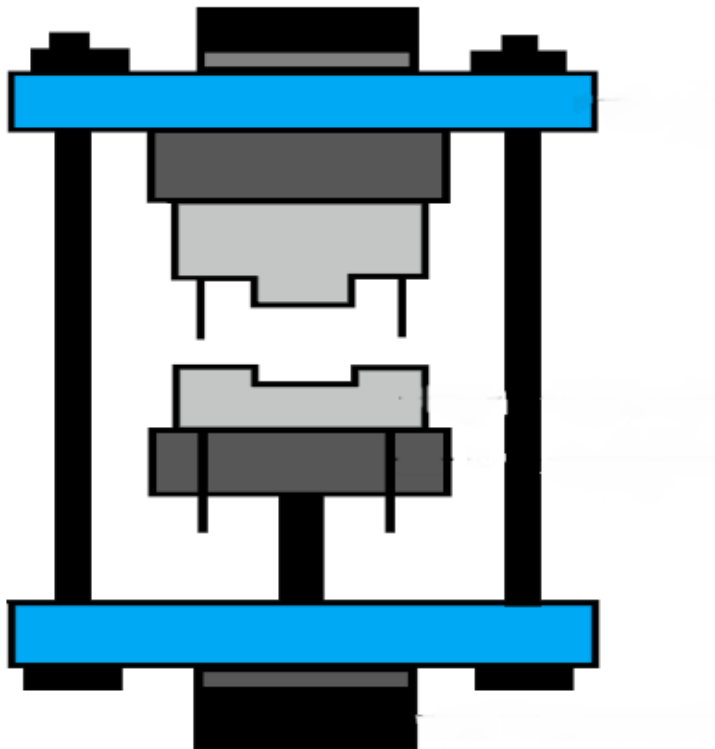
Mode:

Step 15: Observe the compression molding cycle of 52 seconds.

Compression Molding Cycle



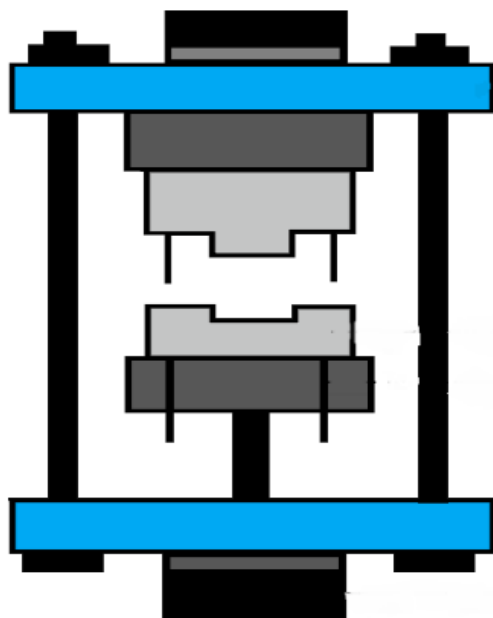
Step 16: Click on "See Result" button.



Article With Flash

See Result

Step 17: If correct parameters were input, a deflashed article (article without flashes) will be shown with a success message. Click on next question.

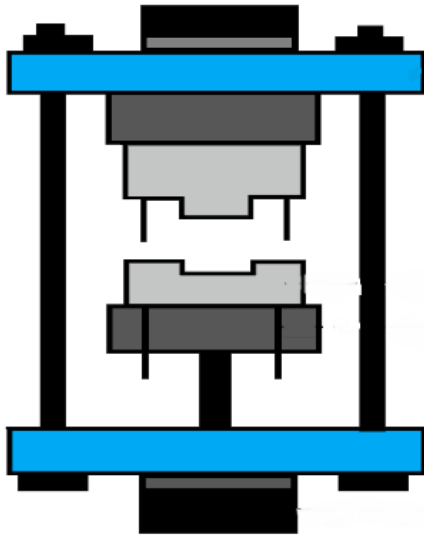


Congratulations! Your article is successfully manufactured

Next Question



Step 18: Incorrect entered parameters will show an error based on the values entered. If error message appears, then click on 'Try again' to go back to the raw material selection, temperature and pressure input tab. Repeat the process by identification of wrong parameter value until the you perform Step 18 successfully.



Compression Molding

Improper formation of article / low stiffness.

Try Again

Step 19: Read and answer the question by clicking on any of the given options. Press submit after the option selection.

Compression Molding

Which of the following steps deals with giving the final shape to the article?

- ☐ a) Breathing
- ☐ b) Mold Open
- ☐ c) Compression
- ☐ d) None of the above

Submit

Step 20: If correct answer is provided, a quiz based on troubleshooting of compression molding process will appear. Select appropriate answers from the dropdown list. Click submit after options

Compression Molding

What should be the temperature and pressure conditions for the following article quality

1. Scorching (Degradation)

2. Excess Flash

3. Article not formed

4. Improper shape of article

Submit

selection.

Step 21: Click on "End" to complete simulation.

Compression Molding

End Simulation

End

Pre-test:

Pre Test

Compression molding is mostly used for the processing of _____

- ☐ a : Thermoplastics
- ☐ b : Fibres
- ☒ c : Thermosetting Plastics
- ☐ d : All of the above

Removal of volatile gases from the mold cavity is known as _____

- ☐ a : Compression
- ☐ b : Loading
- ☒ c : Breathing
- ☐ d : Curing

In compression molding, which of the following factors doesn't have an impact on the process impact cycle time?

- ☐ a : Raw Material
- ☐ b : Curing temperature
- ☐ c : Part Geometry
- ☒ d : None of the above

Thermosetting plastics are generally used for making products of high strength and rigidity.

- ☒ a : True
- ☐ b : False

Which type of molecular structure is present in thermosetting polymer?

- ☐ a : Linear
- ☐ b : Branched
- ☒ c : Crosslinked
- ☐ d : Network

Poly vinyl chloride, Polyamides, polystyrene are examples of thermosetting polymers.

- ☐ a : True
- ☒ b : False

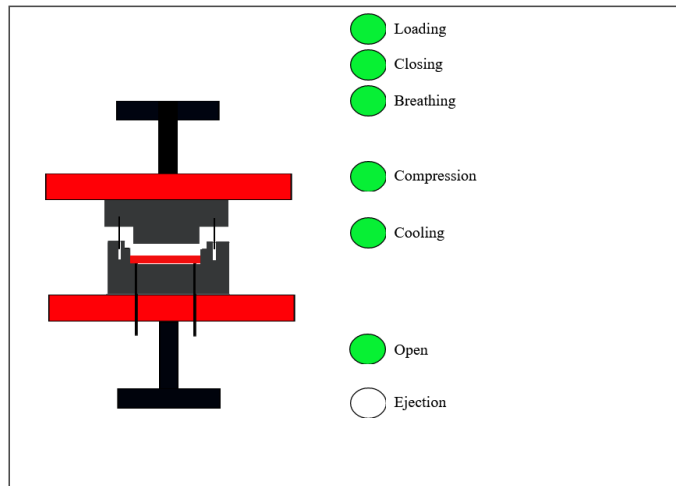
Submit Quiz

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Simulation:

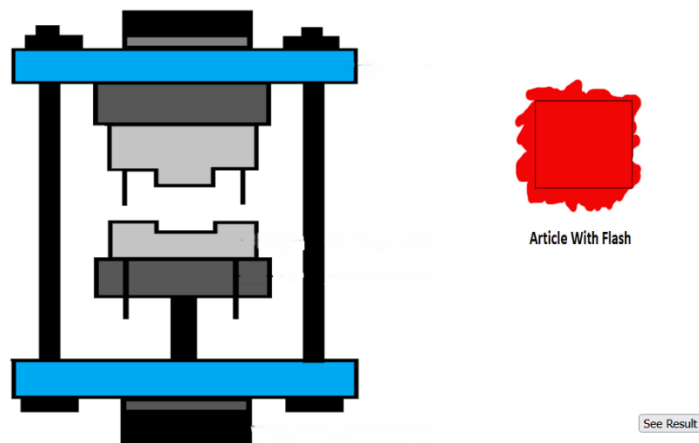
Step 1: Below is the picture when simulation is going on

Compression Molding Cycle



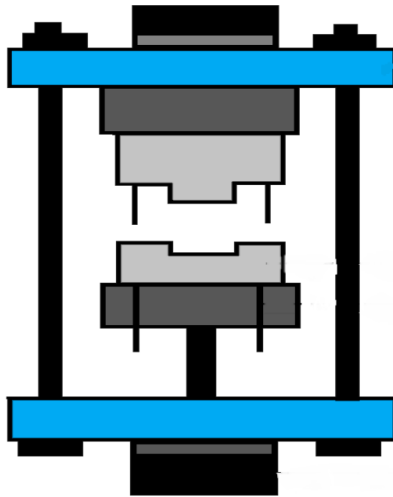
Step 2: Below is the picture showing article is compressed

Simulation



Step 3: Below picture is the final step. It shows that the article is successfully manufactured.

CONGRATULATION



Congratulations! Your article is successfully manufactured

Next Question



Post- test:

Post Test

Which materials can be processed using compression molding?

- ☐ a : Thermoplastics
- ☐ b : Rubbers
- ☐ c : Thermosetting composites
- ☒ d : All of the above

Unsaturated polyester resin mixed with glass fibres, (chopped) filler and a curing system is known as _____

- ☐ a : SMC
- ☒ b : BMC
- ☐ c : Rubbers
- ☐ d : All of the above

Which instrument will be able to help the machine user to measure the amount of pressure applied during the compression operation?

- ☐ a : Thermocouple
- ☐ b : Temperature gauge
- ☒ c : Pressure gauge
- ☐ d : All of the above

Which instrument will be able to help the machine user to measure the temperature of compression molding machine platens?

- ☒ a : Thermocouple
- ☐ b : Pressure gauge
- ☐ c : Hydraulic Piston
- ☐ d : All of the above

Which polymer material is used for compression molding of bottle caps?

Which polymer material is used for compression molding of bottle caps?

- ☐ a : Urea Formaldehyde
- ☒ b : Polyethylene
- ☐ c : Polyurethane rubber
- ☐ d : None of the above

Which polymer can be processed in the temperature range of 160-165 °C?

- ☐ a : Polyurethane
- ☐ b : Polyamide
- ☐ c : Polyester
- ☒ d : Polypropylene

Which media is used for hydraulically operated compression molding machine?

- ☐ a : Air
- ☒ b : Oil
- ☐ c : Water
- ☐ d : Solvent

Which of the following means a step to remove the volatiles during the compression molding cycle?

- ☐ a : Mold Close
- ☐ b : Mold Open
- ☒ c : Breathing
- ☐ d : None of the above

A solid part having 12" diameter requires a minimum clamp pressure of _____ tons/inch².

- ☐ a : 3200
- ☒ b : 201.2
- ☐ c : 2000



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(A Constituent College of Somaia Vidyavihar University.)



A solid part having 12" diameter requires a minimum clamp pressure of _____ tons/inch².

- ☐ a : 3200
- ☒ b : 201.2
- ☐ c : 20.22
- ☐ d : 260

A square part of 4'4 length requires a maximum clamp pressure of _____ tons/inch²

- ☐ a : 37220
- ☐ b : 48003
- ☒ c : 22670
- ☐ d : 226

The bulk density of Urea formaldehyde in its powder form is 1.20 gm/cc. What will be the raw material charge (in grams) in an open flash type mold for a solid block with 10x10x6 cm dimensions?

- ☒ a : 720
- ☐ b : 133
- ☐ c : 173
- ☐ d : 224

The bulk density of polypropylene in its powder form is 0.45 gm/cc. What will be the raw material charge (in grams) in an open flash type mold for a round component with radius of 7 cm and depth 3 cm?

- ☐ a : 225
- ☐ b : 320
- ☒ c : 208
- ☐ d : 223

Scorching in the article is evident when the _____

- ☐ a : Clamping Pressure is high

The bulk density of polypropylene in its powder form is 0.45 gm/cc. What will be the raw material charge (in grams) in an open flash type mold for a round component with radius of 7 cm and depth 3 cm?

- ☐ a : 225
- ☐ b : 320
- ☒ c : 208
- ☐ d : 223

Scorching in the article is evident when the _____

- ☐ a : Clamping Pressure is high
- ☐ b : Curing Temperature is low
- ☐ c : Clamping Pressure is low
- ☒ d : None of the above

Improper formation of article can be due to _____

- ☐ a : Low Pressure
- ☐ b : Low Temperature
- ☒ c : Both A and B
- ☐ d : None of the above

Submit Quiz

14 out of 14

Conclusion:

THE EXPERIMENT TAUGHT US ABOUT

The article with dimensions 10*10*3 cm is successfully manufactured.