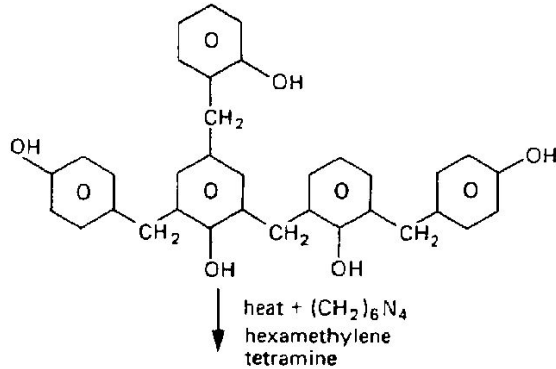




# Thermoset Molding CHEMISTRY

Phenolic novolak resin (formed by combination of phenol and formaldehyde in a 5:4 ratio in presence of acid catalyst)



Donates methylene bridges to allow novolak resin molecules to join together, with elimination of  $\text{NH}_3$  (ammonia)

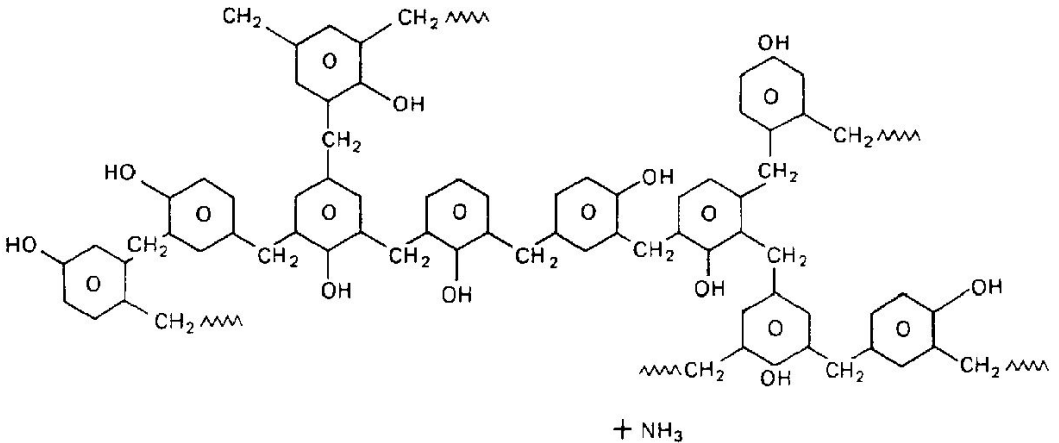


Figure 2: Condensation reaction of phenolic resin.

Thermosets are becoming less popular because they cannot be recycled.

# Thermoset Molding

## COMPRESSION MOLDING

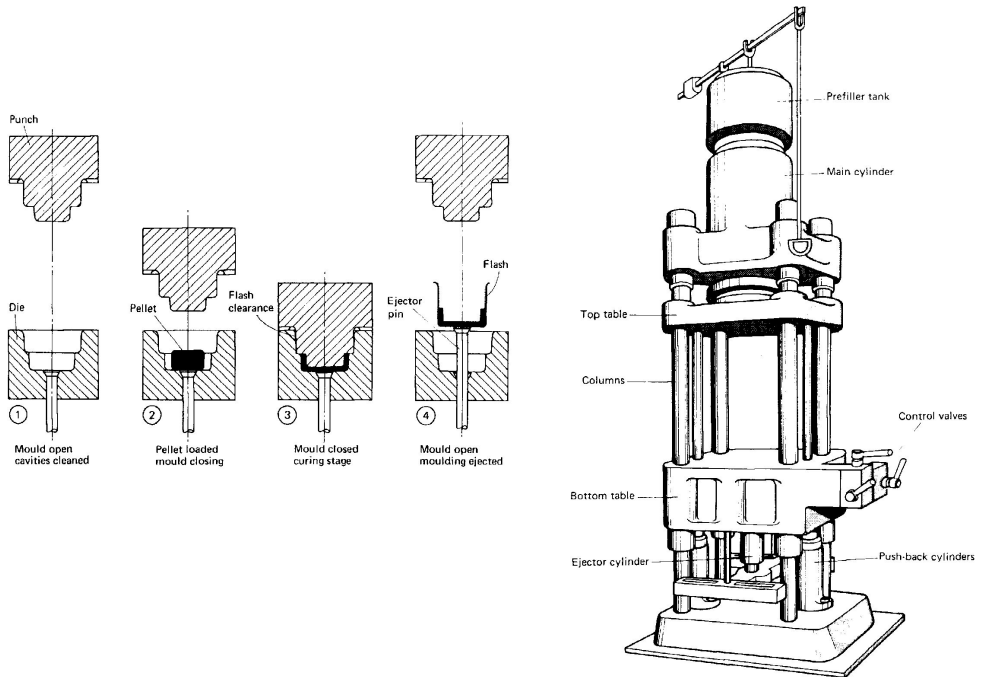


Figure 3: Compression molding thermoset resins.

### Advantages:

1. Small residual stresses
2. Suitable for fiber filled composites (can use long fibers & cavity is not eroded by filler)
3. Inexpensive equipment

Disadvantage — Cannot Recycle

# Thermoset Molding TRANSFER MOLDING

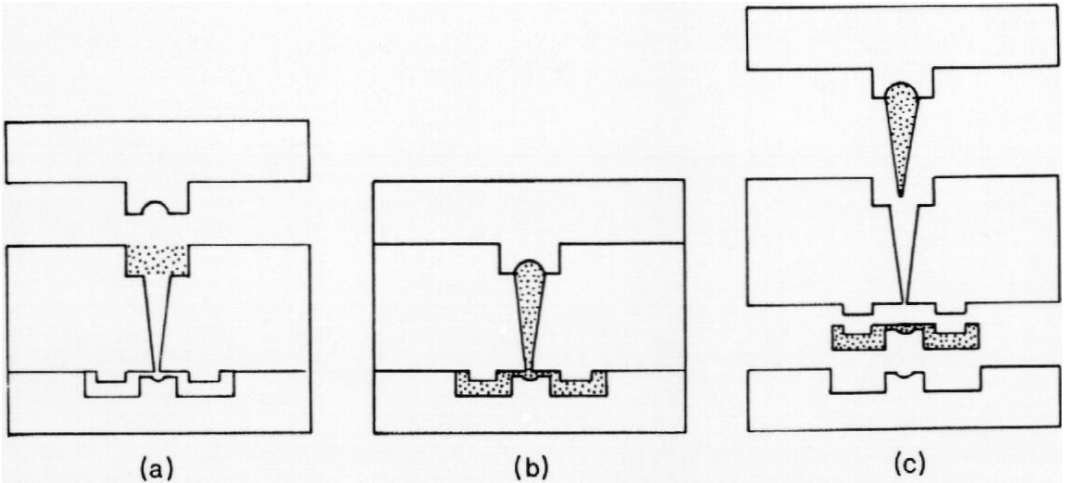


Figure 4: Transfer molding.

## Advantages:

1. Less flash than compression molding
2. Suitable for small intricate parts

## Disadvantages:

1. Flow creates orientation of fibers and wear of mold surfaces
2. Equipment is more expensive than for compression molding
3. Sprue and runners must be discarded

# Thermoset Molding INJECTION MOLDING

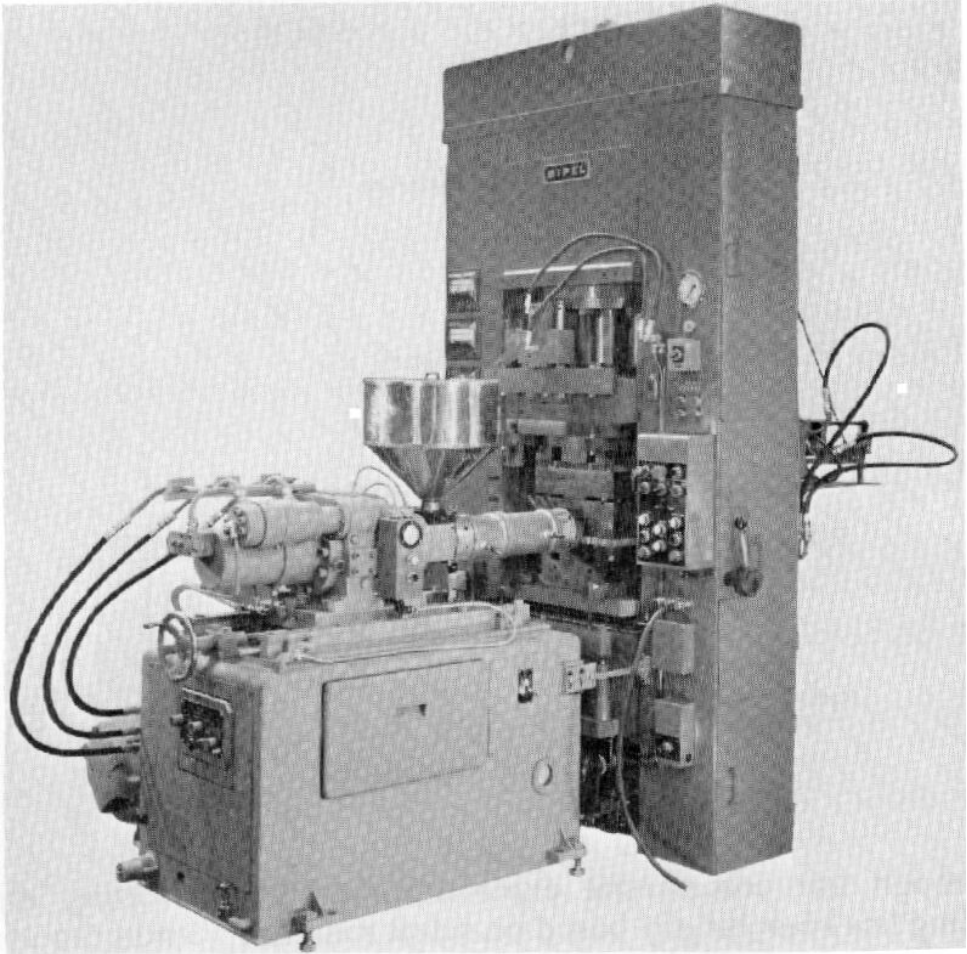


Figure 5: Thermoset injection molding machine.

Similar to injection molding of thermoplastics, but pressures are much lower.

# Thermoset Molding

## INJECTION MOLDING

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Barrel temperature	75°–80°C
Temperature of plasticized material	115°–125°C
Screw speed	40–60 rpm
Screw back time	10 s
Screw back-pressure	2–10 bar
Set injection pressure	
Stage 1	400–800 bar
Stage 2	0–250 bar
Actual injection time	2 s
Injection hold time	8 s
Cure time	30 s
Mould face temperature (fixed and moving halves)	160°–170°C
Total cycle time	45 s

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Figure 6: Injection molding of a 70gram switch cover (largest thickness is 6mm).

### With Thermosets:

viscosity of unreacted resin is low

keep extruder temperature low to prevent reaction in extruder

heat mold to cure resin

injection pressure is low

### With Thermoplastics:

heat extruder to keep viscosity low

cool mold to solidify part

injection pressure is huge