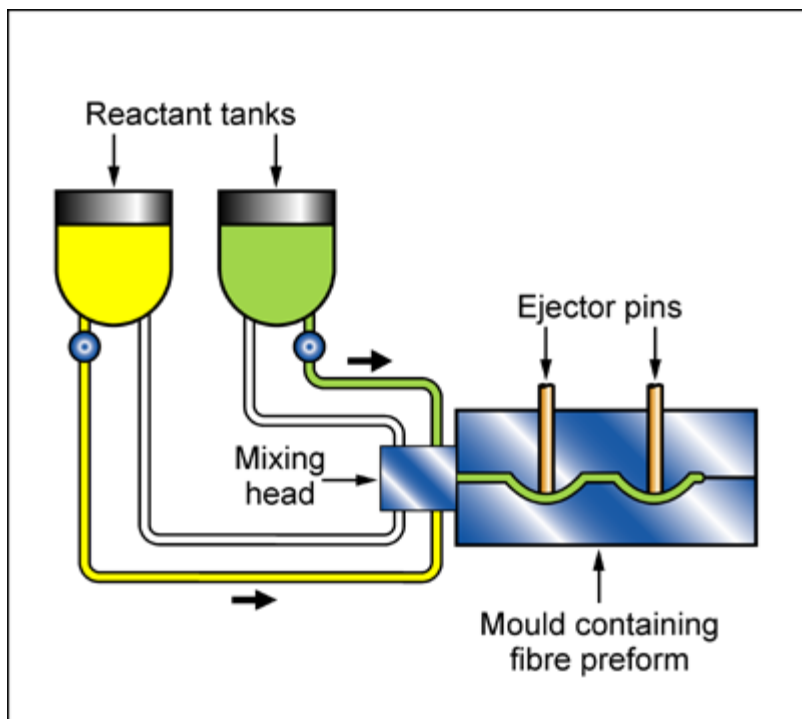


## Description

### Process schematic



### The process

RESIN TRANSFER MOLDING (RTM) allows manufacture of complex shapes in fiber-reinforced composites without high tooling costs. It uses a closed mold, in two or more parts, usually made of glass-reinforced polymers or light metal alloys, with injection points and vents to allow air to escape. Reinforcement is cut to shape and placed in the mold, together with any inserts or fittings. The mold is closed and a low viscosity thermosetting resin (usually polyester) is injected under low pressure (roughly 2MPa) through a mixing head in which hardener is blended with the resin. The mold is allowed to cure at room temperature. The molding is allowed to cure at room temperature. The fluidity of the resin and the low molding pressure allows long tool life at low cost.

### Tradenames

RTM

## Material compatibility

Composites



## Shape

Circular prismatic



Non-circular prismatic



Flat sheet



Dished sheet



Solid 3-D



Hollow 3-D



## Economic compatibility

Relative tooling cost	high
Relative equipment cost	medium
Labor intensity	high
Economic batch size (units)	1e3 - 1e6

### Physical and quality attributes

Mass range	0.8 - 50 kg
Range of section thickness	2 - 6 mm
Tolerance	0.25 - 1 mm
Roughness	* 0.25 - 1.6 $\mu\text{m}$
Surface roughness (A=v. smooth)	A

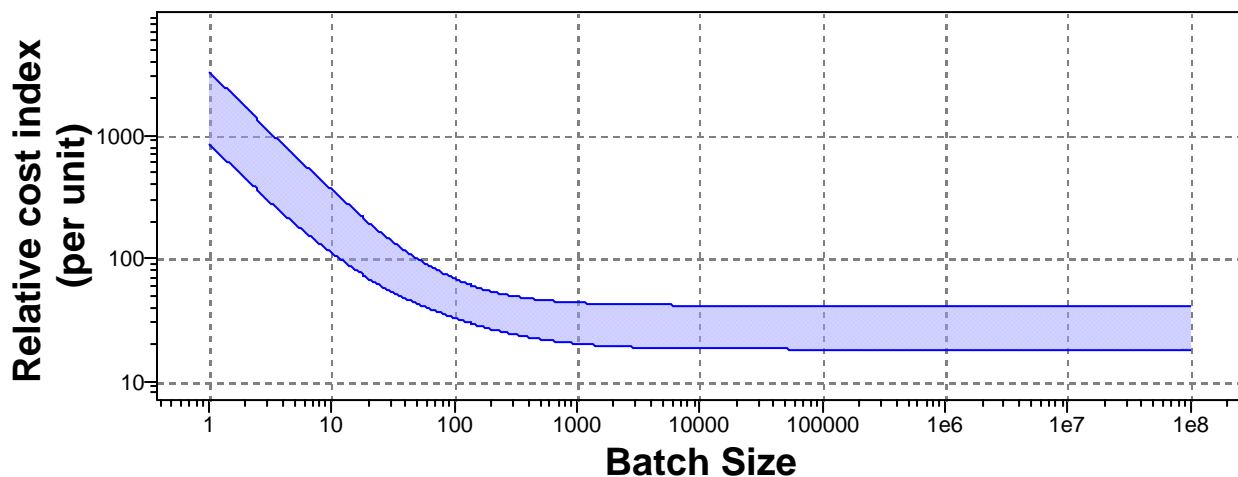
### Process characteristics

Primary shaping processes	✓
Discrete	✓

### Cost model and defaults

Relative cost index (per unit)	* 20.2 - 43.6
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Parameters: Material Cost = 8USD/kg, Component Mass = 1kg, Batch Size = 1e3, Overhead Rate = 150USD/hr, Discount Rate = 5%, Capital Write-off Time = 5yrs, Load Factor = 0.5



Material Cost=8USD/kg, Component Mass=1kg, Overhead Rate=150USD/hr, Capital Write-off Time=5yrs, Load Factor=0.5, Discount Rate=5%

Capital cost	* 8.2e3 - 4.92e4 USD
Material utilization fraction	* 0.85 - 0.97
Production rate (units)	* 5 - 20 /hr
Tooling cost	* 820 - 3.28e3 USD
Tool life (units)	* 500 - 5e3

### Supporting information

### Design guidelines

Resin transfer molding is increasingly used for large fiber-reinforced polymer components. Shapes can be complex. Ribs, bosses, and inserts are possible. Foam panels can be insert-molded to reduce component weight.

### Technical notes

A range of resin systems can be used with RTM: almost any thermosetting resin with a low viscosity is possible, for example, polyester, epoxies, vinyl esters and phenolics. The reinforcement, typically, is a 25-30% volume fraction of glass or carbon in the form of continuous fiber mat.

### Typical uses

RTM is used to make large composite structures such as manhole covers, compress soil casings, car doors and side panels, propeller blades, boat building, hulls, canoe paddles, water tanks, bath tubs, roof sections, airplane escape doors.

### The economics

The mold costs for VARTM are low, making the process economic for small batch

### The environment

It is easy to control emissions from the vented, closed mold with adequate ventilation, so worker exposure to unpleasant chemical vapors is much less than in many other composite-molding processes.

### Links

MaterialUniverse

Reference