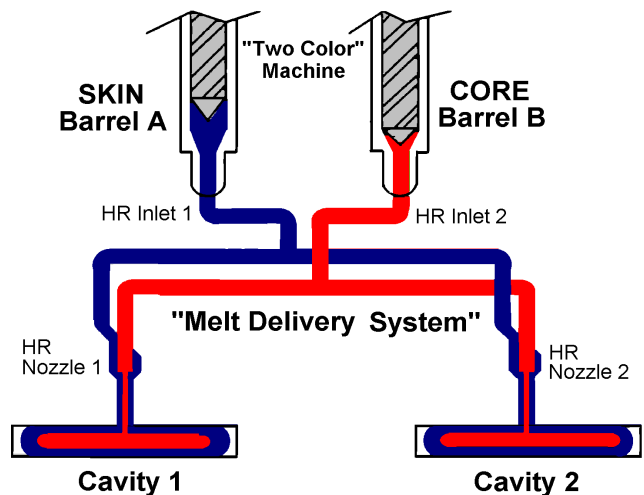


-- Co-Injection Molding --

Process

Co-injection molding is a process in which two or more different polymers are laminated together by injection molding. These polymers may be identical except for color or hardness, or they may be of different polymer types. When different polymers are used they must be compatible (*i.e.*, weld together) and melt at approximately the same temperature.

The term co-injection can denote different processes, such as sandwich construction, double shot injection, multi-shot injection or structural foam construction. Whatever its designation, a sandwich configuration has been made in which two or more thermoplastics are laminated together to take advantage of the different properties each contributes to the structure. Most commonly, the skin material is solid while the core material contains a blowing agent. However, any combination of foamed and/or unfoamed skin and core is possible. For heavy walled parts, cooling time may be substantially reduced by running the skin material at a higher melt temperature for a smooth surface and the core material, which essentially determines cycle time, at a lower melt temperature.



There are three basic co-injection molding techniques -- one-, two- and three-channel. In the one-channel system, the plastic melts are shot sequentially into the mold by shifting a valve. Because of the flow characteristics of the melt and the tendency of the skin material to adhere to

the cooler mold surface, a dense solid skin is formed. Thickness of the skin can be controlled by varying the injection rate, melt temperature and flow compatibility of the two materials.

In the two-channel system, sequential or simultaneous injection of both the skin and core materials is possible. This permits control of the skin thickness, especially in the gate areas on both sides of the part. In this type of molding, it is best if profile injection is used. The use of profile injection permits greater control of the surface appearance. The machine can be profiled by the number of velocity settings a machine has. The velocity can be varied from 0.1 to 4 inches per second.

The three-channel system allows simultaneous injection with a direct sprue gate. The skin thickness may be influenced on both sides of the part. With this system, the foamed core progresses farther toward the end of the flow path than that of the one- and two-channel techniques. Parts can also be designed to be lighter in weight.



Advantages	Disadvantages
Material cost savings and lighter weight parts	Machine costs are 25 to 30% higher than for standard injection equipment
Two different or alike materials can be shot simultaneously into the mold	Good tool makers familiar with tooling requirements are difficult to find in some areas
Some co-injection machines can be adapted for gas assist, which allows the machine to perform dual functions	Material viscosities must be very similar or part can easily be core-rich or skin-poor
Allow an outlet for regrind usage on internal core	Sometimes difficult to obtain technical support for equipment problems

Market Segments

Market	Applications
Automotive	Fender skins Interior components
Plumbing	Handles and faucet components Toilet seat
Appliance	Door panels Handles
Housewares	Cups Thermos bottles

Equipment Suppliers

Battenfeld of America, Inc.

31 James P. Murphy Highway
West Warwick, CT 02893

Contact - Ed Matola, VP Sales and Marketing
(401) 823-0700

Krauss Maffei Corporation

7095 Industrial Road, P.O. Box 6270
Florence, KY 41022-6270

Contact - Virginia Mattmann, Sales Coord.
(606) 283-0200

Cincinnati Milacron / Ferromatik Milacron

4701 Marburg Avenue
Cincinnati, OH 45209

Contact - Robert Hare, General Manager
(49) 7644-780 (overseas)

Nestal Machinery, Inc.

72 Lake George Street
Devens, MA 01433

Contact - Dan Morris, Sales Manager
(508) 772-5100

Engel Canada

545 Elmira Road
Guelph, Ontario
N1K 1C2

Contact - Kurt Fenske, VP Sales and Marketing
(519) 836-0220

Nissei America, Inc.

1480 N. Hancock Street
Anaheim, CA 92807

Contact - Rick McGranahan, Sales Manager
(714) 693-3000

NOTE:

The following supplier specializes in multi-gate systems for co-injection and two-shot molding.

Kortec, Inc.

3 Crafts Road
Gloucester, MA 01930-2135

Contact - Paul Swenson
(508) 283-6543

-- Two-Shot / Two-Color Molding --

Process

The two-shot (or two-color) process requires a machine with two independent injection units, each of which shoots a different material. The first material is injected through a primary runner system, as in a normal injection molding cycle. During this injection, the mold volume to be occupied by the second material is shut off from the primary runner system. The mold is then opened and the core plate rotated 180°. The mold is again closed and the second runner system connected to the volume to be filled. After sufficient part cooling, the mold is opened and the part is ejected. The injection of the first material through the primary runner system and the second material through the secondary runner system occurs at the same time.

This process also enables two dissimilar materials to be mechanically bonded. If the first shot totally solidifies before the second material is injected, a crack will usually form between the two, due to the differential shrinkage.

The two-shot process can also be accomplished with an indexing system (a round table rotating around a horizontal axis) with a primary and secondary station. While the first injection is accomplished at station #1, the second injection is accomplished at station #2. Each injection station is run by an independent injection unit. This allows injection speeds and pressures to be controlled for each material being utilized. The two-shot or two-color process can also be performed by either indexing the mold in the machine or with a rotary table.

Advantages	Disadvantages
Cycle times are fairly fast	Dual injection unit needed either vertical or 90° from main injection unit (requires more floor space)
Not very labor-intensive	Mold costs are somewhat high
Excellent for high volume production	Good mold builders may be hard to find in some areas
Molding flexibility of two rigid materials, two soft ones or a combination	Capital for machine is approximately 20% higher than for standard equipment
Single mold produces finished part	Sometimes where barrels are in tandem, mold balancing is much harder and tools end up being 6, 10 or 12 cavity
Machine can be utilized for standard molding or two-shot	

Market Segments

Market	Applications
Automotive	Knobs Interior panels Under-the-hood covers
Consumer	Toys Industrial grips Hand and power tools
Appliance	Handles Interior panels Sweeper components Cooking utensils
Medical	Syringe components Metering pump components
FDA	Food containers Toothbrushes Sealing devices

Equipment Suppliers

Any machine supplier will build a two-shot machine. Listed here are true two-shot machine manufacturers.

Battenfeld of America, Inc.

31 James P. Murphy Highway
West Warwick, CT 02893
Contact - Ed Matola, VP Sales and Marketing
(401) 823-0700

Cincinnati Milacron / Ferromatik Milacron

4701 Marburg Avenue
Cincinnati, OH 45209
Contact - Robert Hare, General Manager
(49) 7644-780 (overseas)

Engel Canada

545 Elmira Road
Guelph, Ontario
N1K 1C2
Contact - Kurt Fenske, VP Sales and Marketing
(519) 836-0220

Krauss Maffei Corporation

7095 Industrial Road, P.O. Box 6270
Florence, KY 41022-6270
Contact - Virginia Mattmann, Sales Coord.
(606) 283-0200

Nestal Machinery, Inc.

72 Lake George Street
Devens, MA 01433
Contact - Dan Morris, Sales Manager
(508) 772-5100

Nissei America, Inc.

1480 N. Hancock Street
Anaheim, CA 92807
Contact - Rick McGranahan, Sales Manager
(714) 693-3000

-- Insert Molding --

Process

A solid preform (plastic or metal) is placed into a mold and the polymer is shot around it. Preforms are usually produced with a plain exterior, without serrations or knurls. They are bonded by melting of the outer skin, which creates a weld between the insert and outer skin material. The generation of a satisfactory weld requires that the preform material and overmolded polymer be compatible. Normally, a mechanical means, such as flow through slots, enhances the bonding.

When two materials are not of the same polymer type and thus incompatible, it is necessary to use an adhesive on the preform surface prior to molding the second material. Utilizing adhesives, suitable bonding can be achieved. If the preform is metal, it will require cleaning and degreasing prior to applying adhesives.

Advantages	Disadvantages
Machine costs are in mid-range	Most insert molding is run on shuttle type equipment
A good bond can be achieved when like materials are used	Labor-intensive loading and loading of tool
Low cost tooling	Most crystalline materials must set for 24 hours prior to insert molding
Best utilized when molding couplings on hoses or wire connectors	Dissimilar materials will require secondary operations and equipment, adhesives and ovens
	Inserts must be handled carefully or adhesion issues may occur
	Cycle times are relatively long
	Unless dedicated press for each step, down time for mold changeovers

Market Segments

Market	Applications
Appliance	Hose end connectors Fill tubes
Automotive	Wire and vacuum connectors Air ducts
Audio	Speaker surrounds

Equipment Suppliers

Battenfeld of America, Inc.

31 James P. Murphy Highway
West Warwick, CT 02893
Contact - Ed Matola
VP Sales and Marketing
(401) 823-0700

HPM Corporation

820 Marion Road
Mt. Gilead, OH 43338
Contact - Randall Parker
(419) 946-0222

Cincinnati Milacron / Ferromatik Milacron

4701 Marburg Avenue
Cincinnati, OH 45209
Contact - Robert Hare, General Manager
(49) 7644-780 (overseas)

Krauss Maffei Corporation

7095 Industrial Road, P.O. Box 6270
Florence, KY 41022-6270
Contact - Virginia Mattmann, Sales Coord.
(606) 283-0200

Engel Canada

545 Elmira Road
Guelph, Ontario
N1K 1C2
Contact - Kurt Fenske, VP Sales and Marketing
(519) 836-0220

Van Dorn Demag Corporation

11792 Alameda Drive
Strongsville, OH 44136
Contact - David Walters, National Sales
Manager
(216) 238-8960



Plastics 101

Canton, OH
(330) 493-4033