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REACTION INJECTION MOLDING
RIM

Introduction to Reaction Injection Molding

Everywhere you look, there are products manufactured with the reaction injection molding (RIM) process. Armrests. Steering wheels. Window frames. Bumper fascias. Even the soles of your shoes.

What is Reaction Injection Molding?

Reaction injection molding is a simple concept. As its name suggests, the process is based on a chemical reaction. A reactive liquid mixture (usually polyol and isocyanate) is injected or poured into a mold where a chemical reaction takes place. After an exothermic (heat-generating) reaction occurs, the finished part is removed from the mold. Depending on the chemical formulation, the end product can take on a wide range of physical characteristics: foam or solid, highly rigid or very flexible.

Why should I be interested in RIM?

In this age of rising energy costs, many plastics manufacturers are pursuing ways to save material and energy costs. Compared to thermoplastics, where high heat and pressure is required to melt resins, RIM parts are formed from two liquid components that chemically react inside a mold. The RIM process consumes less energy because it requires significantly less heat, clamping pressure and tooling costs.

When it comes to RIM, the most critical process takes place in the mixing head. Complete mixing of the polyol and isocyanate materials is essential in order to produce quality parts.

In addition, RIM equipment:

- is generally less complicated with a reduced initial cost of investment
- requires lower-tonnage presses than thermoplastic molding
- requires significantly less equipment and floor space than injection molding
- uses less expensive molds and/or presses as RIM mold pressures are much lower

Who uses RIM?

From small shops with low volumes of parts to large manufacturers that use RIM for automated online processes, RIM is used in a variety of industries.

During the 1960s, RIM was mainly used for manufacturing high-density rigid polyurethane foam parts such as bumpers and fascias for the automotive industry. Since then, RIM has evolved into an efficient manufacturing process applied to a score of industries: construction, appliances, sports and recreation, electronics, medical and many others.

Today RIM applications include sheathing, roofing, doors, windows and decorative millwork for the construction industry; interior components such as steering wheels, dashboards and NVH applications for the automotive industry; military and aerospace applications; computer enclosures in the electronics industry; and insulation in refrigerators in the appliances industry. The end use applications for RIM are now so varied that today you can come across polyurethanes in many forms: protective coatings, flexible foam, rigid foam and elastomers.

The RIM Process

Is RIM right for your business?

- Are you looking for a cost-effective way to produce parts?
- Are you concerned about rising petroleum costs and associated resin prices?
- Do you want an innovative approach to expand your existing product line?
- Are you a short-run injection molder?
- Do you need an affordable way to produce large parts?
- Would you like to use less expensive molds?

If you answered yes to any of these questions, then you should consider Reaction Injection Molding and the advantages it offers.

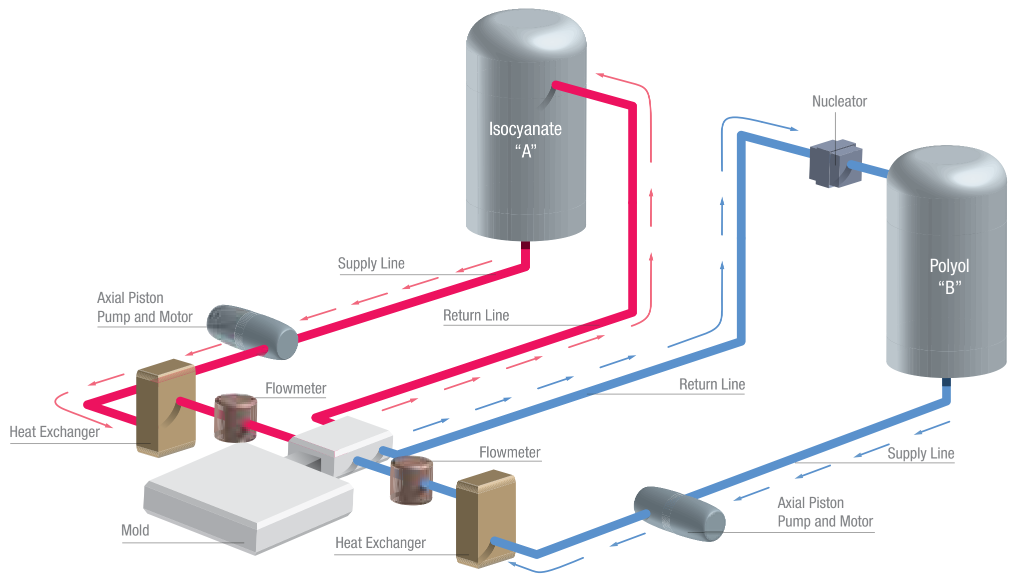
Definitions

- ***Polyol:***

Determines the physical characteristics of the part, including density, strength, flex modulus and color

- ***Isocyanate (ISO)***

Reacts with the polyol to form a thermoset polyurethane plastic



Material storage

In a typical RIM operation, the raw materials are stored in day tanks or bulk storage tanks before processing. The materials are temperature-controlled to the optimum processing temperature as specified by the material supplier. This results in a consistent manufacturing environment day in and day out, and will provide the desired physical properties or cell structure. If the materials have other ingredients like fillers or pigments that need to be evenly dispersed throughout the chemical system, stirring devices or tank agitators are often incorporated into the tanks to prevent settling or chemical separation.

Recirculation

The materials are continuously circulated at low pressure by the pumping system and through the mixing head. When the materials reach the mixing head, they are recirculated back to the day tanks and then through the same path again back out to the mixing head. This low-pressure recirculation can be used to maintain temperature, nucleation, and will help keep added ingredients such as fillers or pigments evenly dispersed.

Dispensing

The two reactive materials, **polyol** and **isocyanate**, are kept separate until they reach the mixing head. When it is time to dispense a shot or make a pour, the machine automatically switches from recirculation to dispense mode. At this point, the metering pumps precisely deliver the materials to the mixing head at the required volume, ratio, flow rate and temperature. The chemicals are then mixed by either high-pressure impingement (about 2500 psi) or in a high shear dynamic mix chamber. The mixture is then injected into a closed mold or poured into an open mold or cavity.

Molding

An immediate chemical reaction occurs inside the mixing head, with a continued exothermic reaction inside the mold cavity as the curing process progresses. When processing foams, significant forces created inside the mold must be resisted to ensure the integrity of the part. The clamping pressure required can be up to many tons depending on the size, expansion rates, and the desired density of the part, along with other material factors. Mounting the mold in a pneumatic or hydraulic press provides the force required to keep the mold tightly closed during the curing process. Elastomeric materials often require very little clamping pressure as they do not expand or generate internal mold forces.

The difference between RIM and injection molding

Injection molding is the process of forcing melted plastic into a mold. With reaction injection molding, two liquid components (isocyanate and polyol) are mixed in a high- or low-pressure mixing head and pumped into a mold. The reaction occurs in the mold, resulting in a polyurethane part.

Conventional thermoplastic molding vs Reaction Injection Molding

	Thermoplastic Molding	RIM
Material	Thermoplastics in pellet form	Low viscosity liquids
Processing Temperature	350° to 450°F (176° to 232°C)	Low processing temperatures 90° to 105°F (32° to 40°C)
Mold Temperature	350° to 450°F (176° to 232°C)	Low mold temperatures 90° to 105°F (32° to 40°C)
Mold Pressure	Multiple tons of pressure	Low internal molding pressure 50 psi (3.4 bar) and up
Floor Space	Equipment and molds require more floor space	Equipment requires less floor space
Energy	More energy to make a product	Less energy to make a product
Investment	High initial investment	Low initial investment

Is RIM a viable alternative to Fiberglass Reinforced Plastic (FRP)?

Definitely. Many manufacturers of heavy-duty trucks and equipment now produce body panels and other large exterior parts from polydicyclopentadiene (PDCPD), a thermoset material molded through the RIM process, rather than fiberglass-reinforced plastics (FRP) in an open mold process. Typical PDCPD applications include:

- Hoods, fenders and fairings
- Bumpers, grills
- Septic tanks
- Snowmobile hoods and components
- Dunnage parts
- Large containers
- Computer and electronics housings

Large body parts made from PDCPD cost about the same as FRP, but are much lighter and more durable.

Benefits of RIM

Large parts

Automotive and heavy duty equipment manufacturers are turning to RIM for large, exterior parts.

Freedom of design

Architectural molding and doors demonstrate the intricate details that are possible with RIM.

1. Very large, lightweight parts

The "flowability" of polyurethane components allows for even distribution of the material within the mold. This lets you produce large parts, which is not possible with injection molding. And because mold pressures are much lower, large presses are not necessary.

2. Low-cost molds

Because of the low injection pressures of the RIM process, mold builders can use a variety of less expensive mold materials including steel, aluminum, Kirksite alloys, nickel, epoxy, silicone and fiberglass. The larger the mold, the greater the savings.

3. Freedom of design

RIM lets you mold complex shapes or highly detailed parts with intricate design features at relatively low tooling and capital equipment costs. Monolithic parts or components with varying wall thicknesses can be designed into the same molded part.

4. Rapid prototyping

Excellent working prototypes can be developed with lead times of 3-15 days, at a cost much less than traditional injection molding. This also allows for ergonomic or functionality testing prior to cutting actual high-pressure injection molds. RIM is ideal for shorter production runs of less than 5,000.

5. Class A Surfaces

The surface finish of RIM parts allows manufacturers to produce Class A painted parts – high-gloss finishes that match high-gloss painted metal parts.

RIM Applications

Physical characteristics of polyurethane RIM products

Depending on the chemical formulation, the end product can take on a range of physical characteristics: either foam or solid, highly rigid or very flexible. Polyurethane products manufactured from the RIM process are:

- Lightweight
- High strength
- Scratch resistant
- Heat resistant
- Impact resistant
- Resistant to organic and inorganic acids
- High R-value

Types of materials manufactured with the RIM process

The two major material categories are foams and elastomers. Foams can be rigid or flexible, and contain a cell structure of some kind. Microcellular foams are the result of direct dissolution of inert gases (like nitrogen, argon or carbon dioxide) into a melted polymer stream. Microcellular foams are typically thermoplastic related, not thermoset related. Elastomers are all solid but have differing durometers; in other words, they can be very soft or gel-like (shoe inserts) or very rigid (automotive aftermarket styling kits).

The difference between SRIM and RRIM

RRIM (Reinforced Reaction Injection Molding) describes a filler that is blended directly into the polyol component of the foam or elastomer. The filler is typically milled glass fiber but can include other mineral substances such as mica, quartz, calcium carbonate or aluminum oxide.

SRIM (Structural Reaction Injection Molding) refers to a closed molding process where a preform of fiberglass or other reinforcing material is placed into a closed mold and then injected with elastomer or foam.

Flexible foam

Rigid foam

Soft elastomers

Rigid elastomers

RIM Application Chart

With the proven success of reaction technology, there is immense potential for new products and applications across many industries. From surfboards to footwear, sporting goods to moldings, it's no wonder that reaction injection molding is billed as "limited only by the imagination."

	AUTOMOTIVE											ELECTRONICS			MEDICAL			HEAVY DUTY EQUIPMENT					
	Bumper Fascias	Energy Absorbing Foams	Window Encapsulation	Door Panel Substrates	Interior Panels	IP Supports	Padded Door Panels	Seat Backs	Seat Shells	Steering Wheels	NVH Applications	Computer Enclosures	Marine Radar Display Enclosures	Laser Welding Workstation Enclosures	Clean-room Device Housing	Prosthetics	MRI Enclosures	Exterior Body Panels	Fenders	Engine Covers	HVAC Enclosures	Interior Engine Covers	Sleeper Cab Interior Panels
FOAM - Flexible		●	●		●		●	●		●						●							
FOAM - Rigid		●		●	●	●			●	●	●	●	●	●	●	●	●						●
ELASTOMERS Any durometer		●	●	●	●	●	●	●	●	●		●	●	●	●	●	●						●
RRIM (Reinforced Reaction Injection Molding)	●	●		●	●	●		●	●	●	●	●	●	●	●		●	●	●	●	●	●	●
SRIM (Structural Reaction Injection Molding)		●		●	●	●		●	●	●	●	●	●	●	●		●	●	●	●	●	●	●

Architectural balustrades, columns, balusters, moldings and other architectural details are manufactured with the RIM process.

FURNITURE		INDUSTRIAL			SPECIALTY VEHICLES					SPORTS/RECREATION						CONSTRUCTION				REFRIGERATION				OTHER APPLICATIONS				
Molded Armrests & Headsets	Simulated Wood Furnishings	Corrosion-resistant Pump Housings	Water Filtration Panels	Castors & Bushings	Recreational Watercraft Parts	Snowmobile Hoods	Lawn Tractor Seats & Fender Decks	Aftermarket Specialty Car Parts	Marine Flotation Foam	Cores for Snowboards, Surfboards & Skis	Bowling Balls (Weight Blocks & Covers)	Sports Helmets	In-Line Skate Wheels	Golf Ball Covers & Golf Club Grips	Archery Targets	Window Frames	Architectural Trim	Concrete Stamps & Formliners	Molded Doors	Domestic Refrigerators	Vending Machines	Refrigeration Doors & Handles	Walk-in Coolers	Shoe Soles & Boots	Credit Cards	Coolers & Insulated Thermoses	Mannequins	Gaskets (FIPG & CIPG)
•	•				•		•					•		•	•			•						•				•
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Steering wheel assemblies are manufactured using a reaction molding process. In addition, many automobile manufacturers are using soundproofing foam and RIM technology to help muffle vehicle and road noise.

Getting Started

How do I incorporate the RIM process into my production facility?

Understanding both chemical processing and manufacturing requirements is critical to selecting the right RIM equipment. A good equipment supplier will have the expertise to make a recommendation. Your supplier should also be able to provide installation, start-up assistance, and answer your questions throughout the lifetime of your machines.

How do I get started?

Choosing the right machine and auxiliary equipment is a crucial first step. The right equipment will speed your production, reduce downtime and determine whether you can make the desired part successfully.

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Reactor® IP

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RD

Dispenses filled and abrasive materials for very large parts.

RL

A low-pressure system for elastomer applications.

RC

A high-pressure system with advanced features and a configurable platform.

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For polyurethane processors demanding optimum performance and flexibility with high output.

RB

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