EXOTHERMIC
REACTION INJECTION MOLDING

Determining the Right Molding Process for Part Design

How RIM Molding Advantages Compare with Traditional Production Technologies

Introduction

This White Paper details the part production processes most often used by industrial designers and compares their features to illustrate when Reaction Injection Molding (RIM Molding) becomes the most effective choice. Many of the more traditional molding processes limit a designer's freedom in some way, while RIM Molding can open opportunities for creativity and inventiveness. Through a comparison of the popular molding processes with RIM Molding, designers can gain a better understanding of the features and limitations of each to minimize risk in their decision and maximize their opportunity for design success with RIM.

The Challenge of Choosing a Process

Determining the right process for part production is a crucial step in the ultimate success of a product. The realities of quantities, lead times, budgets and design features have to be considered against unknowns such as market success and future design changes. Oftentimes a particular process will solve one problem but raise others, and can limit the designer's freedom in some way.

In these cases, the designer may feel the need to eliminate certain design features in order to make part production feasible within the traditional methods they are most familiar with. Creativity is often sacrificed because alternative manufacturing processes were never considered as viable options.

A Solution for Design Freedom

The unique plastics process of Reaction Injection Molding technology, or RIM Molding, can offer great flexibility compared to traditional methods of molding parts. Many designers will find the RIM process to be a viable alternative to satisfy complexity, cost, and timing issues.


RIM is valuable for complex design

The Reaction Injection Molding process works by combining two liquid components that chemically react in a closed mold to form a thermoset plastic part. Unlike thermoplastic injection processes which require very high temperatures and pressures to melt and force plastic into a steel tool, RIM Molding requires significantly less energy and minimal injection force. Instead, the liquids undergo an exothermic, or heat generating, chemical reaction and polymerize inside the mold. Due to the low viscosity of the component liquids (500-1500 centipoise) and low temperature of the system (90°-105°F), an average mold can fill in a few second or less, at molding pressures of only 50-150 psi, and the finished part can be de-molded in as little as 60-120 seconds.

RIM Molding usually employs polyurethane chemistry. By choosing different chemical formulations, the resulting polyurethane can be optimized for flexibility, strength, surface hardness, wear resistance, sound/vibration dampening, thermal insulation, and chemical, electrical, or fire resistance. The low pressure tools can be machined out of aluminum at low costs, shorter lead times, and with greater flexibility in design and tooling changes. Overall, the RIM process can offer designers and engineers unprecedented design freedom to unlock their creativity, while providing unsurpassed part to part tolerance stability at comparatively low cost.

RIM Molding Comparison with Other Molding Processes

The chart below shows a comparison of RIM Molding features against other popular process options based on design capabilities, appropriateness for particular applications, and cost factors:

	RIM Molding	Thermoplastic Injection Molding	Thermoforming	Structural Foam Molding	Fiberglass	Sheet Metal	Aluminum Casting	Urethane Casting
Ability to:								
Mold In Outside Features	✓	✓	✓	✓	✓		✓	✓
Mold In Inside Features	✓	✓		✓			✓	✓
Mold In Stiffening Ribs	✓	✓		✓			✓	✓
Create Variable Walls Thickness	✓						✓	
Encapsulate Metal	✓				✓			✓
Encapsulate PCBs & Electronics	✓							✓
Appropriateness for:								
Creating Large Parts	✓		✓	✓	✓	✓		
Complex Geometry	✓	✓		✓			✓	✓
Reducing Parts & Assembly	✓	✓		✓				✓
Low Production Volumes	✓		✓		✓	✓	✓	✓
Short Tooling Lead Times	✓		✓		✓	✓		✓
Creating Structural Parts	✓	✓		✓	✓	✓	✓	
Part to Part Repeatability	✓	✓		✓		✓		
Cost Comparisons:								
Low Unit cost	✓	✓	✓	✓				
Low Cost Molds	✓		✓		✓			✓
Low Cost Mold Changes	✓		✓		✓			

While it is evident that RIM Molding can offer many cost advantages and invaluable design freedom, it will still not be the best solution for every part or product. The ultimate process choice will vary based on a mix of factors including quantities needed, investment allowed, design features specified and lead time objectives.

The next section explores these comparisons in further detail, evaluating RIM Molding characteristics against the main competing technologies of Thermoplastic Injection Molding, Thermoforming, Structural Foam Molding, Fiberglass Molding, Sheet Metal Fabrication, Aluminum Casting and Urethane Casting to specify if and when RIM would be the most effective choice.

RIM Molding vs. Thermoplastic Injection Molding

RIM can be a great alternative to achieve the mainstream look of molded parts without the high tooling costs or volumes needed for typical thermoplastic parts. Both processes allow for many features to be incorporated into a mold, but only RIM gives the designer the flexibility to produce parts with significant wall thickness variations—typically from .125″ to 1.125″ in the same part. RIM can also produce high strength large parts at a lower cost because mold pressures and costs are significantly lower compared to thermoplastics.

Example of a Large RIM Molded Part

While both processes provide a solution for encapsulating metal, the low temperature, low pressure RIM process is also safe for electronics and other material encapsulation.

Injection molded parts have a higher quality finish than RIM urethane parts, although RIM parts take paint and silk screening well for improved cosmetics and branding.

RIM is valuable for producing low volumes at a low cost, but for volumes over 500 per month, thermoplastic injection molding often becomes the more cost-effective processing option.

Because RIM molds can be machined from aluminum instead of steel, the up-front tooling costs are typically less than one half that of a comparable thermoplastic mold. This is particularly beneficial when part volume is low. Since RIM tools can be made of softer materials, changes to tooling are also much more cost-effective than changes to thermoplastic steel tools.

OTHER DESIGN CONSIDERATIONS: The reaction cycles of RIM are measured in minutes, not seconds, allowing for the addition of holes, side action and undercuts without premiums. The thermoset nature of the polyurethane produced from RIM also eliminates sink marks that can occur in thermoplastic parts.

RIM Molding vs. Structural Foam Molding

Structural foam uses essentially the same process as regular Thermoplastic Injection Molding, so the design considerations of using the Reaction Injection Molding process versus structural foam are similar, but the costs are different with added foaming agent. Thermoplastic structural foam molds require higher process pressure and cost roughly double that of RIM molds, while the structural foam parts tend to be lower in cost. The decision here often relates to quantities.

OTHER DESIGN CONSIDERATIONS: While RIM is the more cost-effective option for low volumes, structural foam molding can be used for jobs with higher quantities where higher tooling costs are offset by lower part costs. Neither process is the best for production of high volumes.

RIM Molding vs. Thermoforming

Both of these processes are valuable for producing large-sized parts, but the design flexibility of RIM molding will make it a better choice for complex parts. Since thermoforming is a sheet forming process, it cannot produce variable wall thickness or internal details without time-consuming, manual gluing of additional pieces to the thermoformed part. Only RIM gives the designer the flexibility to produce parts with significant wall thickness variations of up to .125" to 1.125" in the same part. Any inside features in a thermoformed part must be bonded on secondary, whereas RIM can incorporate all features into the mold for reduced assembly and lower unit cost.

The temperature needed for RIM molding is low enough to prevent damage to encapsulated materials. Antennas, metals, electronics, circuits and other features can be insulated to increase mass, strength, burst protection and branding of parts. Encapsulation cannot be done with the thermoforming process. Produced thermoformed parts have the quality finish of the sheet material, but RIM parts take paint, silk screening and texturing well for improved cosmetics.
Both processes are appropriate for small run volumes and for producing molds for quick turnaround. RIM and thermoforming tools also both require a low up-front cost, but RIM tools are easier to change and will therefore be more cost-effective if market feedback shows that part features should be modified.

OTHER DESIGN CONSIDERATIONS: Thermoformed parts are only as strong as their outside shell, and can often "tin can" or blemish from inherent process variation. RIM parts typically hold tighter tolerances than thermoformed parts. Stiffening ribs can be molded into RIM parts to produce high strength products in any size.

RIM Molding vs. Fiberglass

While fiberglass can be used to produce very large, stiff parts, reinforced RIM parts can offer the same advantages with less labor for a lower unit cost. Traditional fiberglass molding is a slow, manual and labor intensive process, and issues of conformity and accuracy can often arise in these parts. The RIM process can produce more uniform parts with features molded into the interior. Fiberglass is the best option for prototyping very large parts, although it is possible to mold fibers into a RIM part to gain the strength and weight advantage of fiberglass. Both processes provide a solution for encapsulating metal, but only RIM urethane is appropriate to use when encapsulation of PCBs and other electronics is necessary.

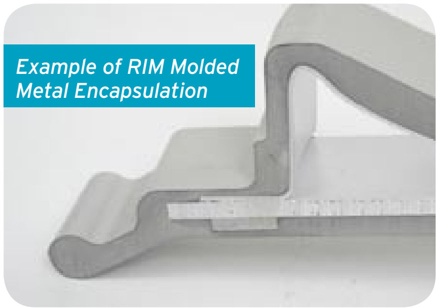
Fiberglass parts can have a high quality finish, but RIM parts are easier to paint for improved branding.

Fiberglass is mostly used to make small quantities of prototype parts. RIM is more cost-effective for actual production of low volumes (25-500 parts/mo.) compared to fiberglass. Neither process is the appropriate for higher production volumes. Both RIM and fiberglass tools require a low up-front cost, and both types of tools allow for cost-effective modification if market feedback shows that features need to be changed.

OTHER DESIGN CONSIDERATIONS: Fiberglass production emits large amounts of hazardous styrenes. RIM is a much more environmentally safe "green" option compared to fiberglass.

RIM Molding vs. Sheet Metal

Sheet metal is a very low cost option for part production, but with this process you sacrifice many design features and often add piece counts to final assembly. RIM allows for much more intricate and sophisticated form development compared to sheet metal. Any features on the inner or outer surface of a sheet metal part must be cut out, welded, or bolted on as a secondary process. With these features molded into a RIM mold, you can reduce assembly, add value to the overall design, and ultimately lower unit costs.



Example of RIM Molded Metal Encapsulation

Materials cannot be encapsulated in sheet metal. Only RIM can encapsulate metals, electronics, and other parts for optimum protection and strength. Both processes produce a high quality finish, but also take paint, silk screening and texturing well for improved branding.

Sheet metal is the most cost-effective option for small production volumes, but RIM could be taken into consideration if the part design is complex. While sheet metal tooling turnaround is very quick, RIM Molding can incorporate features from production molds that require less secondary costs than sheet metal.

Up-front tooling costs of sheet metal are lower than that of RIM tools, and modifications to the design can also be made at low costs. The trade-off is that many design features cannot be incorporated into sheet metal like they would with the RIM process, and non-rectilinear sheet metal parts become cost prohibitive in production.

OTHER DESIGN CONSIDERATIONS: Using RIM molding will yield a much more attractive, sculpted design that is lighter in weight and has better chemical resistance and insulation properties.

RIM Molding vs. Aluminum Casting

Many features in aluminum casting can be cast in, but any critical features must be machined as a secondary operation. RIM allows these features to be molded in for reduced handling and reduced cost. Both methods allow for variable wall thickness—down to 0.60" for aluminum casting, and from 0.12" to 1.12" in RIM. Another major difference is appearance quality. Clean-up for casting is done with a grinder while RIM Molding delivers an excellent finish.

Materials cannot be encapsulated with aluminum casting. Only RIM can encapsulate metals, electronics, and other parts for optimum protection and strength. Compared to RIM, the finish quality of aluminum casted parts is low; and RIM can take paint, silk screening and texturing better for improved branding.

Both processes are appropriate for small run volumes, but are not cost-effective when dealing with larger quantities (over 500/mo.). RIM tooling lead times are shorter than for aluminum casting. Both RIM and aluminum casting require a low up-front cost, although RIM is slightly more cost effective if tooling modification will be needed.

OTHER DESIGN CONSIDERATIONS: With RIM, you can create very large, light-weight, low-cost parts that would otherwise be limited in design with aluminum casting.

Example of Finishing on a RIM Molded part

RIM Molding vs. Urethane Casting (Rubber Molds)

Both of these processes offer a good deal of design freedom, including the ability to mold in features and encapsulate materials. They differ in the fact that only RIM allows for part design with significant wall thickness variations—typically from .125″ to 1.125″ in the same part.

Both RIM and urethane casting can be used to encapsulate a variety of materials, from metals to electronics. Each also produce a high quality finish, and take paint, silk screening and texturing well for improved branding.

Urethane casting in silicone rubber molds is often the more cost-effective choice for small production volumes, but rubber molds have a limited cycle life and long-term production can become cost prohibitive compared to RIM. Both processes are appropriate for producing molds for quick turnaround.

The initial tooling costs of urethane casting are lower than that of RIM. Tooling modification is also very cost-effective, but when aiming for production parts RIM becomes the better choice cost-wise.

OTHER DESIGN CONSIDERATIONS: Many companies utilize rubber molds for years prior to converting to more permanent tooling, which can end up being extremely expensive. Because RIM can bridge the gap between prototype and production with parts that are precision molded instead of fabricated or cast, it can actually be most cost effective to utilize RIM in lieu of rubber molding.

The Decision: When RIM Molding Yields Success

As you can see, RIM Molding is most beneficial within certain design, timing and volume parameters. This production method adds the most value when a part requires:

RIM Molded Instrument Housing

Complex Design Features / Large Molded Parts

RIM Molding should be considered for larger and more complex parts, because is often a great alternative for designers who want the mainstream look of molded parts but cannot justify the tooling costs and volumes of typical plastic processes. With RIM, you can develop a sculpted, structural design that minimizes hardware and includes value-adding features, all at a price point that is cost-effective for low to mid-range volumes.

Low Tooling Costs

Because RIM molds can be machined and fabricated from aluminum instead of steel, the up-front tooling costs are typically one half that of a comparable thermoplastic mold. This is particularly beneficial when part volume is low. Since RIM tools can be made of softer materials, tooling changes can be made quickly, easily and more cost-effectively.

Short Lead Times

The low cost tooling investment of RIM alleviates risk while expediting lead times. RIM's feature based machining can drastically reduce processing and assembly time to deliver production molds within 4 weeks. This bridges the gap between prototyping and production with tools that yield molded parts instead of fabricated ones.

Lower-Run Production Volumes

RIM Molding is an optimal choice for low to medium volume production. Because initial tooling investments are low, short runs remain economically viable and allow companies to minimize inventory while the product's market success is being evaluated. RIM molds are easier to machine so design changes can be made quickly as needed, and the process is often a more economical choice compared to rubber molding, thermoforming, fiberglass and other molding processes.

High-Quality Finish or Brand Enhancement

The surface finish of RIM molded parts can be painted to produce Class A parts. Silk screening and other surface treatments can also be applied to add to the appearance and branding of the product's design. Some of the comparative processes produce a better quality finish, while others do not take paint or screening as well. The tolerance and dimensional accuracies in RIM Molding are unsurpassed.

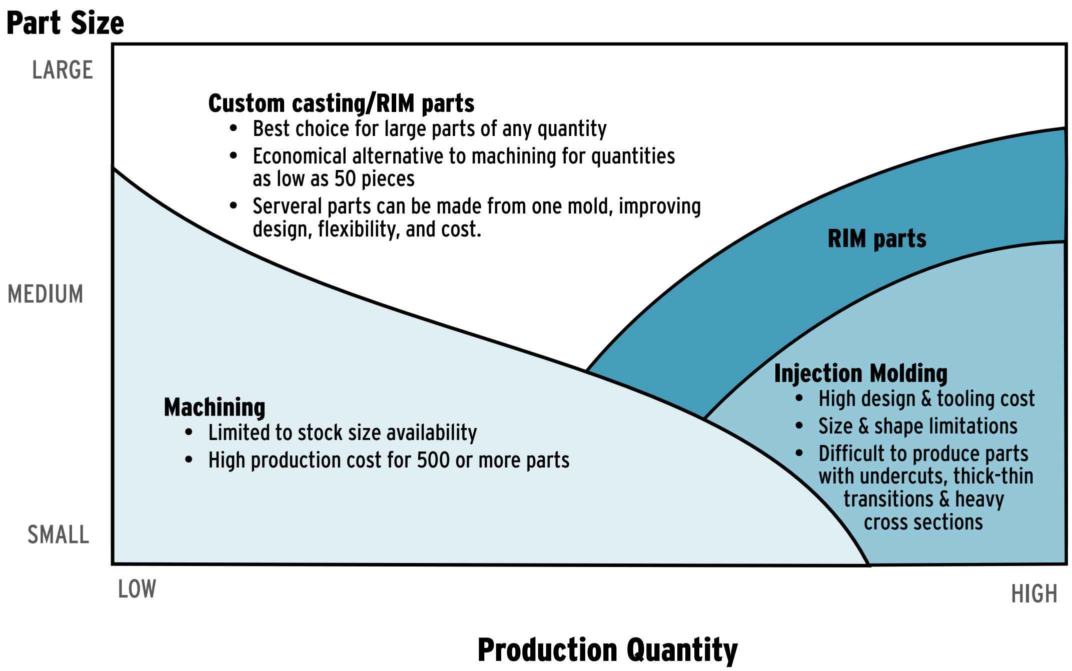
Encapsulation Capabilities

The low molding pressures and temperatures of RIM allow even the most sensitive electronic boards and components to be encapsulated without damage. RIM encapsulation can include structural members to increase strength, mass, burst protection and insulation while improving the appearance of almost any material. This is a unique benefit that often cannot be obtained with traditional molding processes.

Conclusion

There are many considerations to account for when deciding on a part production process. When a design requires complexity and creativity, the Reaction Injection Molding offers many compelling advantages over other traditional molding methods. While RIM Molding may not be the right choice for every part, its unparalleled freedom for unique design, paired with its encapsulation capabilities, quality finish appearance, low volume runs, shorter lead times and lower tooling costs can open many opportunities for successful part prototyping and production.

To learn more about RIM Molding and how it compares to other process options, or for assistance in evaluating your part needs to determine if RIM will provide the most benefits, please contact:



PAUL STECK, PRESIDENT
Exothermic Molding, Inc.
50 Lafayette Place
Kenilworth, NJ 07033
1-908-272-2299
sales@exothermic.com
www.exothermic.com