Reaction Injection Molding:

5 Reasons To Use RIM For Complex Parts

Paul K. Steck

Exothermic Molding, Inc.
50 Lafayette Place
Kenilworth, NJ 07033
1-908-272-2299
www.exothermic.com

Executive Summary

Reaction Injection Molding (RIM) is a unique method for creating plastic parts that is growing in popularity among industrial designers in the United States. The RIM process combines low viscosity polyurethane resins under low pressure and low temperature to produce plastic parts of almost any size. This White Paper presents five advantages Reaction Injection Molding has over competing technologies. They are:

- The Ability to Create Very Large Parts
- Encapsulation of Other Parts and Materials
- High Quality Surface Finish
- Variable Wall Thickness
- Lower Cost Tooling

These five advantages give industrial designers and engineers unprecedented design freedom. By eliminating the drawbacks inherent in competing processes, Reaction Injection Molding makes plastic part design easier, and unlocks the creativity of designers and engineers.

Introduction

Industrial designers have a wide array of material choices for their products. Some of the choices include formed metal, fiberglass, thermoplastic, thermoform, and structural foam. But each choice limits the designer's freedom in one way or another.

Reaction Injection Molding overcomes many of these limitations, while also possessing a set of advantages that makes it the superior alternative to other methods for many plastic parts. This White Paper presents the advantages of RIM, and addresses some of its limitations. It is an overview of the Reaction Injection Molding process from a designer's perspective.

What is Reaction Injection Molding?

Reaction Injection Molding (RIM) was developed in Europe by Bayer AG in the late 1960s as an alternative to thermoplastic injection molding. Instead of relying on melted plastic pellets being pressed into a steel mold under high temperature and high pressure, RIM consists of two low viscosity liquids (an isocyanate and a polyol) being mixed and injected into a lightweight aluminum or epoxy mold under low pressure and low temperature. In the mold, the liquids undergo an exothermic (heat generating) chemical reaction and polymerize into polyurethane. 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 one second or less, even at molding pressures of only 50-150 psi, and the finished part can be demolded in as little as 30 to 60 seconds. By choosing different formulations of resins, the resulting polyurethane can be optimized for flexibility, strength, dimensional stability, surface hardness, wear resistance, sound/vibration dampening, thermal insulation, and chemical, electrical, or fire resistance.

For many years, Reaction Injection Molding has experienced widespread use in Europe and in the American automotive industry (where it is widely used for both internal and external body parts). As more industrial designers in the United States have learned about the design freedom that RIM allows, its use has been spreading to other industries, including medical equipment and electronics enclosures.

The Five Unique Advantages of RIM

Due to the low viscosity of the components and the low temperature and low pressure inherent in the molding process, Reaction Injection Molding possesses some very compelling advantages over rival technologies such as metal, fiberglass, thermoplastic, thermoform, and structural foam. The following are 5 advantages Reaction Injection Molding has over competing technologies.

1) The Ability to Create Very Large Parts

Reaction Injection Molding is superior when creating large parts because of two unique characteristics: the low viscosity of the component chemicals and the innate strength of polyurethane, which allows a part to act as both a structural and an aesthetic component.

The low viscosity of RIM's component chemicals allows large molds to be filled quickly and completely. This quality makes it possible to mold a part as a single piece, where other technologies require multiple parts to be molded and assembled. This flowability also ensures that fine details can be included in the mold and that the material will accurately and consistently fill the details for each part. The low viscosity components also require lower mold pressures and generate less heat, allowing for lower cost molds to be used.

Deere & Company took advantage of this characteristic when designing the parts for a new combine. Faced with the need to produce a one-piece rear shield for the machine, they selected the Reaction Injection Molding process and designed the part out of rigid polyurethane. Measuring 6 feet by 6 feet, the finished part weighs only 56 pounds. CNH Global, makers of Case IH agricultural equipment also turned to RIM for the outer shell of their new AFX series combines. Each combine is comprised of nine large RIM molded parts, including a 101-inch by 76-inch behemoth.

The low viscosity of the chemical components is also crucial when molding very long parts, such as an energy-generating wind turbine blade being developed by the U.S. Department of Energy and private partners. When complete, each of the two halves of the blade will be a single part measuring 24 feet in length, tapering in width from 40 inches at the base to 9 inches at the tip. The combined assembly will weigh over 300 pounds.

The second unique property is the ability of a part to act as a structural member while still possessing enough aesthetic characteristics to serve as a finished surface. Because of the flowability of the polyurethane components, intricate ribbing can be designed and easily molded into the part, enabling it to act as its own support structure, even at large sizes.

Thieme Corporation relied on this ability to create highly finished yet structurally rigid parts for a computer tomograph system. By designing strategically placed and shaped ribs into the parts, they succeeded in creating an enclosure made of only 12 panels that is strong enough to be moved after assembly. The linchpin of the structure is the 87-inch by 67-inch rear panel which weighs 74 pounds and is one of the largest known single shot RIM parts ever molded. Thanks to RIM, the parts came out of the mold ready to use, with only a coat of polyurethane paint required to complete the design.

2) Encapsulation of Other Parts and Materials

Reaction Injection Molding is widely used to encapsulate other materials and parts, either to enhance the structural strength of the RIM part, or to protect the item being encapsulated. In addition to being a low pressure and low temperature process, utilizing low viscosity and easy flowing component materials, RIM polyurethane is a highly adhesive material, allowing complex parts to be encapsulated without fear of deformation, unwanted separation of parts, and without damage to delicate components.

While RIM parts can be designed with stiffening ribs and other structure-enhancing design features, it is not uncommon to embed metal, carbon fibers, or glass fibers in the part for added rigidity. Through the use of these composite parts, the benefits of RIM polyurethane can be extended into applications where polyurethane alone cannot provide sufficient strength.

Kendro Laboratory Products faced such a situation when designing a new high-speed centrifuge. They needed a lightweight yet very rigid part with a complex geometry and a high quality cosmetic finish. They found their solution in a RIM part with an encapsulated aluminum and steel internal shell. By encapsulating this metal sub-structure with polyurethane, they got the strength they needed in a part that required minimal finishing.

The other primary use of encapsulation is to protect a component for security or environmental reasons. Because of RIM's low pressures and low temperatures, delicate components such as circuit boards, sensors, wiring harnesses, and other electronic components can be safely encapsulated without damage.

Kendro also faced this situation when designing their centrifuge product. They needed a way to safeguard their proprietary electronics from competitors, as well as protect the delicate circuit board and wiring from the stresses in the centrifuge. By fully encapsulating the circuit board in a RIM part, with only the wiring harness exposed, they achieved both goals: the circuitry cannot be accessed without destroying it, and the circuitry is permanently protected from the harsh environment inside the centrifuge.

3) High Quality Surface Finish

The low viscosity of the RIM liquid components allows fine details to be accurately and consistently molded into the part. This property not only saves money in finishing, but also allows greater freedom for designers to create specific textures for their parts.

Where color is a consideration, RIM parts are excellent at taking paint or other coatings. One reason RIM parts are so widely used in the automotive industry is their ability to perfectly match painted metal parts while still maintaining flexibility and impact resistance.

An exciting alternative to traditional finishing for parts with a simple geometry is to finish it while it is still in the mold by using in-mold painting. Unlike molding processes where high temperatures and high pressure would interfere with any attempt to decorate a part while still in the mold, Reaction Injection Molding allows the designer to specify that the part be finished as it is created, drastically reducing the finishing needed after molding. In many cases, a designer can specify that a polyurethane paint be applied to the mold before the main shot of polyurethane is injected. This paint coats the mold and becomes the finished outer skin, and the main shot, once injected, bonds to it permanently. The result is a piece that is completely finished upon demolding.

Surface finish quality was not lost on a major bank when they were designing a kiosk for their branches. One important consideration, in addition to the need for lightweight materials to minimize shipping costs, highly accurate part reproduction to facilitate assembly, and fast turnaround time to meet their deadline, was the need for a durable surface that represented their brand's colors accurately. RIM's ability to take paint accurately and consistently on each of the 2300 identical copies of the kiosk enabled the bank to meet their goal at an affordable cost.

4) Variable Wall Thickness

An important property that Reaction Injection Molding has over competing technologies, such as thermoforming or metal, is the ability to create variable wall thicknesses in the part. Because the polyurethane components remain in a liquid state as they fill the mold, a 1/8-inch wall cavity can be filled just as easily as a 1 1/4-inch wall cavity.

This ability to accommodate varying wall thicknesses, as well as complex geometries and structural features, was a major factor in Becton-Dickinson choosing RIM to produce the door assembly for their Phoenix Automated Microbiology System. The design, with complex curves, raised surface details, reinforcing ribs, molded-in bosses, and wall thicknesses varying from .09 to .40 inches, was a challenge for other molding technologies, but served as a showcase for RIM's capabilities.

5) Lower Tooling Costs

As with any molding technology, the cost of the tooling is a key consideration. The molds for thermoplastic injection and structural foam molding are large and expensive due to the high temperatures and pressures required to create parts. In addition, the presses must be large, and often require quite a bit of energy to produce a part. In contrast, the low temperature and low pressure inherent in the Reaction Injection Molding technology allows the use of lower cost mold materials, such as aluminum and epoxy, smaller presses, and much less processing energy.

Because RIM molds are made with materials that are easier to machine, the tooling costs are lower, the turnaround time is shorter, and the molds themselves can be more compact. In fact, for production volumes of 200 or fewer parts per batch, RIM parts are usually lower in total unit cost than parts made with other molding processes.

In addition, because of lower mold pressures, molds can be smaller. As a result, it is often possible to create molds containing multiple cavities, allowing multiple parts to be made in one mold. Producing multiple parts in one mold reduces tooling and unit costs even further.

Conclusion

Reaction Injection Molding has compelling advantages. RIM's ability to create large parts, encapsulate other materials and assemblies, produce fine surface finishes, and mold walls of varying thicknesses gives designers and engineers unparalleled freedom to design cutting edge parts. This design freedom, together with lower tooling costs and shorter lead times, make Reaction Injection Molding the superior process for many plastic parts.

We have presented the top 5 advantages Reaction Injection Molding has over other processes. However, these are by no means the only advantages. RIM parts also excel at heat resistance and thermal insulation, dimensional stability, resistance to organic and inorganic acids and many solvents, and are highly resistant to weathering.

For more information regarding Reaction Injection Molding, please contact:

Paul Steck, President
Exothermic Molding, Inc.
50 Lafayette Place
Kenilworth, NJ 07033
1-908-272-2299
sales@exothermic.com
www.exothermic.com