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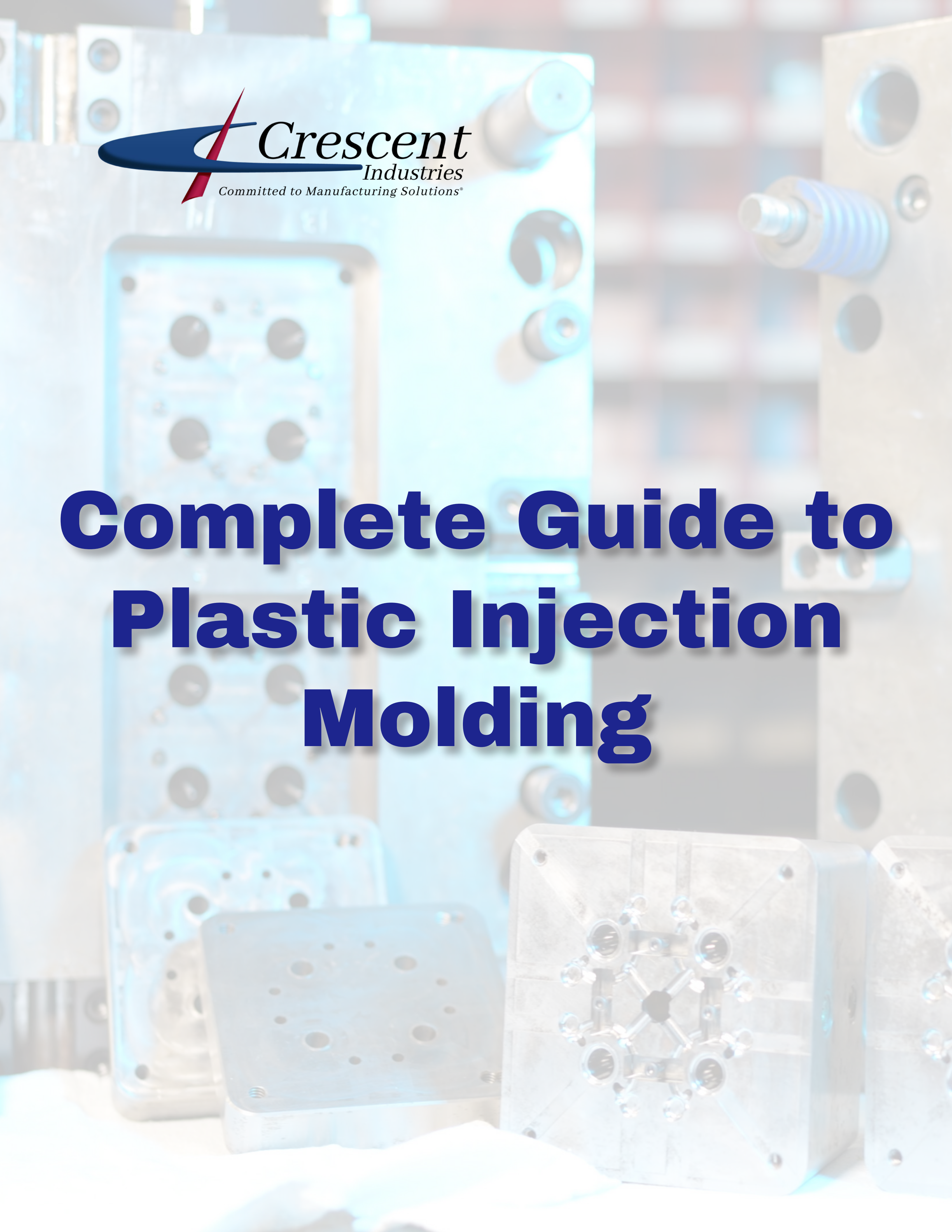
Complete Guide to Plastic Injection Molding



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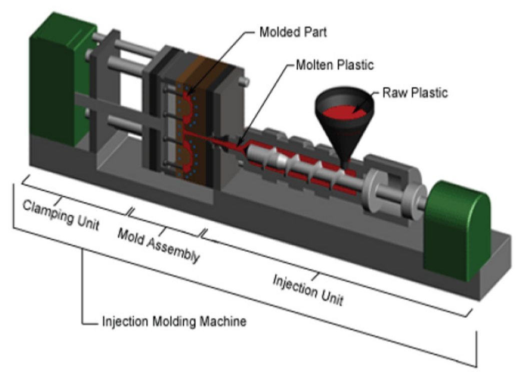
PLASTIC INJECTION MOLDING PROCESS

THE PLASTIC INJECTION MOLDING PROCESS

Plastic injection molding is the manufacturing process for fabricating plastics parts of varying sizes, complexity, and application. The process requires a vertical or horizontal injection molding press, a mold, and raw plastic resin. The plastic resin material is melted in the injection molding machine and then injected into the mold, where it cools and solidifies into the final part or parts. The process consists of four stages that include Clamping, Injection, Cooling, and Ejection.

1. Clamping Unit of Injection Molding Machine



Clamping consists of each half of the injection mold is attached to the injection molding machine via the clamping unit. The powered clamping unit pushes the mold halves close and exerts sufficient force to keep the mold securely closed while the liquid resin material gets injected into the mold cavities.

The time required to clamp the mold and hold it closed depends on the size of the molding press. Clamping is one factor you will need to determine the size of the injection molding press required to manufacture your component. Once you know the size press your part requires, you'll know one element your injection molder needs to produce your product.

2. Injection Phase of Resin Raw Material

Injection is when the raw material is fed into the injection molding press and advanced toward the mold by the injection unit. During the advancement, raw resin material becomes melted by heat and pressure. The injection unit takes the molten plastic using the build-up of pressure packs and hold the material in the cavities of the mold.

For accurate melt temperatures, a combination of settings needs to be applied, including the barrel temperature, nozzle temperature, and injection mold. The barrel and nozzle temperatures impact the flowability of the plastics throughout the mold. The mold temperature affects the flow through the mold as well as the cooling down of the molded part. The barrel and nozzle temperatures set should be considered carefully. If the temperatures are set too high, it produces an overflow and flash, and too low of a temperature can result in unfilled parts.

Plastic pressure is another element of injection molding. It refers to the physical force applied to the melted resin by the head of the screw when thescrew moves forward, a process controlled by the automated system of the injection molding press.

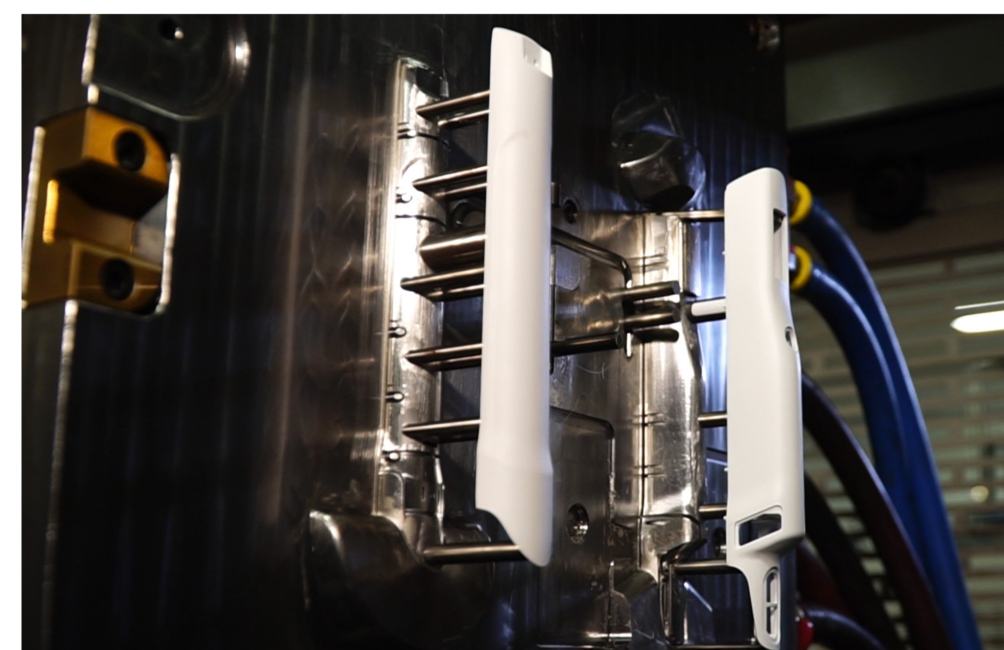
Temperature and pressure are two of the elements adjusted when establishing a stable injection molding process.

3. Cooling Time for Plastic Injection Molding

Cooling of the molten plastic inside the mold cavities will solidify into the shape of the part. Cooling begins inside the mold as soon as it makes contact with the interior mold surfaces. The mold will not open until the required cooling time has elapsed. The resin raw material manufacturer provides recommendations for establishing the injection mold temperature. The part and mold designs, as well as the resin raw material used, helps determine the cooling times. The injection mold design incorporates internal cooling.

4. Ejection of Plastic Part

Ejection occurs after the required time has passed to cool the part. When the clamping unit opens the injection mold, an ejection mechanism pushes the part/parts out of the mold. During the cooling process, the component shrinks and adheres to the mold cavities requiring force to eject the part. After the ejection and removal of the part or parts, the mold closes for the injection of the next shot, starting the next cycle.



VERTICAL VS HORIZONTAL PLASTIC INJECTION MOLDING

VERTICAL VS HORIZONTAL INJECTION MOLDING

Vertical vs. horizontal injection molding operates according to the same general principles of injection molding (injecting liquid plastic into a mold to take the form of the mold cavity as the material hardens), each one offers unique benefits and application suitability.

The primary difference in vertical vs. horizontal injection molding is the configuration and movement of the mold. In the vertical injection molding process, the mold clamping action occurs vertically, in an up and down motion. The clamping mechanism and injecting mechanism are located along the same vertical plane. In the horizontal injection molding process, the mold clamping action occurs horizontally, with each half of the mold moving sideways to join. We will now take a closer look at each type of process, as well as pros and cons.

The Vertical Plastic Injection Molding Process

In vertical injection molding, the two halves of the mold move vertically, up and down, to open and close. The injection mechanism is typically located at the top of the mold. Gravity plays a large role in filling the mold cavities, along with the injection pressure. This can help with filling time and consistency.

Vertical injection molding equipment is designed with open clamps and rotary tables. This allows for work with multiple molds and simultaneous operations — pre-molding, injection molding and post-molding. As a result, there is less of a need for manual operation and intervention, as well as higher efficiency, increased productivity and reduced costs.

One key difference in a vertical mold, as compared to a horizontal mold, is that pieces do not automatically fall out of the mold after being ejected (as is the case with horizontal molds). In vertical molds, pieces must be extracted by hand or robotic arm.

Use Cases

•Multiple concurrent operations: The design of vertical molds and their use of rotary tables means two bottom halves and one top half can be used in tandum so that pre- and post-molding operations can be occurring while parts are being filled. This is especially useful in operations such as insert molding or overmolding, where inserts or substrates must be loaded prior to resin injection.

•Insert and Overmolding: Vertical molds are ideally suited to insert molding and overmolding due to the configuration of the mold. Inserts are naturally held in place by gravity, rather than having to be built into the cavity or use other methods to remain in position.

Pros

•More consistent material flow and temperature distribution
•Advantageous for insert molding, especially when compared with older or more basic horizontal molding machines
•Can easily be manually operated and used with revolving tables to create inlays and combination parts
•Machine footprint is half the size of typical horizontal molding machines
•Pressure and clamping force required are lower due to the role of gravity in the process

Cons

•Manual part removal can be more time consuming
•Parts may be damaged during removal by robots or human operators
•Removal timing must be precise, which is more difficult in a manual process
•Manual removal step can make for inconsistent cycle times

The Horizontal Plastic Injection Molding Process

Horizontal injection molding has historically been the more commonly used type of injection molding — though that does not mean it is inherently superior. As we will continue to examine, each method has distinct applications, pros and cons.

In horizontal injection molding, the mold opens and closes along a horizontal axis. Due to this configuration, consistent, correct injection pressure is required to fill the mold cavities and help ensure proper packing and cooling. Horizontal molds are typically built with more cavities than their vertical counterparts, and are thus able to produce more parts per cycle. In addition — thanks to the horizontal separation of the mold halves — parts from these molds naturally fall out of the cavity upon ejection, and do not need to be manually extracted.

Use Cases

•Ideal for cylindrical parts
•Typically used for higher-volume production runs
•Advantageous for standard molding that does not require inserts or overmolds

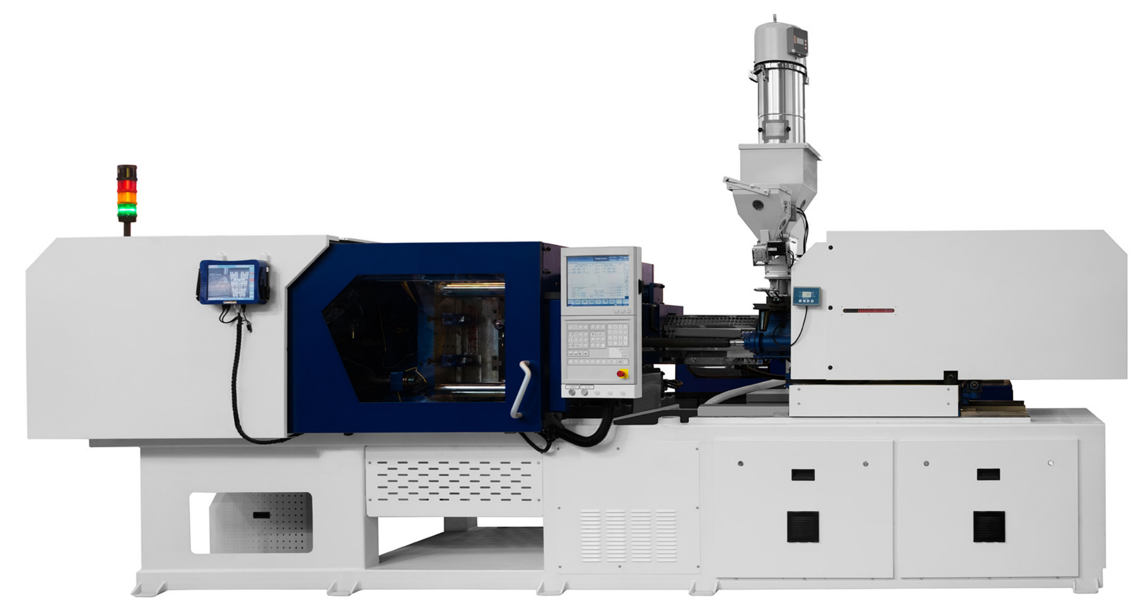
Pros

•Efficiency in parts produced per cycle
•As a more common type of machine, more options are available, such as hydraulic or electric options
•Consistent cycle times and continuous operation

Cons

•Insert molding is much more difficult and inefficient
•Machines take a larger footprint than vertical molding machines

As you can see, each process has unique strengths and scenarios for which it is ideal. For example, for insert molding, vertical injection molding will almost always be the right choice.



5 ELEMENTS OF INSERT INJECTION MOLDING FOR YOUR PLASTIC PART OR DEVICE

5 ELEMENTS OF INSERT INJECTION MOLDING

Insert injection molding uses advanced injection molding technology to combine diverse thermoplastic and metal components into a single finished part. A wide range of applications manufactured today use the insert molding process.

This article focuses on five main elements of the insert molding process to make your custom component or device.

1. The insert injection molding process combines materials and components into a single unit.

The insert molding process follows the same principles as injection molding except for the addition of an insert placed in the custom-built mold, either by hand or robotics. First, resin raw material pellets become melted and then injected into the mold cavities. The molten material fills in the features around the insert, creating an incorporated assembled component. The injection press opens, and the part ejects from the mold. Now, you have one part anchored securely to the insert, and a great deal stronger than if assembled after the molding process.

To aid injection molders in the process of insert molding, they will use vertical/vertical injection molding presses. Vertical/vertical presses use gravity to hold the insert in place during mold closing. These tend to be more efficient, having multiple tool bottoms used with one top half tool. While one bottom half is molding with the top half, the other bottom half is available to be loaded with the insert. Ultimately, reducing production time.

The raw materials used for insert molding are the same as injection molding. For extreme high heat applications, select an engineered thermoplastic because they can withstand very high temperatures, and the components can withstand very harsh environments.

2. Benefit of Insert Injection Molding includes improved plastic part reliability and strength with enhanced design flexibility.

Manufacturing components or devices using the insert molding process results in a tight, secure seal with the plastic part, which helps to strengthen the parts' reliability and resistance to vibration and shock. This reliability makes these parts an ideal solution for surgical instruments, knobs, devices, electrical components,housings, and more for a wide variety of industries.

The use of metallic materials increases the tensile strength of a part and its conductivity while reducing the weight of the component. This combination of plastic with metal or other insert materials increases the product design options to design engineers for low to high volume production runs.

3. Part design for insert molding should include solutions to shield the insert during the molding process.

Despite the frequent use of the insert molding process, you still need an injection molder experienced with this process. Implementing a few basic guidelines for your part design will achieve success.

•Provide means of holding the insert during the molding process.

- •Using bosses or undercut features add retention strength for the molded part and around the insert.
- •Help shield the insert during the injection molding process. (Your injection molding partner can help finalize the design, for manufacturability, this is why it is best to use an experienced insert molder.)
- Working with an experienced insert molder, you will receive feedback on what inserts and components work together to achieve the desired product outcome.

4. Types of Inserts Used for Insert Molding

The variety of inserts used during the insert molding process widens to a huge diversified list that follows.

• **Magnets**	• **Spring Contacts**	• **Rivets**
• **Screws**	• **Clips**	• **Threaded Fasteners**
• **Studs**	• **Pins**	• **Bushings**
• **Contacts**	• **Surface Mounts**	• **Tubes, and more!**

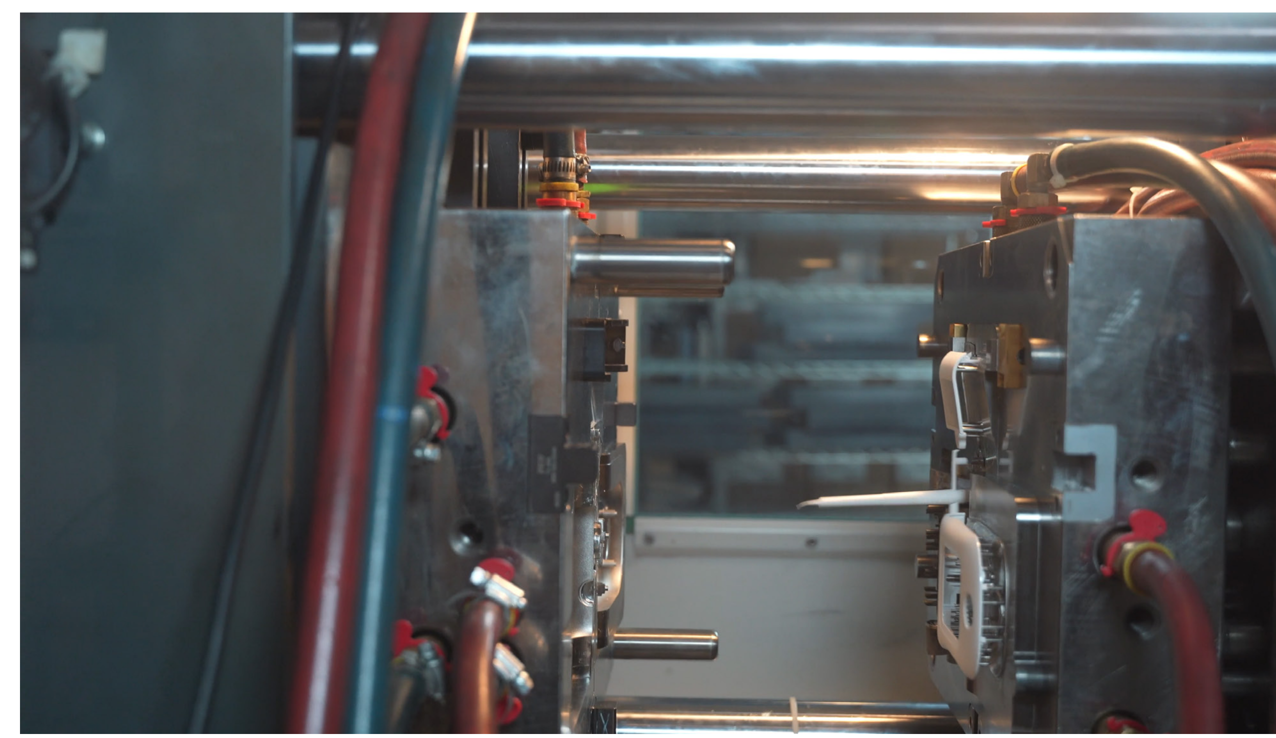
The inserts manufactured from an array of materials, for example, stainless steel, brass, aluminum, bronze, copper, Monel, and nickel/nickel alloy.

For convenience, some injection molders will also manufacture the inserts to offer vendor integration and a single-source solution. Therefore, receiving engineering guidance, design support, proper mold design, and smooth production runs for your product. Please note, make sure you choose an injectionmolder with the same quality certifications your project requires.

5. Costs of Insert Injection Molding

The upfront costs for an insert molded part include the insert and the injection mold. The cost savings begin with the elimination of post-molding manufacturing steps, and labor to assemble the parts after molding. Also, achieving increased production throughputs of products.

The insert molding process used for manufacturing plastic injection molded parts for a wide variety of applications in the medical, pharmaceutical, dental, defense, safety, electronics/electrical, and industrial markets.



OVERMOLDING FOR PLASTIC INJECTION MOLDED COMPONENTS

OVERMOLDING FOR PLASTIC COMPONENTS AND DEVICES

The process of overmolding includes molding one material on top or around another. A base layer is injection molded first, and then an additional plastic layer is molded over and around the base layer - resulting in a single, finished product. Typically, overmolding combines two types of plastic materials to produce a single component or device. The injection molding of two different plastics creates a unified structure that is strong and rigid on the inside and flexible, colorful, and easy-to-hold on the outside. Leaving no gaps or spaces within a product and thus eliminates contamination.

Often the exterior layer is an elastomer giving the desired texture or physical property. For instance, pliability, enhancing the product's aesthetic and functional features. An example would be soft-touch handles in medical instruments to improve grip and minimize slipperiness

Benefits of Overmolding Plastic Components

Durable Designs – Parts and devices can help to reduce vibration and other sources of wear and tear that can eventually break the materials apart. Parts that have been molded together withstand the stress of use and are a more durable product with an extended life. Make products resistant to water, dust, and vapor.

Vibration Resistance – Products, when exposed to noise and vibration, can loosen the product's shape and severely affect the accuracy and reliability of the product. Overmolding creates high-strength and high-touch parts by isolating materials that are vulnerable to vibrations.

Safety Mechanisms – The plastic injection molding technique allows manufacturers to mold different durometer materials onto sharp corners or edges to ensure safety for the user. And makes applications more resistant to shock.

Aesthetic Value – The craft of overmolding enables manufacturers to create unique designs by using materials of any texture or color that match the product specification and function. An unlimited choice of colors provides the ability to color-code products and explore bright colors for greater usability and ease-of-use.

Ergonomic Benefits – Overmolding offers practical benefits besides adding beauty and style to a product. It allows manufacturers to add handles of any shape or thickness to products without natural grips offering sleek materials or coarse surfaces for more comfortable and easier to grab.

Overmolding Design Considerations

The challenge of the overmolding process is to make sure the two pieces -rigid substrate and outer elastomer – fit together without any gaps, slack, or slippage. So, it's a matter of making molds that create a perfect fit, which in turn heavily strong injection molding engineering team that has intimate knowledge of the overmolding process and simulation software to anticipate possible issues before fabrication of the mold or production begins.

Overmolding Applications

- Medical devices and instruments
- Parts with grip handles
- Knobs for controls and assemblies
- Encapsulated electronic devices and electronic components
- Communication and navigation devices

The overmolding process used wide variety of applications for the medical, dental, pharmaceutical, military/defense, safety, electronics/electrical, and OEM/industrial markets.

WHAT IS CLEANROOM INJECTION MOLDING?

CLEANROOM INJECTION MOLDING

When a plastic part is to be manufactured, e.g., an implantable medical device, it must be kept as clean as possible. Such a part must be manufactured in a sterile environment. That kind of environment may be referred to as a “cleanroom." A cleanroom is a space where the number of airborne contaminants per unit volume, such as dust and other airborne microbes, are controlled to decrease the chances of contamination. These particles are controlled by a High-Efficiency Particle Air (HEPA), which filters the air before entering the cleanroom, and is changed several times per hour, according to the cleanroom class, as established by the International Standard Organization (ISO) 14644-1.

Cleanrooms with the intention of keeping a product free of contaminants are kept at a positive pressure so that particles escape from the cleanest to the least clean area. However, there are cleanrooms that are kept under negative pressure to keep nothing out of the cleanroom, such as quarantine stations and chemical analysis facilities.

Plastic parts are manufactured in a dedicated room that is optimized to reduce the risk of contamination from dust or other particles. This process is known as cleanroom molding. In the medical, pharmaceutical, and biotechnology industries, parts often have to be manufactured in a sterile environment.

Before delving into cleanroom molding, it is important that you understand the difference that exists between an ISO 7 and an ISO 8 cleanroom.

ISO 7 and ISO 8 Cleanrooms for Plastic Injection Molding

ISO stands for International Standard Organization - this is made up of various organizations from different countries that work together to develop and publish standards. In this way, internationally valid standards are created that entrepreneurs must adhere to across borders.

The classifications of cleanrooms above are according to ISO 14644-1. The classification according to US FED STD 209E (cleanroom classes 1 - 100,000) is no longer valid since November 29, 2001; the cleanroom classes ISO 1 - ISO 9 has been in effect since then.

The standard ISO 14644-1 defines the degree of purity of the air. This is set by determining limit values. The ISO classification is based on the particle concentration per m³. The highest purity is in ISO class 1, while the lowest is classified in ISO class 9. This standard for cleanroom classes is mainly used in cleanroom systems that are used for production in the semiconductor industry.

ISO classificaiton number (N)	The maximum value of the permissible concentrations (particles / m³) equal to or greater than the sizes considered, which are shown below		
	>=0.5µm	>=1.0µm	>=5.0µm
ISO 7	352,200	83,200	2,930
ISO8	3,520,000	832,000	29,300

Most plastic cleanroom injection molding takes place in a Class 7 or Class 8 cleanroom. If the plastic part has a very low resistance to impurities, such as used lenses in thermal imaging telescopes, it may require a more sterile environment.

ISO 7 cleanroom is a closed injection molding area, separate from the rest of the business district with hard walls. ISO 7 is mostly used for surgical interventions without implantation of foreign materials such as low invasive surgery, vascular, obstetrics, ophthalmology.

The standards for ISO 8 cleanrooms are less stringent than those for ISO 7 cleanrooms. In the ISO cleanroom, the store’s molds are surrounded by movable curtains. ISO 8 is majorly used for short-term surgery such as visceral surgery, day surgery, and urology.

Environmental Control for Injection Molding in Cleanroom

The required environment for ISO 7 and ISO 8 cleanrooms are environments with a lower degree of risk, such as general surgery, gynecology, patient preparation/awakening corridors, intensive care and resuscitation, etc. To ensure environmental control, several checks on the verification of instrument calibrations adjustment of the treatment system, airflow, air unidirectional check (where filtering plenum is present), noise and the smoke test should be carried out.

Points to consider in the required environment include:

- Adequate airflow: To ensure that the air is pure and a tight number of particles are maintained, class 7 and 8 cleanrooms use positive airflow to ensure certain particles.
- Use of Electric machines: Electric machines should be used instead of hydraulic engines in most cleanroom environments. This would prevent more airborne particles.
- Coverage Requirements: In an ISO 7 cleaning room, engineers and operators must be fully covered when entering a cleanroom. Such coverings include shoe covers, full-body clothing and economical covers. In classroom 8, the coverage requirements may be more stringent.

- Packaging Limits: Cardboard or coated plastic packages are common in a cleanroom environment. Packing, such as some corrugated board material capable of producing excess particles, is not allowed in cleanrooms.

Post-Molding Operations in a Cleanroom

In Cleanroom injection molding, the types of medical devices must be put into consideration. These medical devices are categorized into different classes. In addition, classification is risk-based, that is, the risk the device poses to the patient and/or the user is a major factor in the class it is assigned. Class I includes devices with the lowest risk, and Class III includes those with the greatest risk.

As indicated above, all classes of devices are subject to General Controls. General Controls are the baseline requirements of the Food and Drug Agency (FDA) Act that apply to all medical devices: Class I, II, and III.

The US FDA regulates all medical devices marketed in the US, which are grouped into three broad classes. Any medical device approved by the FDA is classified as Class I, II, or III depending on the device's risk, invasiveness, and impact on the patient's overall health.

Class I devices have minimal contact with patients and low impact on a patient's overall health. Examples of such devices includes electric toothbrush, tongue depressor, oxygen mask, reusable surgical scalpel, bandages, hospital beds, etc. Since this class of devices has the most minimal level of risk, they may not require a cleanroom injection molding.

Class II medical devices are more complicated than Class I devices and present a higher category of risk because they are more likely to come into sustained contact with a patient. Such devices include catheters, blood pressure cuffs, pregnancy test kits and syringes. These devices pose a greater risk, though they have medium complexity. For this reason, such devices can be sure to be safe and effective when more stringent regulatory controls are carried out. Most of these devices can be assembled or modeled in an ISO 8 cleanroom. Those whose manufacturing processes do not require a cleanroom include pregnancy testing kits and condoms.

The FDA defines Class III devices as products which “usually sustain or support life, are implanted or present a potential unreasonable risk of illness or injury." Such devices include breast implants, pacemakers, defibrillators, etc. Due to the nature of these devices, they carry the highest risk and are very complex. As a result of their complexity, all devices under this class have the most stringent regulatory controls and are normally assembled and molded in cleanrooms. The reason for this is to reduce the contamination rate from airborne particulate.

Injection Molding in Cleanroom Applications

Cleanroom molding application can be done on a variety of medical devices. A good ISO 7 cleanroom can be used for packaging services and contract assembly. Custom fixtures are built, and automation is used to ensure that the assembly process for simple or complex operations is effective. Packaging services provided by the ISO 7 cleanroom cover various medical, pharmaceutical, and dental products.

An effective ISO 8 cleanroom is capable of housing different injection molding machines, which includes the vertical press. Such devices can be used to manufacture the following:

- **Medical device housings**
- **Surgical instruments**
- **Implantables**
- **Emergency room products**
- **Fluid delivery devices**
- **Fluid delivery containers**
- **Cardiac products**
- **Blood delivery housings**

Other products that can be manufactured include pediatric devices, medical imaging, dental products, and science and research devices.

Quality Control for Plastic Injection Molding

One of the procedures that qualify a cleanroom for the manufacturing of medical devices is obtaining the required certifications. Such certifications include the GMP, FDA, and ISO 13845:2016.

Good Manufacturing Practice (GMP) is a system that is responsible for ensuring that consistent manufacturing and control of products are in line with quality standards. This system is put in place to reduce any production-related risk and covers every aspect of the production process. Written procedures that are well detailed are required for each process, to ensure that the quality of the finished product is up to standard. Such measures will ensure that quality control is carried out during the cleanroom injection molding processes.

It is important that the cleanroom is in a controlled environment to ensure that plastics used in making these medical devices are not contaminated by dust and other particles. According to the Medical Device and Diagnostics Industry magazine, the Food and Drug Administration (FDA) requirements states that, in a case whereby product quality is affected by environmental conditions, “the manufacturer shall establish and maintain procedures to adequately control these environmental conditions." To establish this control, cleanroom manufacturing is needed.

Just like the GMP, ISO 13485 is another system that is designed for an organization that deals with the production, servicing, and installation of medical devices. Some internal and external certification bodies also use this standard in their auditing processes. Every five years, all ISO standards undergo revision in order to keep up with the market place trend. The ISO 13485:2016 is the latest design that responds to the current quality control practices. Such practices include technological changes and regulatory expectations. This new version greatly emphasizes on changes that relate to the regulatory requirements, risk management and risk-based decision making.

Procedure Documentation

The regulation and maintenance of cleanroom certification, protocol, and accreditation for the injection molding of medical devices is highly comprehensive. Cleanroom injection molders must strictly adhere to a number of variables to ensure that they comply with the standards. Such variables include quality control systems that check, control, and eliminate dust and particles that do not align with the specification for ISO 7 and ISO 8 cleanroom standards.

For this reason, procedure documentation must be put in place. Procedure documentation should be carried out to ensure that verification of controlled conditions are always available in events of customer request, routine check, procedural deviation, or repeated cycles. Such procedure documentation should physically monitor the mold pull cycles, process lifecycle and product/equipment testing.

Risk Management for Plastic Injection Molding in Cleanrooms

Risk Management is carried out through the implementation of specific analysis modules like fault tree analysis (FTA), hazard analysis and critical control point (HACCP), and failure mode and effect analysis (FEMA). When microbial risks are known and evaluated, injection molders will be able to develop a continuous assessment to control contamination in the manufacturing process. In this way, injection molders will also be able to identify acceptable limits in the manufacturing process.

Some FDA-regulated implantable medical products can lead to adverse and serious health effects when not monitored. For this reason, lot traceability is required in risk management. With a lot number, processes involved in the manufacturing process can be traced to ensure that risks are managed. Lot traceability monitors the ingredients, constituent parts, equipment, and labor, involved in the product manufacturing process. Consumers can also contact the manufacturer and research on the production of the goods through an identifier given by the use of lot traceability.

PLASTIC INJECTION MOLDING PROCESS MONITORING FOR QUALITY COMPONENTS

PLASTIC INJECTION MOLDING PROCESS MONITORING

For engineers, injection molding process monitoring plays a significant role in the quality and efficiency of the molding processes. An injection molding partner that engages in injection molding process monitoring is focused on maximizing productivity while maintaining quality, and delivering the best results for your investment. We will look at what injection molding process monitoring is, how injection molders implement and manage it, and how you — as an engineer — gain benefits from it.

Overview of Process Monitoring

In a big-picture sense, injection molding process monitoring is a way of overseeing the results of key molding process parameters, including:

- Injection pressure
- Melt temperature
- Mold temperature
- Air temperature
- Filling time
- Packing/holding time
- Cooling time

What Is Real-Time Injection Molding Process Monitoring?

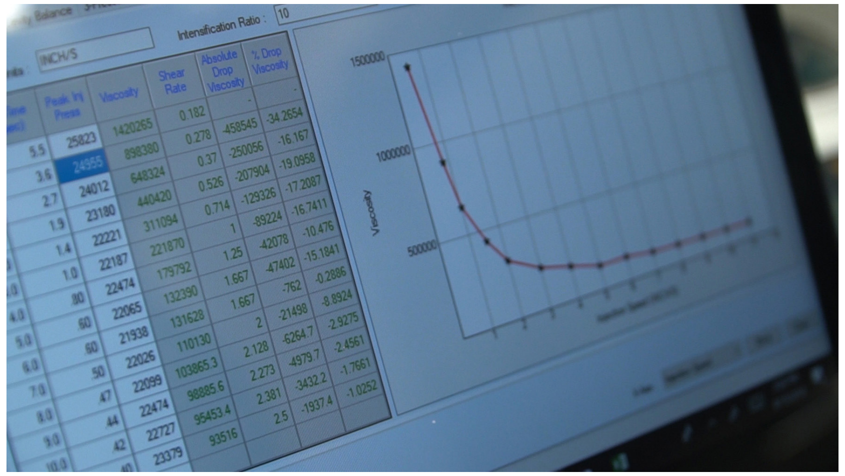
With a high-level understanding of injection molding process control, we can now take a closer look at how this practice is implemented and how it works:

- Hardware: The first step in implementing injection molding process control is adding the right hardware to equipment. This is typically in the form of sensors that measure and communicate factors such as temperature (for the mold, material and air), injection pressure and timing for each step in the molding process.

- Software: Once readings and data are collected via process monitoring, they are used in several ways — all facilitated by software. Software enables real-time analysis of data readings, comparison against historical data and optimal parameters.

- Real-time communication and monitoring: Today's monitoring equipment is effective primarily because of the real-time action that it enables. Wired or wireless communication enables near-instantaneous transmission and analysis of real-time data. This allows the injection molder to evaluate efficiency of the injection molding process parameters and make real-time production decisions to increase quality and reduce rejects.

- People: Without the right people on hand, none of the above investments will be as effective as they can be. Trained and experienced personnel make sense of data analytics, monitor processes, and ultimately direct any necessary action based on these readouts. These actions are at the core of the benefits of process monitoring, which we will expound upon next.



Benefits of Injection Molding Process Monitoring

Process monitoring can yield the following benefits:

Identify process inefficiencies:
As briefly mentioned above, molding process monitoring enables data collection, analysis, comparison and, ultimately, action. In this process, deviations from programmed-in optimal parameter ranges, as well as from historical data, can quickly be identified and analyzed to determine whether adjustments are necessary.

Fluctuations in parameter readings can mean that aberrations are present in the process — whether in process times and temperatures, or in equipment calibration. When operating outside of optimal parameter ranges, injection molding will usually not be as efficient as it can be. This could lead to part rejects, along with longer production times and increased costs over the long run. Process monitoring can quickly identify and rectify these inefficiencies.

Monitor mold performance:
A mold typically has a rated service life, as well as a recommended maintenance interval. With process monitoring, your molding partner gain more insight into the actual performance and health of the tool, allowing them to make informed decisions about maintenance and mold repair. For example, monitoring data may show that the mold is still operating within acceptable ranges at a scheduled maintenance interval.

Conversely, data can identify potential issues that occur between scheduled maintenance — potentially preventing damage to the mold and equipment. In addition, monitoring data can give you a much more accurate picture of when it's time to replace a mold.

Proactive quality assurance:
Quality assurance is typically a reactive, hands-on process: inspecting finished pieces and rejecting those that are not to spec. Injection molding monitoring allows for a more proactive quality assurance process, identifying potential defects right when they occur, and allowing monitoring personnel to earmark rejected parts in advance.

In addition, monitoring can improve quality assurance and reduce defects through the real-time monitoring, analysis and adjustment benefits described above. By identifying potential quality root causes from the onset, technicians can make adjustments to help ensure that equipment continues operating and producing parts to spec — resulting in faster overall production speed and time-to-market.

PLASTIC INJECTION MOLDING POST-PROCESSING

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Parts Decoration

If you need your injection molded parts decorated for aesthetics, identification, directions or more, there are several different methods to achieve results.

Pad Printing

The pad printing process consists of transferring a 2D image onto a 3D plastic part. The printing process requires the use of an etched plate (also known as a cliche) and pad to transfer the image. The silicone pad transfers the image from the etched plate to the product. Because of this, printing can be done on various shaped surfaces making it a desirable process for plastic components.

Laser Techniques

1. Laser Marking uses a laser beam to discolor the surface of the material to black or gray, producing the desired text or graphic. The part remains smooth

2. Laser Engraving requires the part's material to be removed by the laser, creating the design.

3. Laser Etching melts the material of the part creating a raised mark on the product's surface making the text or graphic.

Inkjet Printing

Industrial inkjet printing uses a flatbed UV-Led, high-resolution printer to print images up to 1200 dpi on plastic components. The process can simultaneously print five different colors like a regular paper inkjet printer as well as several parts at one time.

Part Assembly Methods

There are four different post-molding part assembly methods used for plastic injection molding. We examine these four different joining methods so you can make the best choose for your project.

Mechanical Fastening

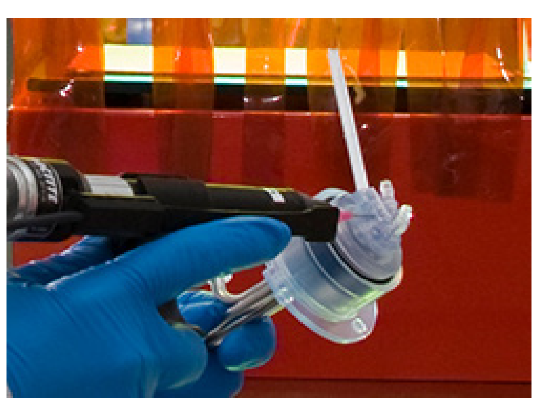
Mechanical fastening is used when a product needs disassembled for servicing or replacement of inner parts. Metal inserts are typically recommended for more stability for the part, and requires the plastic resin to be able to withstand the strain of the fastener and the repeatable stress around the fastener. Mechanical fastener types include screws, rivets, pins, or nuts. Threaded fasteners work best on parts with thicker sections and push on lock nuts or clips are more suited for thinner sections of a part.

Solvent and Adhesive Bonding

Solvent bonding the plastics are softened by coating them with a solvent, then clamping or pressing them together to form one part. Adhesive bonding consists of two parts joined by a chemical that is applied to the surface of both parts.

These bonding methods require either a solvent or adhesive consumable, but the initial upfront investment is low. Also, requires on-going maintenance of the applicators and associated equipment, but provides flexibility in the process and works well for a wide range of materials and applications.

UV Bonding



UV Bonding is the method of using ultraviolet curing with high-intensity ultraviolet light to cure or dry adhesives. This method works well when bonding plastic to non-plastic materials such as glass or metal, but limited to clear materials.

Ultrasonic Welding

The process where sonic pulses are transmitted to the plastic part by a resonant vibrating tool called a horn, which causes two plastic materials to vibrate against each other. The vibration heats and fuses the two parts together. Different resin families can be joined using this method as long as their melting temperatures are within 30°F and their composition is compatible. The technique is fast and offers lower cycle times. Assembly rates of more than 25 parts per minute are possible with a single station.

Kitting and Packaging Services

Kitting

Kitting is the process of putting together a range of products in one ready to use kit. If your injection molder performs this at the point of manufacturing, you will save time and money. It reduces the need for extra material handling because you will have completed assembled kits ready to be shipped to your customer. The kitting process becomes streamlined and faster because so many kits are being put together at one time.

Some examples include medical device trays and surgical procedure kits. Think how kitting services performed by your injection molder will save you time for your project.

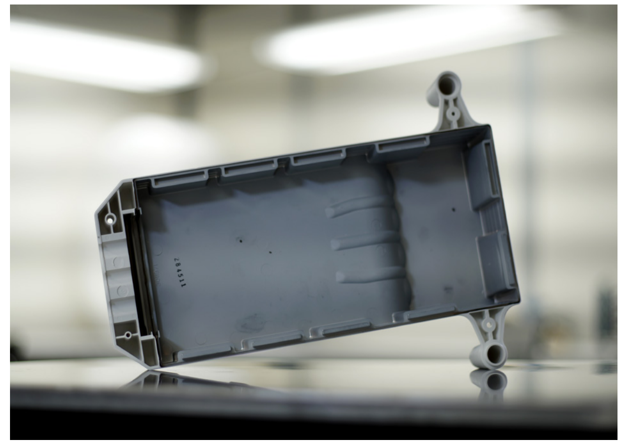
Packaging

Packaging includes putting parts or assembled devices in a box for shipping to your facility. Packaging also consists of the part/device packaged in a ready to use or ready for sterilization packaging. Tyvek industrial packaging protects parts from environmental factors like elevated humidity, condensation, fiber contamination, as well as provides a particle barrier. The Heat sealing process ensures a durable seam for the package. It also allows for printing using standard commercial printing equipment. Packaging comes in custom sizes, seals and is available in coated or uncoated versions depending on your application.

Shielding & Plating

Shielding

Shielding becomes necessary because plastics allow for EMI, RFI, and ESD interface, which is catastrophic for electronics, so a thin layer of aluminum provides EMI, RFI, and ESD absorption.



Plating

Plating is the process of applying a metal coating on a plastic part to enhance corrosion and wear protection, add electric conductivity, or improve part appearance.

Leak Testing

Leak-testing consists of different methods of measuring the integrity and leak-proofness of a plastic part. Pressurized fluid, pressurized air/gas, and vacuum testing are the various methods used. Pressurized fluid simulates "real-word" conditions for plastic parts designed to have fluid pass through. The pressure air/gas method will be faster than fluid testing. Vacuum leak testing works well when you have a part that will have an internal vacuum applied. Vacuum testing can create leak paths that are not shown by pressure testing.

Annealing

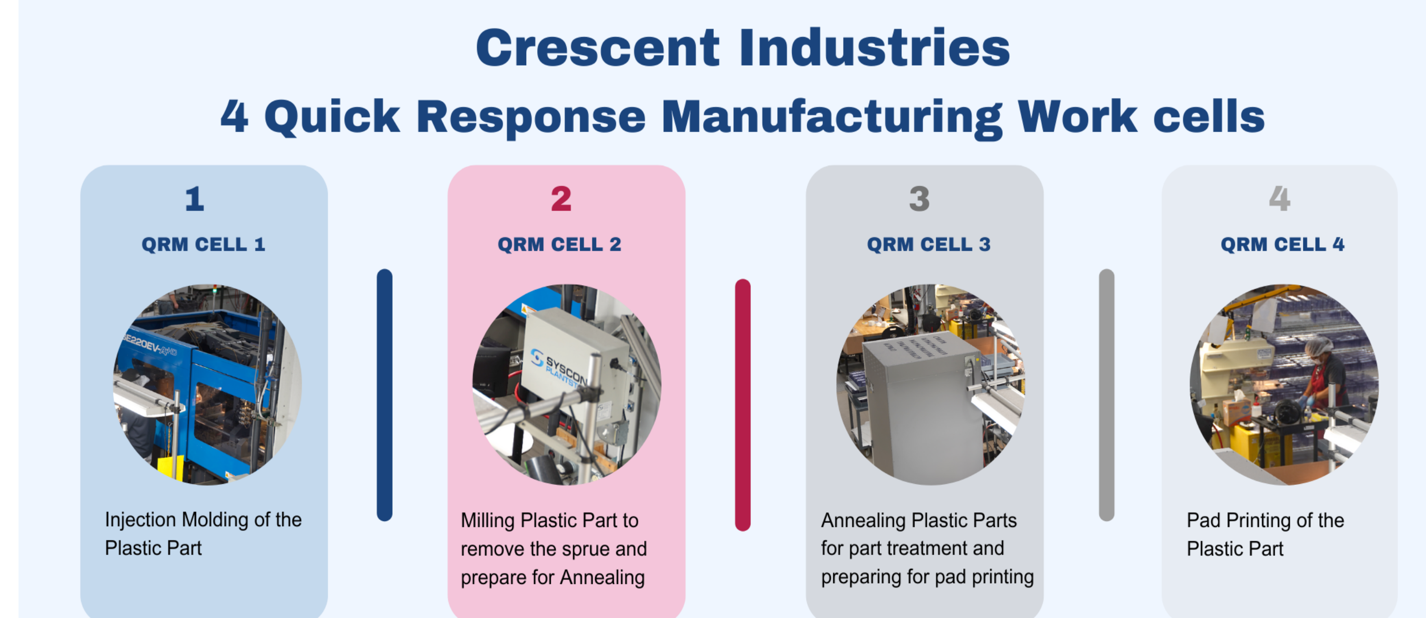
Annealing incorporates heating the plastic part to half of the melt temperature in a forced air circulating oven and then letting the part cool back down, causing the material to relax, reducing the molded stress. Annealing helps part stability over time and increases the mechanical and thermal properties.

If a part requires painting, annealing typically will be done because the tiniest of cracks will be very visible against the paint.

Crescent Industries QRM Workcell for Post-Molding Operations

This Quick Response Manufacturing (QRM) Workcell consisting of injection molding presses to manufacture the molded components, and all equipment necessary to perform the post-molding operations (kitting, assembly, pad printing, industrial inkjet printing, laser marking, milling, etc.) As well as the packaging and labeling for shipment to you.

The benefits include the elimination of non-value operations by locating people, equipment, and resources in a single path cell for increased throughput and reduction of lead times.



PLASTIC INJECTION MOLDING PRESS TONNAGE CALCULATOR

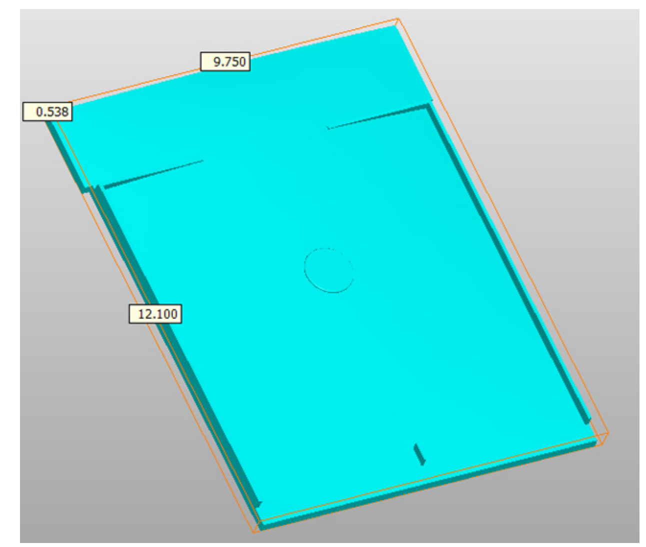
PLASTIC INJECTION MOLDING PRESS TONNAGE CALCULATOR

The calculator tool will give you a close estimate of the size press tonnage your plastic injection molded part will require, so you have a better understanding of the requirements needed by your potential injection molding partner.

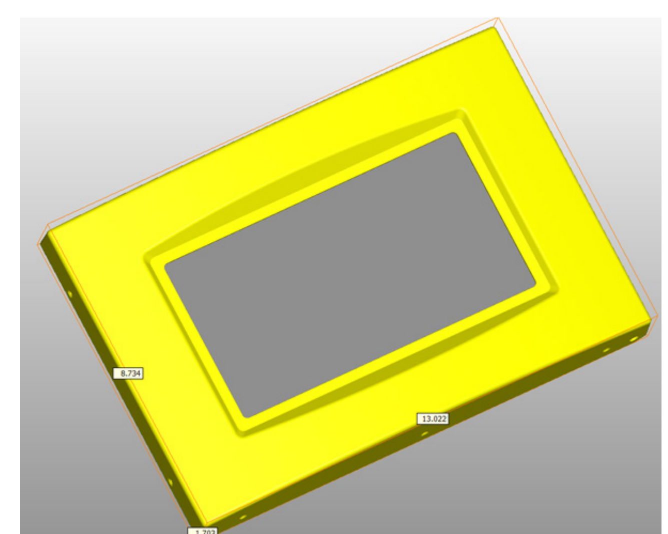
Although it is a simple calculation, there are a few considerations to review. This calculator focuses on the length and width dimensions and does not measure depth.

The calculation is slightly different between a solid plastic part and a cored-out (no plastic area) plastic part. Use the calculator tool now!

Solid Part



Cored Part



UNDERSTANDING PLASTIC INJECTION MOLDING COSTS BY EVALUATING TOTAL COST OF OWNERSHIP

UNDERSTANDING PLASTIC INJECTION MOLDING COSTS BY EVALUATING TOTAL COST OF OWNERSHIP

One of the biggest issues in the injection molding industry—for both molders and customers—is evaluating the total cost of ownership of a product or project. Though there are several things OEMs can do to make their RFQ's more accurately match their molding needs, customers still need to carefully and comprehensively analyze the quotes received from potential vendors and look at all of the capabilities of those vendors.

While OEMs tend to be very price conscious, they really should be cost conscious and look at the total scope of their project. There is a stark difference between an upfront price per part and the long-term cost of supplying those parts over the production lifetime of part—the latter is usually referred to as the "total cost of ownership", "total landed price", or "total manufacturing cost". This difference gets obscured when customers compare what they think are bids for the equivalent work and materials, but in fact are "apples to oranges" comparisons. This is one very common reason why some customers object to above-reasonable prices from injection molders.

This problem impacts the industry in two big ways: injection molders who actually deliver competitive value lose out on business unfairly, and customers who think they are getting a good deal actually end up incurring large "hidden" expenses which weren't reflected in the quote. When evaluating your potential supply chain partner, OEM's need to look at not only their capabilities on an initial project but how the supplier will support all aspects of the project.

Too often, OEMs will use only the quoted price per part for comparing the bids they received. This is a problem because other costs which can significantly impact the total landed price tend to get ignored and new costs can often creep up if your supplier doesn't have all of the capabilities you need.

Fortunately, these problems can be avoided. In this article, we'll discuss how customers can thoroughly and fairly evaluate and compare the total costs of quotes they receive from prospective injection molding suppliers.

Support Throughout the Entire Product Life Cycle

In order for an OEM to determine if a molder is truly able to meet their needs, that customer must consider the entire injection molding from the initial concept, prototypes, initial production, and high-volume manufacturing. As the molding project evolves in scale and complexity each year, ongoing support by the supplier will be needed to successfully ramp up production to meet demand.

That in turn requires a vendor with excellent project management capabilities, as well as other proper resources such as the specific equipment (including metrology machines and inspection tools), skilled personnel on their team, and all relevant ISO certifications that are needed across other projects as well.

What does this have to do with the total cost of ownership?

Plenty. Here are two recent cases we have seen where the supplier's production capacity was mismatched for the total production lifetime of a molded part, resulting in high unexpected costs for the OEM:

One OEM chose a supplier to produce their initial prototyping and short run production. Once the production demand increased and the production volume began increasing, the supplier mentioned that they could not support the high-volume production levels due to capacity and resource restraints. The customer was forced to move the tools to a supplier who could successfully handle high volume orders.

We also witnessed another scenario where a customer selected a vendor for initial production runs—only to learn later when their product hit the market that the supplier only does high volume production. The OEM incurred extremely high setup fees from that supplier and was also forced to find and source from a supplier who could handle their low and medium volume needs.

Lessons to learn

Be selective when choosing the suppliers on your project, something that may seem like a great fit at this stage of your product lifecycle can cost your big time down the road. Really dig deep into the core competencies of the potential supplier and think longer term about your product, you need a partner that can handle all of your needs from cradle to grave and beyond. This is a core reason why Crescent Industries has invested so much back into our capabilities, departments, equipment and automation.

The Impact of Mold Maintenance on Tooling Lifetime

Customers need to ensure that preventative mold maintenance is included in all the quotes they receive, especially if high volume production is expected for many years. Preventative tool maintenance can extend the life of the tool, saving OEMs from the high costs of high scrap rates, reject rates, unexpected downtime, mold repair, and even mold replacement.

Although preventative mold maintenance does save money for customers, there is some cost associated with it an it's minimal compared to issues that can arise without a solid PM plan. This is especially true if the part material is corrosive, requires high mold temperatures, high molding pressures, or contains abrasive elements such as glass (note that all these factors will also increase the cost of the tool).

On quotes for new production, this maintenance cost can "shift" to the tooling price since molds with more cavities require less frequent mold maintenance for higher production runs. Since the tooling price tends to be one of the few items customers zero in on, this shift from downtime (factored into the price per part) to the upfront tooling cost can be deceptive because that higher upfront tooling price is actually a visible investment which saves customers lots of future hidden costs.

Thus, if one molder factors this crucial maintenance into their quote, but another molder doesn't, then the two quotes can't be fairly compared, and the customer is at risk of incurring much higher costs down the road.

How the Quality of the Mold Impacts Total Cost of Ownership

The quality of the injection mold has a huge impact on the total cost of the production of parts. A high-quality mold which is properly maintained and made out of the most durable materials will pay for itself many times over due to producing more parts per cycle, a longer production lifespan (as the higher upfront cost is amortized over many more parts), minimized unexpected downtime, fewer costly repairs, and lower scrap rates.

There are lots of things which go into a high-quality mold before the first part is made. Many of these are covered by the Society of Plastic Industry (SPI) mold classifications:

Class 101 Mold

These molds are for 1 million cycles (before major maintenance) or more and fast cycle times. Not surprisingly, they are fabricated from only the highest-grade materials, and cost the most.

Class 101 mold bases must have a minimum Brinell Hardness Number (BHN) of at least 280, and all cavities, cores and other molding surfaces must have a hardness of at least 48 on the Rockwell C scale. Guided ejection, temperature control features must be present (e.g. in cores, cavities, slides, and anywhere else possible), slide wear plates, corrosion resistant cooling channels, and parting line locks are all required for Class 101 tools.

Class 102 Mold

Class 102 molds are for no more than 1 million cycles (before major maintenance) and are a good fit for parts made out of abrasive materials (like glass-filled resins) and parts with tight tolerances. These molds are still near the top of the mold price range, as they are made with high-quality materials.

Like Class 101 molds, Class 102 mold bases must be a minimum of 280 BHN and the all the molding surfaces need to be hardened to a Rockwell C hardness of 48. The temperature control requirements are the same for Class 102 tools as well.

For Class 102 tooling, guided ejection, slide wear plates, corrosion resistant cooling channels, and plated cavities are all optional, depending on the total production quantity required by the mold.

Class 103 Molds

For no more than 500,000 cycles (before major maintenance), Class 103 molds are a very common and economical choice. The mold base hardness requirement drops to 165 BHN, while cores and cavities must be hardened to at least 280 BHN. All other features are optional.

Choose the Right Tooling

These three SPI classes are meant to easily define the mold's quality to facilitate uniform quotes for the same types of molds from different suppliers. The SPI class may detail the quality of the materials and standard shot life before major maintenance however, they don't indicate the level of molding expertise, DFM analysis, mold fill simulation, QC, and other labor which went into the mold. High quality and multi-cavity molds will have lots of this, and it will show in the tooling cost.

When it comes to molded plastic parts, the old adage is still true: you get what you pay for. If a low cavity tool is picked in an effort to save money, there's a risk that tool won't be able to keep up with production requirements, resulting in frequent downtime for repairs and maintenance. In the end, the customer may have to purchase a new tool. That's why it's critical for molding customers to make sure the tool class in the quote matches both the volume and quality (including surface finish and other cosmetic items) needed for the part.

How Lower Prices Can Lead to Hidden Costs

There can be plenty of hidden costs which can lurk beneath the one or two numbers customers usually focus on: the price per part and the upfront tooling cost.

Awarding the business to the molder with the cheapest tooling and lowest price per part can end up costing OEMs much more than an "expensive" CM in the long run. Anytime a mold is less costly to buy up front, it may well mean higher on-going costs during the life of the tool. These added expenses include frequent repairs and maintenance over the life of the tool. Other hidden costs include poor part quality and a slower than anticipated cycle time, both can lead to shortages of consistent high-quality parts.

One or Two Numbers Cannot Capture Everything

For customers to effectively achieve total cost reduction while avoiding the large hidden costs listed above, it is necessary to run and maintain a mold at the highest efficiency possible. That requires risk mitigation in the form of maintenance and a well-designed mold.

In summary, a lot of factors need to be considered when comparing competing quotes for injection molding, not just the upfront tooling and per part costs. By better understanding all the cost impacts of a potential vendor's offer, customers can make wiser choices when they award business, actually reduce the total cost of ownership, and boost their bottom lines.

Remember, short term mindset choices can cost you significantly in the life cycle of your product. Think about where your product could be in 2-3 years, and choose suppliers based on that.

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