PROPERTY

COMMENTARY PAPER

Plastic is changing the world – but not without manufacturing equipment risks

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Plastic revolution

When you look around, it's nearly impossible not to find something that is made from or incorporates plastic. From water bottles and food storage containers to rigid pipes, wire insulation, building siding, medical components, car parts and cellular devices – plastic is connected to many of the things we use on a daily basis.

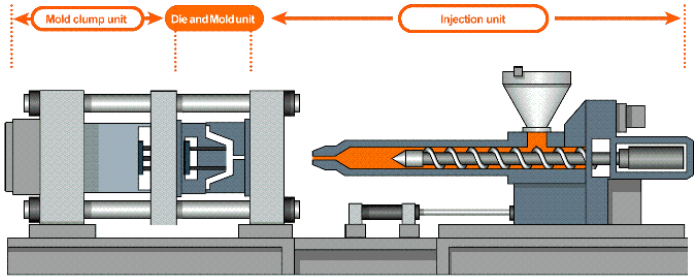
According to Adam Millett at VirtueBrush, the primary motivation behind the creation of synthetic plastics was to replace elephant ivory. Back in the 1860s, many everyday items were made out of ivory, including combs, jewelry, cutlery handles, piano keys and billiard balls. In 1863, in an effort to save the elephants, a New York-based billiard ball company called Phelan and Collander launched a competition to find a suitable replacement for ivory to make their product. The prize money was $10,000, which equates to about $352,000 in 2022.

This led a young inventor named John Wesley Hyatt to invent a substance he named 'Celluloid'. Derived from plant cellulose, this was the first human-made plastic and although it didn't win the competition as it had a propensity to explode upon collision, it was a truly revolutionary invention. This was the first time humans could create substances unbound by the limits of nature, and clearly, the world would never be the same again.

According to Grand View Research, "the global plastic market size was valued at USD 593.00 billion in 2021. It is expected to expand at a compound annual growth rate (CAGR) of 3.7% from 2022 to 2030. The increasing plastic consumption in the construction, automotive, and electrical & electronics industries is projected to support market growth during the forecast period. Regulations to decrease gross vehicle weight to improve fuel efficiency and eventually reduce carbon emissions are driving plastic consumption as a substitute for metals, including aluminum and steel, for manufacturing automotive components."

Plastic forming production

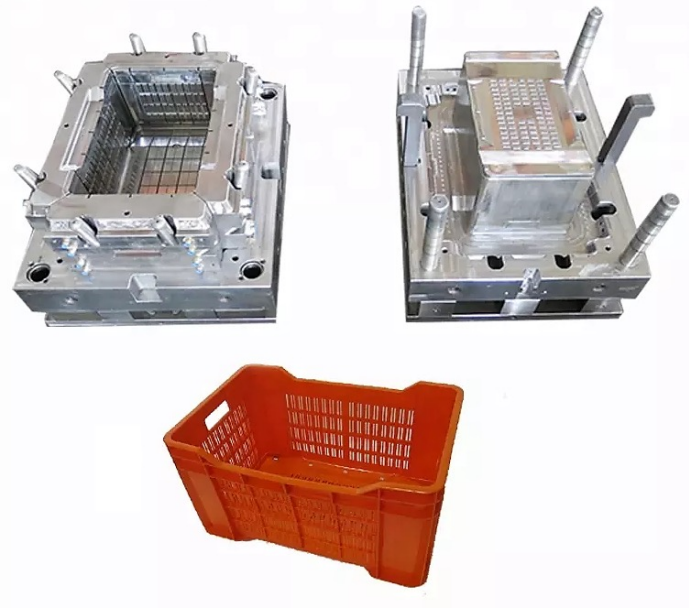
Plastic injection molding (PIM) accounts for about 80% of durable plastic items we utilize daily. The other 20% are formed via rotational molding, extrusion blow molding, injection blow molding, reaction injection molding, vacuum casting, thermoforming and compression molding. Since injection molding is the most commonly used process in the fabrication of small, medium and large sized plastic parts, we will focus on PIM throughout this commentary.



Manufacturing equipment

Plastic injection molding requires an injection molding machine, raw granular plastic material and a machined mold. The granular material is resin pellets. The pellets are fed through a hopper into a heating barrel, which is part of the injection unit. Once heated to a predetermined temperature, the pellets become a highly-viscous free-flowing polymer. Polymers are flexible substances that have the ability to stretch. The molten plastic is driven by a large screw and injected into a mold – often machined from steel or aluminum – where it cools and solidifies into the designed part. The screw is withdrawn, the mold opens, and the part is ejected. The cycle repeats and is used to fabricate hundreds of thousands of parts in a relatively short period of time.

Molds for plastic injection consist of high-strength metal components that have been built to operate in two halves. The composition of an injection mold is significant in order to function properly during the injection molding process. Almost all of the mold components are designed for tolerances of less than +/- 0.001" or 0.025mm, one-third of the thickness of a piece of copy paper.



Injection molding has a slew of advantages. Plastic with different properties can be utilized, parts can be made of any color, the design tolerance is tight, high-volume orders are cost effective and the waste produced is not only small but can be re-ground and reused. The disadvantages are that to make a steel mold, the initial cost is relatively high. It can take about a month to complete the mold design and manufacture the custom mold.

Loss examples

Manufacturer of high voltage tension line insulators

Insulators are used in electrical equipment to support and separate electrical conductors without allowing a current through themselves. Insulators are made from glass, porcelain or composite polymer materials.

One example of a loss involves a fire that originated in or around a large injection molding machine. An electrical engineer determined that the origin of the fire was in the electric oil heater. Maintaining a specific temperature in the mold is equally as important as the temperature profile in the barrel that melts the plastic resin. Temperature is controlled by running water or oil lines through the mold. Water cooling lines are used for lower temperature applications, while heated oil lines are used when the mold must be maintained at a temperature above the boiling point of water. The heater was maintained by the insured and for some repairs non-standard parts were utilized.

Manufacturer of aerospace parts

A fire ignited in or around a 95-ton injection molding machine. Specified tonnage is the maximum clamping force the machine can produce, to keep the mold closed during the injection process. Small injection molders may produce a clamping force up to 25 tons, while larger machines produce 4,000 tons and beyond. As such, at 95 tons, the fire damaged machine was relatively small. An investigator determined that a leak in the machine caused an electrical arc in the cabinet below.

Manufacturer of parts for all-terrain vehicles

A significant fire broke out at an injection molding and thermoforming plant – burning for 20 hours. The cause of the fire is unknown, although the origin was in or around one of a dozen injection molding machines.

Manufacturer of road reflectors

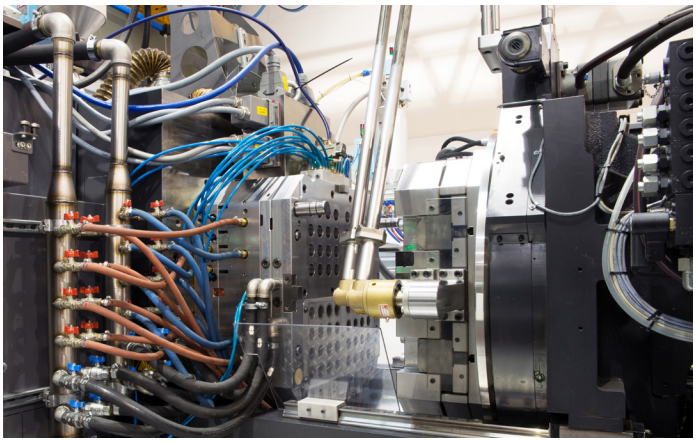
A fire erupted in a plant that operates around the clock after an injection molding temperature control unit malfunctioned. The injection molding machine sustained damaged that deemed it a total loss.

Loss considerations

CNA Insurance published a risk control guide for the plastic processors industry. Under property claims it is noted that 60% of fire incidents involve production machinery and equipment. Fires resulting from lightning accounted for the remaining 40%. The Inland Marine Underwriting Association (IMUA) published a guide to plastic manufacturing that provides causes of loss to consider, outlined below.

Dust explosions

Dust explosions are a risk when operations use finally pulverized plastic or produce dust by grinding, machining or sanding in finishing work. Plastic pellets for injection or extrusion molding are commonly known as molding powder. It's important to minimize the escape and dispersion of dust throughout the production floor. Installation of dust collections systems in areas where dust is generated is key to controlling dust explosion hazards. All electrical equipment should be designed to safely operate in a combustible dust atmosphere.



Static electricity

Many operations in plastic plants generate static electricity. Because plastics are strong electrical insulators, static electricity can rapidly build up on them to spark discharge – a hazardous condition if dust or flammable vapors are present.

Hydraulic pressure system

Hydraulic systems are used to clamp molds and to provide pressure to rams or screws which force molten plastic into molds by compression, transfer or injection molding. While hydraulic fluid is not as dangerous as flammable solvents, it merits consideration due to its high average flammability. Whenever possible, the use of nonflammable hydraulic fluids or hydraulic fluids with a high flashpoint is advised. Hydraulic lines and fittings need to be routinely inspected and serviced for leaks and loss of tightness.

Heating elements

Molding and extrusion operations are susceptible to risks associated with local overheating of electrical components. Operating temperatures normally range from 300 - 650˚F, depending on the plastic being processed. Some areas within equipment may not be regularly purged by flow of the plastic feedstock. Material remaining in such areas can be subject to extremely high temperatures or be kept too long at a normally acceptable temperature. Decomposition may then take place – resulting in the release of gases that may be combustible. Cleanliness in molding and extruding areas is imperative to reduce the risk of ignition from overheated barrel bands, where flammable vapors may be generated.

Key takeaways

- According to Grand View Research, "the global plastic market size was valued at USD 593.00 billion in 2021. It is expected to expand at a compound annual growth rate (CAGR) of 3.7% from 2022 to 2030. The increasing plastic consumption in the construction, automotive, and electrical & electronics industries is projected to support market growth during the forecast period. Regulations to decrease gross vehicle weight to improve fuel efficiency and eventually reduce carbon emissions are driving plastic consumption as a substitute for metals, including aluminum and steel, for manufacturing automotive components."
- Plastic injection molding accounts for about 80% of durable plastic items we utilize daily.
- 60% of fire incidents involve production machinery and equipment. Fires resulting from lightning accounted for the remaining 40%.
- Dust explosions are a risk when operations use finally pulverized plastic or produce dust by grinding, machining or sanding in finishing work.
- Many operations in plastic plants generate static electricity – a hazardous condition if dust or flammable vapors are present.
- While hydraulic fluid is not as dangerous as flammable solvents, it merits consideration due to its high average flammability.
- Molding and extrusion operations are susceptible to risks associated with local overheating of electrical components. Cleanliness in molding and extruding areas is imperative to reduce the risk of ignition from overheated barrel bands, where flammable vapors may be generated.

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Get in touch with an expert

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Throughout his 20 years of experience as a firefighter, police officer, and fire origin and cause investigator, Kevin Heflin has completed more than 500 hours of classroom fire investigation training. Kevin has investigated more than 650 fire and explosion incidents involving serious injuries, fatalities, subrogation issues and multi-million-dollar losses. For more information, contact **kevin.heflin@efiglobal.com**.

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Adam Mills is a licensed professional engineer in multiple states and has over 14 years of engineering experience. Adam has prepared designs and performed inspections and testing of various machinery systems including hydraulic and power transmission machinery. He has experience conducting loss investigations and providing consulting services on the topics of mechanical and fire protection engineering. His expertise includes, but not limited to mechanical failures, HVAC systems, water losses and plumbing failures, vehicle forensics, and fire protection systems.For more information, contact **adam.mills@efiglobal.com**.

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