Manufacturing Intelligence:

Plastic injection moulding

Manufacturing Processes

We know that your clients take risk management seriously and that it plays a key role in the service you offer. We've produced this guide to highlight the controls your clients can take to help reduce the risks associated with the production processes of injection moulding

Process overview

Injection moulding is the process by which plastic raw materials are heated into a molten state and squeezed (injected) into a mould.

The raw material, most often a thermoplastic polymer in pellet, granular or powder form, is placed into a hopper. The hopper feeds the material into a heated injection chamber (extruder barrel), through which it's forced by a ram or reciprocating screw. The heated molten material is forced through a non-return valve to fill the cavity of a mould where the pressure is maintained while it's allowed to cool and harden. To reduce the injection moulding cycle time and ensure uniform heat dissipation, a fluid cooling system is commonly used with an ethylene glycol mixture. When the plastic is cooled and solidified, the mould halves open and the finished products are ejected from the press.

The mould is in 2 halves held shut with a system of clamps which are often hydraulically operated.

Plastic waste and trimmings are either removed for recycling by third parties or can be re-granulated on site for use back at the front end of the process.

The mould or die used in the plastic injection moulding process can be expensive to manufacture and are typically used in mass production runs where thousands of items are produced. Moulds are constructed from hardened steel, pre-hardened steel, aluminium, and/or beryllium copper alloy, meaning some can be theft attractive. The moulds can be manufactured either by CNC machining or by using electrical discharge machining processes.

Modern injection moulding machines are controlled by an in-built computer, with sensor fed information being used to control the actions of the machine ensuring consistent output and quality. Injection mouldings count for a significant proportion of plastic production, from the manufacturing of micro parts and small items like disposable razors and bottle lids to large components such as car bumpers and wheelie bins. The machinery can be used to manufacture one consistent part in a repeating process, or there could be a multi impression tool designed to incorporate many components on the same tool with a single injection.

Risk features

Business Interruption

Consideration should be paid to the nature of the moulds used in the injection moulding process. These can include unique, bespoke and one-off moulds which can be of high value and extremely difficult to replace. They've limited application hence their theft attractiveness is low unless made from non-ferrous metal.

However, significant damage (especially fire damage) can render the mould unusable therefore leaving the manufacturer with potential long lead time and business interruption to reproduce the original mould.

Relatively small fires can result in a significant business interruption (often greater than property loss) due to contamination from smoke, water extinguishment, heat etc. rendering all stock unsuitable for sale.

Material Damage

Modern machinery has the ability to be run unattended with automated hopper feeds providing the raw material. Smaller operations will have more labour intensive production procedures, whereas larger operations with higher capacity machines require constant monitoring and attention.

Unattended running of machinery is generally not an attractive feature for insurers. This is principally because a small fault in an unattended machine can quickly escalate to a major problem when no one is in attendance to spot and correct the issue quickly.

In repetitive batch processing, high piled storage in fixed metal racked systems can be expected, which can bring a significant fire loading to the premises and is a feature which needs to be considered as part of the Fire Risk Assessment. It's a better feature when businesses have fully separated storage of finished stock from the production areas, ideally in a separate building or otherwise with at least a two-hour fire separation.

Appropriate storage arrangements for flammable liquids is also important.

Risk features

Employer's Liability

Raw materials comprise plastic pellets, granules and powders including additives such as fillers, pigments, fire retardants and stabilisers. Loose granules or spillages can create slip hazards. Similarly, there needs to be good dust controls, effective extraction of any dusts and fumes and monitoring of workplace exposure. This needs to be carried out as part of the COSHH Assessment and necessary controls formulated to prevent/reduce exposure to your employees. When the material is heated during the process, plastic fume can be produced which includes respiratory sensitisers, irritants and carcinogens. The extent of fume production is influenced by the material being processed, the temperature being applied, the operating procedures, the reliability of temperature control and machine maintenance. Machine cleaning, maintenance and fixed ventilation play an important role in mitigating any potential plastic fume.

Workplace ergonomics, poor posture and handling can create musculoskeletal disorders leading to significant injury and claims potential. Proper assessment of workstations and activities is required to avoid and control this exposure.

Public Liability

It's important to understand the functionality of the range of component parts manufactured and also the client's position in the ultimate chain of supply.

Parts may be manufactured solely to customer specification or your client or they may provide some form of design service. It's important that the client retains full traceability for of all aspects relating to supply, design and manufacture.

Common Material Damage and Business Interruption Hazards

The tables below highlight some specific hazards present in injection moulding along with those associated precautions which will help prevent major physical property loss. Generic risks resulting from arson, electrical sources and waste aren't mentioned here.

Features always present

Hazard	Control
Hydraulic fluid leakage from hoses and machinery.	■ Professional and regular maintenance of machinery and equipment. ■ Use of shields to prevent hot fluid coming into contact with hot surfaces. ■ Frequently checking hose and machinery condition.
Overheating during the production process.	■ Ensure that thermostatic cut-offs and fire detection equipment are in good working order.
High quantities of raw materials, including high piled storage.	■ Effective storage management, incorporating separate storage for the various classes of goods e.g. raw materials stored away from finished goods. ■ Effective management to ensure that accumulations of raw materials, finished goods and packaging aren't a feature.

Hazard	Control
Increased fire ignition and propagation potential when highly flammable liquids are stored to the amount of: **1. Up to 50 litres in workroom or storeroom** **2. Above 50 litres within the premises** **3. Above 50 litres in open air.**	■ Highly flammable liquids in a work or storeroom should be stored in a suitable closed vessel in suitably placed cupboard or bin which is a fire resisting structure. ■ Highly flammable liquids in the premises should be stored in a suitable compartment that benefits from 2 hours fire resistance with external ventilation to the open air. ■ Highly flammable liquids in the open air should be stored in a suitable building constructed with a sump or bund wall and benefiting from a minimum of 30 minutes fire resistance.

Common Material Damage and Business Interruption Hazards

Features sometimes present

Hazard	Control
Ignition danger when re-granulation processes are undertaken.	■ Professional and regular maintenance of machinery and equipment. ■ Frequent clearing of the areas where ground materials are prone to accumulate.
Explosive atmospheres.	■ Full DSEAR Risk Assessment in conjunction with the Fire Risk Assessment should be carried out.
Ignition hazard from cleaning methods and cleaning infrequency.	■ Avoid use of flame guns to clean moulds.
Business Interruption danger when there's a reliance on a single customer.	■ Consider any large contracts in action with a single customer and look for other customers. ■ A fully maintained Business Continuity Plan (BCP).
Dependence on specialised moulds/dies.	■ Keep store plans and designs off site. ■ Build replacement into a fully maintained BCP.

Hazards and Precautions

The tables below highlight some specific hazards present in injection moulding, along with the associated controls to help prevent significant injury or third party property damage. Generic risks arising from manual handling, warehousing or any work away from the premises aren't mentioned here.

Features always present

Hazard	Control
Slips from raw material spillages.	■ Good housekeeping and cleaning procedures.
Injuries occurring through faulty guarding.	■ Control of guarding should be ensured with frequent checks and adequate staff training.
Burns to the skin following contact with hot surfaces or splashing of plasticised material/hydraulic fluid.	■ Adequate insulation. ■ Control of guarding with frequent checks and adequate staff training.
Cuts from knives or sharp edges.	■ Employing a safe system of work. ■ The provision of appropriate PPE.
Manual handling and Ergonomic related injuries.	■ Implement management controls around lifting and lifting equipment subject to preventative maintenance. ■ Lifting and handling, posture and workplace assessment as well as training for staff.
COSHH and dust inhalation.	■ Effective and maintained extraction. ■ Provision of appropriate PPE.

Hazard	Control
Noise induced hearing loss.	■ Formal noise risk assessment by competent and trained person(s). ■ Reduce noise levels as far as possible through the use of soundproofing and engineering controls, supplemented by the provision of PPE.
Failure of products due to defect.	■ Routine and robust quality control procedures with particular emphasis on safety critical or high potential liability components manufactured. ■ Quality control inspections could include visual inspection batch testing, thickness measurements and defect detection systems which can include surface and embedded techniques. ■ Records of product testing together with calibration of testing equipment need to be maintained. Full traceability should also be maintained in respect of products or parts supplied.

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