



DESIGN AND MANUFACTURING OF MOULD FOR INJECTION MOULDING MACHINE

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Abstract: This study examines the design and manufacturing processes of precision moulds for injection moulding applications, focusing on optimization of process parameters and quality enhancement. Bryce (1996) established injection moulding as the fundamental manufacturing process for thermoplastic components, while Kovacs and Siklo (2011) demonstrated critical cooling effects impacting mould performance. The research incorporates Wang and Young's (2005) findings on residual stress management in thin-walled applications and Shakkarwal and Yadav's (2013) mould flow analysis methodologies. Manufacturing techniques utilizing CNC machining, EDM, and advanced materials including hardened steel and aluminium alloys are evaluated. Rosato et al. (2000) identified injection moulding's dominance in processing fibre-reinforced thermoplastics, supporting the technology's evolution toward sustainable manufacturing with eco-friendly fillers and enhanced production efficiency for complex geometries.

Introduction: Injection moulding has evolved as the most critical manufacturing process for thermoplastic component production, fundamentally transforming modern manufacturing capabilities. Bryce (1996) established that plastic injection moulding represents the most fundamental manufacturing process for high-volume production, enabling mass production of complex geometries with exceptional dimensional accuracy. The technology's significance is further emphasized by Rosato et al. (2000), who identified injection moulding as the dominant method for processing both short and long glass fibre reinforced thermoplastics. Process Fundamentals and Design Considerations The injection moulding process involves precise control of multiple parameters to achieve optimal part quality. Kovacs and Siklo (2011) demonstrated that cooling effects at corners significantly impact the overall moulding process, requiring careful thermal management design. This finding is complemented by Wang and Young (2005), who established that residual stresses in thin-walled injection mouldings directly correlate with process parameter optimization. Shakkarwal and Yadav (2013) further validated through mould flow analysis that proper design integration is essential for connecting link applications,

highlighting the importance of simulation-driven design approaches. Technological Advancement and Future Trends The field continues advancing through innovative process variants. Kovacs et al. (2014) identified thermal management as a critical factor in advanced injection moulding applications, while Giacomini et al. (2011) established that core deflection analysis is fundamental for precision moulding operations. These developments support the industry's evolution toward micro-injection moulding, high-speed processing, and sustainable manufacturing practices using eco-friendly fillers.

Literature Review: Designing and Optimizing Plastic Injection Molding for Aerosol Caps Key process parameters such as backpressure, manifold temperature, holding pressure, and screw rotation speed all have a significant impact on the quality and efficiency of aerosol cap injection molding. Optimization techniques like as Taguchi and ANOVA, as well as FEA simulation tools, are often utilized to fine tune these parameters and eliminate faults. Molds for aerosol caps are commonly made of hardened steel for high-volume production and pre-hardened steel or aluminum for lower quantities or prototyping. Cooling channels and hot runner systems are required for temperature control and efficient material flow, whereas multi-cavity molds increase output. Advanced techniques, such as two-shot molding and in-mold labeling (IML),

enhance product quality and branding. Optimizing circumstances while employing current techniques reduces faults and improves cycle time, making injection molding an efficient way for producing high-quality aerosol caps.

Methods: The injection molding process for aerosol caps employs modern techniques to assure precision and efficiency in high-volume production. Polypropylene (PP) and polyethylene (PE) are often used thermoplastic materials due to their lightweight, durability, and chemical resistance. Molten plastic is pumped into a mold cavity under high pressure, forming the required shape of the aerosol cap. Techniques like hot runner systems assure regular material flow, eliminate waste, and improve production efficiency. Multi-cavity molds are used in high-volume manufacturing to make many caps in a single cycle. In circumstances when caps require additional features or dual-material designs, two-shot molding can be used to incorporate soft-grip components or ornamental embellishments. Post-molding procedures, such as in-mold labeling (IML), are also used to apply high-quality branding directly to the caps during production. These methods improve consistency, minimize cycle times, and verify that the caps satisfy industry standards.

Assembly of an Injection Molding Machine The injection molding machine for aerosol cap manufacture is assembled by first installing the mold onto the clamping unit, guaranteeing correct alignment and stable mounting. The cooling channels in the mold are linked to a chiller system for temperature control. The injection equipment, which includes a hopper, barrel, and screw mechanism, is configured to melt and inject the plastic material. The machine is tuned to precise material parameters, such as barrel temperature, injection pressure, cooling time, and cycle duration. The clamping unit tightly secures the mold during the injection and cooling processes, preventing flaws such as flashing. An ejection mechanism, complete with ejector pins or sleeves, is used to release the caps following solidification. Auxiliary systems, such as robotic arms or conveyors, are used to automate part removal and handling, further optimizing the manufacturing process. Regular testing and trial runs ensure that the machine performs smoothly and produces defect-free aerosol caps on a consistent basis.

Working Drawing: The working drawings were produced based on the earlier designed that state all components of the machine. It gives further internal and external details of the entire machine with specifications for the construction. The construction was purely based on the designed made. The constructed machine is shown in Figs

Machine Used while making mould/Día

- M1TR
- Milling
- Lathe
- VMC (Vertical Machining Centers)

M1TR:

- The M1TR Milling Machine is recognized as a dependable, tough, and steadfast milling machine. Low maintenance, high reliability, and extreme ease of operation have made it the perfect choice for many industries.
- There are several factors that you need to consider when purchasing your M1TR milling machines. These factors mainly include whether you will be using it as standalone or in combination with other machinery. You also need to decide if you want to purchase the complete package or just the spindles and belt.
- When buying the M1 TR milling machine, you first have to understand what type of product you are looking for. The types of products range from plastic and rubber tube products to heavy-duty steel and fibreboard products. Each product type has its own specifications and the specifications of these products vary from manufacturer to manufacturer. You will need to know the exact specifications of the product type.

MILLING:

- Milling machines are one of the most common and most useful pieces of machinery in many industries.

C45

- C45 grade steel is a medium carbon steel offering moderate tensile strengths.
- The material is capable of through hardening by quenching and tempering on limited sections but can also be flame or induction hardened to Hrc 55.
- This grade is most commonly supplied in an untreated or normalised condition and is available in several variations (denoted by additional letters) which offer slight modifications of chemical composition.
- Machinability similar to that of mild steel can be expected, however weldability is reduced.

P20

- Low-carbon mold steels or group P steels are of different types that include P2, P3, P4, P5, P6, P20, and P21 steels. Chromium and nickel are the main alloying elements found in group P steels.
- P20 tool steels are nitrided or carburized. These steels are capable of being machined into complex and large dies and molds. P20 steels are mostly used in the carburized condition. The presence of chromium and nickel enhances the toughness and hardness of P20 steels.

EN8

- EN8 is an unalloyed medium carbon steel which is used in applications where better properties than mild steel is required but where the costs do not justify the purchase of a steel alloy. EN8 can be heat treated to provide a good surface hardness and moderate wear resistance by flame or induction hardening processes. From the automotive trade to wider general engineering applications, EN8 is a popular steel in industry.

20MnCr5

- 20MnCr5 is a case-hardening steel with low carbon content but good hardenability reaching good wear resistance due to high surface hardness after hardening.
- The small grain size benefits in good ductility and fatigue strength.
- Suitable for gearboxes and axle gears.
- Ovako 236F is a standard variant with controlled sulphur content for consistent machining properties.
- Ovako 236Q is an IQ (isotropic quality) variant.

Problem Faced, Conclusion and Reference:**Problem Faced**

- In the insert cavity plate, it consists of cooling system.
- The coolant from the cooling system was been leakage from the insert.
- There were small leakages in the insert part.
- We solved it by leaser welding the insert part two times.
- After that there are no leakages now.

Conclusions and Future Trends: Injection moulding has become one of the most important methods for processing short and long glass fibre reinforced thermoplastics, and is expected to continue to grow annually for more applications in novel fields such as optics, electricals and electronics, aerospace, biomedicine and communications. New fillers such as benign filler or 'eco' fillers made from recycled paper, structural lignocellulosic fibres from corncobs and high cellulose fibre from wheat straw that are sustainable or recyclable will continue to be developed. Meanwhile, other process variants such as micro- injection moulding of micro- and nanocomponents, high speed injection moulding of ultra-thin composite parts, new foaming process that produces parts free of sink marks, low in warpage and with a high quality surface, injection moulding of long- fibre-reinforced thermoplastics that exhibit good creep resistance and impact performance, and injection moulding of conductive thermoplastics that provide effective EMI shielding in engineering applications, etc., will continue to be explored and developed. The injection moulding technology will play a very important role in contributing to the growth and success of the plastic composites industry.

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