Design, Manufacturing & Analysis of Aquarium Filter & Its Mould

[1]Ghotkule Omkar R., [2]Kamble Sagar S. [3]Dimble Kiran B.,[4] Jain Pankaj D.,[5] DongareVikram S., [6]Prof S.S. Sable.
Department of Mechanical Engineering, UCOER Pune. Maharashtra, India.

Abstract: - *The injection moulding machine is a machine that melts plasticize the moulding material inside the heating cylinder and inject this at a certain pressure into the mould tool to create the moulded product by solidifying the material inside it. The injection machine is constructed of a mould clamping device that opens and closes the mould tool, and device that plasticize and inject the moulding material. In this project "Design, manufacturing & Analysis of aquarium filter and its mould" we are going to design a mould for aquarium water filter components and after designing we are going to manufacture mould and filter also and after manufacturing we will analyze it using NX-CAD, NX-CAM.*

Keywords: *NX-CAD, NX-CAM*

1. INTRODUCTION

Injection moulding machine offers many advantages to alternatives manufacturing methods, including minimal losses from scrap (since scrap pieces can be melted and recycled), and minimal finishing requirements. Injection moulding machine differs from metal die casting, in that molten metals can simply be poured, and plastic resins must be injected with force. It is most common used method for mass production of plastic articles of a heated cylinder, heating the materials in the heating chamber, and forcing the molten metal into a closed mould, where the final solidification of the molten metal in form of the configuration of the mould cavity takes. The intending injection machine will be made from mild steel and medium carbon steel. It can only be used for the production of small components such as key holder, bottle cap, tally, ruler, and clothes peg. The mild steel is used for the construction of supporting plates, hopper, mainframe, mould, and platens, handle, and tie bars.

2. MAJOR MOULDING DEFECTS

2.1Air trap

Air traps occur when converging flow fronts surround and trap a bubble of air. The trapped air can cause incomplete filling and packing, and will often cause a surface blemish in the final part. Air trapped in pockets may compress, heat up and cause burn marks.

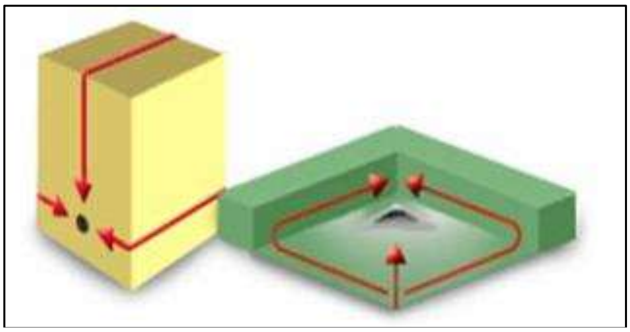
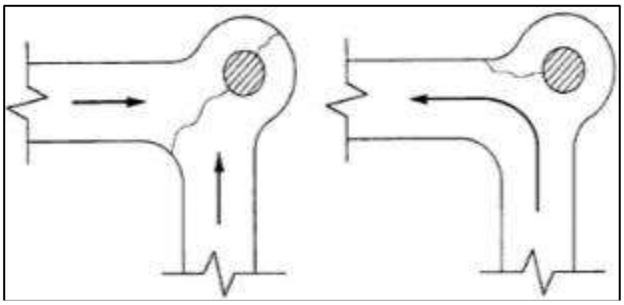


Fig.1: Welding Cracks

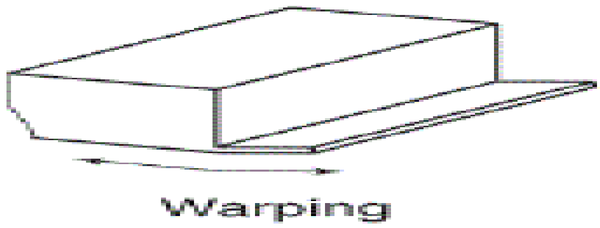
2.2Weld Lines

Weld lines are actually more like a plane than a line that appears in a part where molten plastics meet each other as they flow from two different parts of the mold.



2.3 Warping

Warping (or warpage) is the deformation that occurs when there is uneven shrinkage in the different parts of the molded component. The result is a twisted, uneven, or bent shape where one was not intended



2.4 Flash

Flash is a molding defect that occurs when some molten plastic escapes from the mold cavity. Typical routes for escape are through the parting line or ejector pin locations. This extrusion cools and remains attached to the finished product.

3. PROBLEM STATEMENT

There are three components in Aquarium filter assembly, currently these components are moulded in three separate moulds, which is time consuming and costly process, and hence we are going to design a single mould for three components.

4. OBJECTIVE

There are several objective of this project as follows:

- To reduce cost required for mould making
- To reduce time of complete operation of filter making
- To analyze the mould and component
- Use the geometry for product as input to mould design
- Define parting line along with a core and cavity
- Calculate the tonnage for the given mould
- Determine mould layout by specifying the gate location, sprue diameter, gate thickness, gate location or other design parameters for flow analysis
- Using Mould Flow to simulate the flow and finding fill time, weld line, warpages, sink mark etc.
- Using the above evaluation for determining mould design
- Validation through trials and testing

5. METHODOLOGY

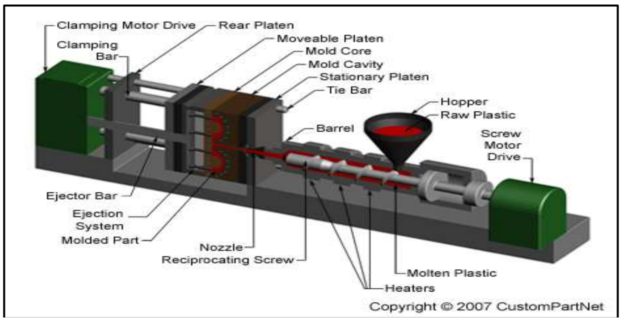
The analytical formulation for a problem involves reference to the empirical and pure Engineering practices for arriving at a solution. Typically, empirical formulae that are historically developed for the application can offer a solution for the given problem. For e.g. - The tonnage (clamping force for both halves) for Plastic Injection Moulding needed to produce the component is derived from the projected surface area of the component. 3D model and mould design created using NX9 software such as UNIGRAPHICS. Analysis / Simulation can be performed using suitable software in the CAE domain. The popular software used in the industry can be identified as Mouldex / Mould Flow/ Any customized software used by Industry, etc. For the dissertation work, the sponsoring Company would employ one of the above software for finding the solution. From the simulation hesitation, air traps, and over-packing. The analysis will also help the mould designer to design a perfect mould with minimum modifications and which will also reduce the time and cost. Thus analysis/simulation provides an insight into the nature of processing and consequently offers valuable inputs towards the design of the mould.

Methodology is a systematic approach for the realization of total task. It consists of the following detail:

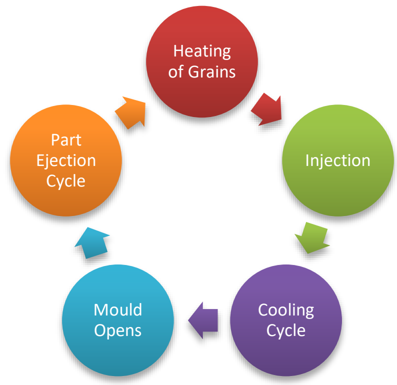
Cost estimation: Mould cost estimation is crucial especially for small and medium batch of production runs where the cost of a mould represents a significant percentage of the product development cost. It is the probable cost of an article before the manufacturing starts. By compiling statement of the quantities of the material required and production time required, the probable cost is computed.

5.2 Injection moulding

Injection moulding is a method of forming a plastic product from powdered thermoplastics by feeding the material through the machine component called the hopper to a heated chamber in order to make it soft and force the material into the mould by the use of the screw. In this whole process pressure should be constant till the material is hardened and is ready to be removed from the mould. This is the most common and preferable way of producing plastic products with any complexity and size.



5.1 Basic Operation Cycle



The project is consists of the 5 steps that are given below;

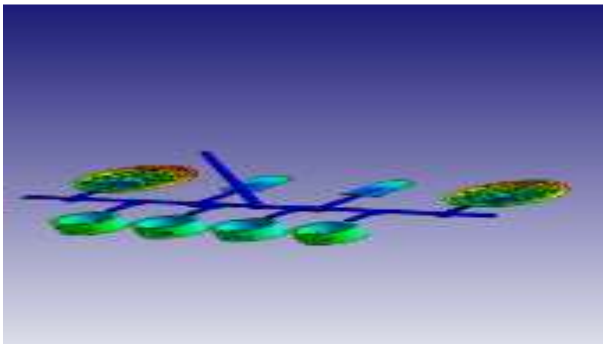
I. 3D Modeling
II. Analysis
III. Material selection
IV. Mould making
V. Manufacturing

I.3D Modeling

Modeling is the process of taking a shape and moulding it into a completed 3D mesh. The most typical means of creating a 3D model is to take a simple object, called a primitive, and extend or "grow" it into a shape that can be refined and detailed. Primitives can be anything from a single point (called a vertex), a two-dimensional line (an edge), a curve (a spline), to three dimensional objects (faces or polygons)

I. Analysis
UG NX-9:-

- Siemens NX software is an integrated product design, engineering and manufacturing solution that helps you deliver better products faster and more efficiently.
- Integrated CAD/CAM/CAE: Smarter Decisions, Better Products
- NX provides key capabilities for fast, efficient and flexible product development:
- Advanced solutions for conceptual design, 3D modeling and documentation
- Multi-discipline simulation for structural, motion, thermal, flow and multi-physics applications



II. Material Selection: -

The material selection procedure includes three steps:

a. APPLICATION SCREENING
b. GENERIC FAMILY AND SPECIFIC GRADE IDENTIFICATION
c. PROCESS SELECTION AND COST ANALYSIS

Step I — Application Screening

The first step in using the plastic material selection guide is to determine if plastics should be considered for the application. This is a screening process which is accomplished by developing a set of simple functional requirements which the component should meet, determining the component category, and evaluating the component requirements against an End Use Requirement Check List. When establishing component functional requirements, consideration should be given to the following factors, and the influences of the possible variations within each factor upon satisfactory performance of the component under consideration.

- Structural
- Performance
- Environmental
- Design Criteria
- Economics Factors
- Manufacturing Processes

Within the structural requirements it is important to concern oneself with special physical abuses, including those associated with assembly and shipping as well as those the customer is expected to give it. In the performance requirements, any standards such as Federal, SAE, ASAE, or U.L. should be considered. Step II Generic Family And Specific Grade Identification In this portion of the Selection Guide, the generic family or families and specific grades of plastics within the families are identified for the component under investigation. When the analysis has been completed, the most promising material or materials should be tested to determine full suitability in the application being considered.

Step III — Process Selection And Cost Analysis

The remaining step establishes the most logical method(s) of fabrication and the relative tooling and moulding costs. Final cost of the component will, of course, be based on a combination of the material selected, the type of fabrication used and the size of the tooling, e.g., single or multiple cavities. Part thickness also affects moulding machine time.

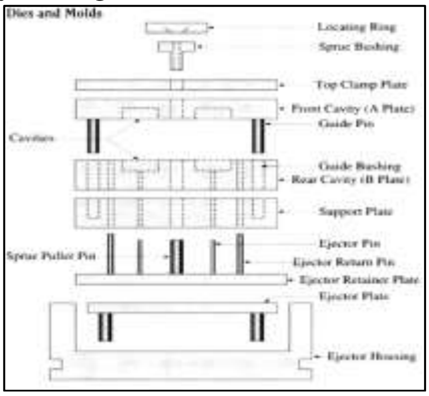
The materials used to construct injection molds range from aluminum to hardened steel: Aluminum for simple low production prototypes. The relative low strength of aluminum that makes it quicker to fabricate into molds likewise limits its useful life. Aluminum molds are typically intended to produce from a few thousand to a few hundred thousand parts with relatively simple features. Prehardened tool steel for moderate production, more complex molds. Prehardened tool steel molds are much stronger and more durable, yet still soft enough to be worked by conventional machining processes such as milling and turning. Prehardened tool steel molds are typically intended to produce from one hundred thousand to five hundred thousand parts, and can have a wide array of features such as slides and more intricate shapes that might break in an aluminum mold. Hardened tool steel for high production, long life molds.

Hardened tool steel molds are the most durable and expensive because part way through fabrication their components are heat treated to achieve hardness greater than can be machined. From that point on, the fabrication must continue using grinding and EDM processes. Hardened steel molds are intended to produce one million or more parts. Their hardness enables them to resist wear from their own operation and the abrasion of the plastic material, particularly glass fiber reinforced materials. Hybrid construction is very common, where steel parts are used in an aluminum mold to add strength to a slender feature, or parts of a steel mold are hardened to prevent wear at a rotating or sliding mold

FILTER COMPONENTS SPECS.

Specifications	**Value**
1. Material Used	HDPE(High Density Polyethylene)
2. Density of Material	0.96g/cc
3. Shrinkage Allowance	1.5 – 4%
4. Mass of components	Coarse Filter-0.932gms
	Filter Flap-0.159gms
	One Way Valve-0.860gms
	Total Mass=1.951gms

Mould making Mold A hollow form or cavity into which molten plastic is forced to give the shape of the required component. The term generally refers to the whole assembly of parts that make up the section of the moulding equipment in which the parts are formed. Also called a tool or die. Moulds separate into at least two halves (called the core and the cavity) to permit the part to be extracted; in general the shape of a part must be such that it will not be locked into the mould. For example, sides of objects typically cannot be parallel with the direction of draw (the direction in which the core and cavity separate from each other). They are angled slightly; examination of most household objects made from plastic will show this aspect of design, known as draft. Parts that are "bucket-like" tend to shrink onto the core while cooling and, after the cavity is pulled away, are typically ejected using pins. Parts can be easily welded together after moulding to allow for a hollow part (like a water jug or doll's head) that couldn't physically be designed as one mould.



Mould

More complex parts are formed using more complex moulds, which may require moveable sections, called slides, which are inserted into the mould to form particular features that cannot be formed using only a core and a cavity, but are then withdrawn to allow the part to be released.

I. Cavity Plate

Cavity plate

II. Punch plate:

Punch plate

- Material:HCHCR(high carbon high chromium steel)
- Dimensions:200*155*45

III. Mould Assembly:

Mould Assembly

III. Manufacturing

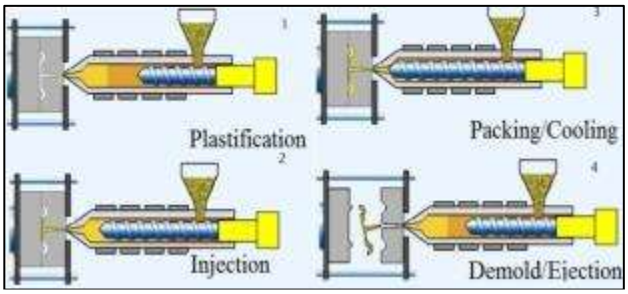
Once the design is completed manufacturing begins. Mold making involves many steps, most of which are very exacting work requiring highly skilled mold makers. One mistake can ruin or cause major repair expense to a work piece that has undergone a series of manufacturing steps over several weeks. The processes employed in mold making include:

- Milling and turning
- Heat-treating
- Grinding and honing
- Electrical discharge machining
- Polishing and texturing

To save cost, common mold components are purchased from suppliers. Frequently, outside services are required from subcontractors, which use specialty equipment such as thread grinding, etc. When all of the parts are completed the next step is to fit, assemble and test the mold. All of the mold component parts must fit together precisely to achieve an aesthetic result on the product and for the mold to not wear out rapidly or break. The mold must be fluid tight to contain the molten plastic. Yet, at the same time the mold must have venting features added to allow the air to escape. The behavior of the plastic material when moulded has been anticipated, however there can be some variance in the actual result. The mold must be tested to insure the products are correct and that the mold is performing properly. Where high accuracy is required, the mold may intentionally be made "metal safe" with the final adjustments coming after the first moulding trial.

Manufacturing Process

Injection moulding is a manufacturing technique for making parts from both thermoplastic and thermosetting plastic materials in production. Molten plastic is injected at high pressure into a mold, which is the inverse of the product's shape. After a product is designed, usually by an industrial designer or an engineer, moulds are made by a mold maker (or toolmaker) from metal, usually either steel or aluminium, and precision machined to form the features of the desired part. Injection moulding is widely used for manufacturing a variety of parts, from the smallest component to entire body panels of cars. Injection moulding is the most common method of production, with some commonly made items including bottle caps and outdoor furniture. Injection moulding typically is capable of tolerances equivalent to an IT Grade of about 9–14.



Parameter	Specification
Weight	3.56 tons
Injection temp.	180°C
Injection pressure	60 kg/cm^2
Injection time	1 sec
Cooling time	24 sec
Clamping force	80 tons
Hooper capacity	25 kg
Oil tank capacity	200 lit
Opening speed	700 rpm
Pump	1 hp
Heater used	4
Temp. of heater	170°C
Machine size (L*W*H)m	4.2*1.0*1.6
Motor	3 – 5 kw/hp

6.CONCLUSION:

After doing all calculations and analysis we have concluded that making a mould with combined cavity rather than individual cavities it is cost effective and time saving.

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