Design & Analysis of Injection Mould of Submarine Engine Part

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Abstract : Since few years ago molding process is quite difficult and time taking process. At first Drawing board and then 2D software were usedafter which patterns were made. But suitable result never gets most of time. So that cost of molding increases and time require for design is more. Due to the technological advancement the process of Mold Design has fastened and also the results are convincing. By using 3D software can create Parametric Design, Which is editable. Also can look at number of possibilities for designing a mould. In this paper design of mould done in such way that productivity will increase. Two step of product making convert in one step with modification done in mould.

IndexTerms - progressive tool, cam design, slide design, Lock Plate, Increase Productivity, Raw material.

I. INTRODUCTION

1.1 Background

Injection moulding is an extensive global manufacturing process for making simple to intricate plastic, ceramic and metal parts. Injection moulding converts wax, thermoplastics, thermo sets as well as powdered metals and magnesium into thousands of products. Injection moulding is the most commonly used manufacturing process for the fabrication of plastic parts. A wide variety of products is manufactured using injection moulding, which varies widely in their size, complexity, and application. The injection moulding process requires the use of an injection moulding machine, plastic raw material, and a mould.

Today's competitive environment demands that to survive in the market, entrepreneurs need to ensure that their products get designed and manufactured in the minimum possible time, and at the lowest cost, without compromising on the quality aspect. This means that Design, Engineering, and Production departments must work together in an integrated fashion. The advent of CAD / CAM has paved the way for a highly flexible, accurate, fast and integrated approach to creating and manufacturing products.

Nowadays, CAD and CAM capabilities are coupled together in a single software package, so as to allow us to transition smoothly from Product Design, Mould design, to CNC Programming and CNC machining. A CAD Software gives us a variety of Creation tools which allow us to proceed in a step by step way, so as to create a 3D representation of the product. These allow the creation of 2D lines, arcs, fillets and wire frames, and then enable us to use these 2D features to build 3D Surfaces or Solids. The primary surfaces created, can further be modified using Modification tools, so as to obtain the final product. Similarly, Moulds i.e. Core and Cavity for these products can also be created using the previously created geometry. Once the product models are ready, the next activity is to get them machined. The products that we see in the markets today are very complex and demand such high quality for surface finish and accuracy, which cannot be obtained by manual machining on conventional machines. We need to use High precision CAM software which gives us the simulation of machining and codes are automatically generated. After the G and M codes generated we send them to VMC Machine for Manufacturing.

Injection Moulding-Overview

Injection moulding is a manufacturing process for producing parts from both thermoplastic and thermosettingplastic materials. The material is fed into a heated barrel, mixed, and forced into a mould cavity where it cools and hardens to the configuration of the mould cavity. After a product is designed, usually by an industrial designer or an engineer, moulds are made by a (or toolmaker) from metal, usually either steel or aluminum, 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.

1.2 Fundamentals of Polymers

Polymers are a large macromolecule built up of repetition of small and simple chemical units called monomers. The polymer can be of long chain molecules or branched long chain molecules or molecules of interconnected three-dimensional networks. The repeat unit of the polymer is equivalent or nearly equivalent to the monomer or starting material from which the polymer is formed.

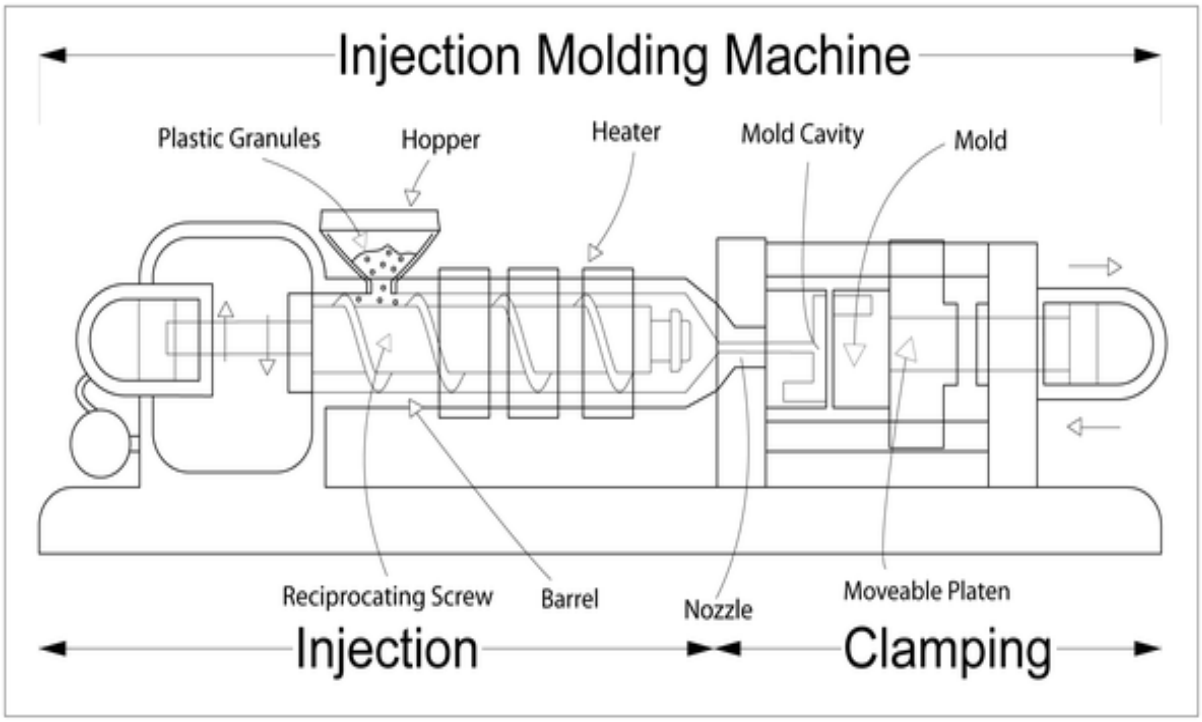

Fig1.1 Schematic Diagram of Plastic Injection moulding

1.3Thermoplastic Materials

The term plastics refer to a vast range of materials based on macromolecular organic components. Traditionally plastics have been divided into two major clarification attempts to categories plastic from the chemical structure of the polymer constituent. Sometimes based on the tonnages of plastics used, references also made to 'commodity' or large-huge plastics and specialty polymers bit this basis is purely commercial and naturally is bound to vary with time depending on usage pattern.

Mould Fabrication

The machine which is used for producing injection molded parts plays a vital role. The device must be accurate in giving correct injection pressure, molded temperature control system, proper alignment between the two plates, etc. A good injection moulding machine will give consistent good quality products. The different types of plastics materials used for producing various products must be of will grade quality. If substandard plastic raw materials are used, good quality plastic components are also assured. Process Characteristics Utilizes a ram or screw-type plunger to force molten plastic material into a mould cavity. Produces a solid or open-ended shape which has conformed to the contour of the mould. Uses thermoplastic or thermo set materials.

Produces a parting line, spur and gate marks.

1.2 Organization of Dissertation

Project Development

Design projects must always have a logical plan, to ensure that the most appropriate method is used to develop a product. The research will reveal the scope and status of any similar work conducted, which may either render the project irrelevant or help to guide the student towards the various methods by which a design problem may be tackled. After doing thorough background research into the topic – thereby gaining an appreciation of the requirements of SPMs – a comprehensive literature review of appropriate articles within the available engineering databases was compiled. Although it was important to understand the various ways that shock absorbers have been tested in the past, the literature review also revealed that the available equipment had not previously been utilized as a shock absorber test rig.

The next step in the project development was the collation of the various design ideas and concepts. After investigating the limitations of the previous Testing Machine chosen to assist in the overall design, the concepts were narrowed down to the two most appropriate designs. These were further examined according to the design requirements to ensure that the developed concept was the most suitable design for this project.

A detailed design of the chosen concept was conducted which included engineering analysis using ANSYS software. To ensure that the concept was sound and that no areas had been overlooked, the design was inspected by the supervisor, and a seminar was conducted to present the idea to the NSK Fab & Weld, body for scrutiny and constructive criticism, before being submitted for manufacturing.

II. LITERATURE REVIEW

After the G and M codes are generated we send them to VMC Machine for Manufacturing.Kuang-HuaChanget. al. have studied "3D Shape Engineering and Design Parameterization"(2011).This paper presents a brief review and technical advancement on 3D shape engineering and design parameterization in reverse engineering, in which discrete point clouds are converted into feature-based parametric solid models. Numerous efforts have been devoted to developing technology that automatically creates NURBS surface models from point clouds. Only very recently, the development was extended to support parametric solid modeling that

allows significant expansion on the scope of engineering assignments. In this paper, underlying technology that enables such advancement in 3shape engineering and design parameterization is presented.

S. Amiraa,D. Dubeet. al. have studied "method todetermine hot permeability and strength of ceramic shell moulds"(2011).The author of this paper discussing improved method to evaluate both the strength and the permeability of ceramic mould specimens under high temperature conditions. In order to maintain safe testing conditions and use lower testing pressure to prepare ceramic mould. Author using Darcy"s law for calculating Airflow, pressure drop & hot permeability& a hoop stress formula is used to calculate the hot strength from the bursting pressure. This is very simple method to implement in foundries.**J.Q.Ran** et. al. havestudied "Design of internal pins in injectionmould CAD via the automatic recognition of undercut features."(2010).Injection moulding which is an important manufacturing process in this process design plays important role, the author of this paper tell about the designing of with the help of computer (CAD).He tell that, due to development of CAD/ computer design various features are developed like identify injection pin in injection mould.Theapproach in CAD is to automatically identifying the undercut features which is first proposed. For the given parting directions, all the inner and outer undercut features are identified based on the topological relationship of geometrical entities. Determination of whether the bounding boxes of any two internal pins and the main core projection have intersection area, the deep inner undercuts are located. The complete methodology is finally implemented andverified through case studies.
Mohd.RizwanHamsinet. al.have studied**.**Author of this paper tells about runner in which he describe the design & analysis of plastic injection mould runner. This designing of runner is based on Ellis model, a viscosity model of flow network which constituting of elements &nodes. The analysis is done by FEA software, A Cross WLF viscosity model was used in the FEA analysis. This FEA simulation of injection moulding is conducted for 8 and 16 cavity runners. Runner layout is assumed as pressure at the end of each element which is acting on initial and final boundary condition. The author tells that as per boundary condition the length & size of runner can be adjusted. Due to this pressure drop is same on each gates. The final boundary condition for the first element was set as the initial boundary condition for the next element. Through this Ellis model, similarities are shown between calculated results &obtained through simulation by implementation of methodology equal time & pressure required for filling each cavity at each gate as well as uniform part filling. A predictive FEA performed prior to actual manufacturing is helpful in order to produce good moulds.

Jiaren Jiang et. al. have studied "Dimensionalvariations of castings and moulds in theceramicmould casting process"(2007).The author of this paper focusingCeramic mould process which is to produces high precision moulding at a relatively low cost for the production of small number of parts. There is a constant demand for improving the process capabilities including dimensional accuracy and consistency. In this study, dimensional changes and arability of ceramic moulds accuracy and consistency discussed using a pyramid-shaped part.Author tells that accuracy of mould plays important rolein obtaining accurate tolerances with change in dimension, location and orientation of having significant effects on the overall linear dimensional changes & variability on the mould.Author conclude that stepped pyramid-shaped part is used to determine dimensional changes of moulds and mould casting process.

C.K. Moket. al. have studied "An Internet-basedintelligent design system for injection moulds"(2006).The author of this paper focusing on the rapid growth of Internet and information technologies in recent years who provides solution to support and product developments. Thisauthor described about prototype Internet-based intelligent design system for injection moulds. The knowledge base of the system would be accessed by mould designers through interactive programs he should have intelligence and experience to design the total mould. Author approach is adopted both speeds up the design process and facilitates design standardization to increases the speed of mouldmanufacture. Here author gives case study is presented to illustrate the operations of the Internet-based mould design system

Literature gap

In project two step manufacturing process convert in single step manufacturing process by using advance design software like UG-NX. By this development, production rate get increase.

III. PROBLEMDEFINITION

To developed Design of mould and analysis into Single Stroke of injection mould.

IV. OBJECTIVE

The project that we have selected has major objective of making aware the new age technology of 3D CAD/Mould Wizard along with the CAE, due to which following activity becomes easy, Complex Mould Designs, Drawing Creation, Material Flow Simulation.

Following are the advantages of these technologies,

- Heavy Reduction in Design Time
- Reduction in Design Cost in Long term
- Optimization in Mould Design
- Easy Creation of Core & Cavity
- Standard part library for Injection Moulding
- Material Flow simulation in the Mould
- Specifying Cooling Lines

Easy location of Ejector Pins
Possibilities of Machine Tool Path Generation We can use the CAD data for creating manufacturing program using CAM i.e. Computer Aided Manufacturing.

SCOPE

- Study; verify the dimensions of plastic product. Confirmation on the dimension is precise and suitable for fabricated.
- Study function of the components and configuration of the mould. These include understand all the components in the mould and its each function.
- Development of multi-cavity mould by using most suitable manufacturing process.
- Development of transparent product.

V. MATERIAL SELECTION

- The NORYL family of modified PPE resins consists of amorphous blends of PPO (PPE) resin and polystyrene. NORYL, due to its original chemical composition, exhibits unusually low moisture absorption. Therefore, excellent electrical insulating properties are realized over a wide range of humidity and temperature conditions. Chemical attack from water, most salt solutions, acids and bases are also minimal with NORYL. The addition of glass fiber reinforcement enhances both the mechanical and thermal properties of the underlying NORYL material.
- Properties
- • Good electrical insulating properties
- Due to its extremely low water absorption with values as low as 0.07%, NORYL is an excellent electrical insulating material.
- • Long-term dimensional stability

Chemical composition:

Chemical composition for tool steel P20 Material for core & cavity supporting plates Carbon SteelApplication: Automobile Industries, Pumps, Petrochemicals and Oil & Natural Gas.
GRADE C45 is widely known for its quenching and tempering ability. This kind of steel is widely used various industries for general engineering purposes. This range is designed to withstand tremendous amount of weights and pressure. This steel plate is rust proof in their make and it has been made using the best technology available in the market and they have been priced at very reasonable rates in the market.

VI. VII. DESIGN, ANALYSIS&MANUFACTURING

Design Calculations for Mould

1. Clamping force

The clamping force (tons) available in machine control the maximum projected area of the moulding that can be produced. The Injection pressure of plastic material within the mould develops a force, which tends to open the mould. This force is proportional to projected area of the moulding and feed system and must be opposed by available clamping force.

Because of the various losses occurring in the heating cylinder nozzle and feed system only a proportion of the pressure produced by injection cylinder is transmitted to the cavity.

Total clamping force required

2. Shot weight

Weight of component = 94gms
Weight of feed system =7gms
=101gms

3. Part ejection force

Ejection pins force the part out of the mould after the part has cooled and solidified enough. As an injection moulded part shrinks, it can literally form an interference fit around mould cores, especially if the part draft angle is not sufficient.
Therefore, part ejection force (P)
Where,
= 0.00924

d =Male core diameter in mm =63.5mm.

t = Thickness of moulded part, mm = 3.175mm.
ν =Poison‟s ratio of noryl = 0.33

e =Modules of elasticity of noryl= $2.482*10^3 N/mm^2$
μ =Coefficient of friction =0.39
a =Area of contact that shrinks on core

Where,

α_p= Coefficient of thermal expansion for noryl =$3.3*10^{-5}/^oC$

T_{melt}= Melting temperature for noryl=310^oC $T_{ambient}$=Ambient temperature=30^oC

Ss= Shrinkage Allowance for carbon steel

Where,

α_s= Coefficient of thermal expansion for steel=$12.5*10^{-6}/^oC$
T_{mould}=Moulding Temperature =$190\ ^oC$

Cooling time calculation

A mould is a heat transfer device. Its purpose is to transfer the heat out of the plastic after it has been injected into the mould, and to do this as quickly as possible. The faster that a mould achieves this, the more efficient it is considered. Efficiency of a mould will also be related to how well it achieves certain mechanical functions, but the cooling portion of a moulding cycle represents a significant portion of the cycle in most applications. Based on this, a newcomer to the industry might be forgiven for thinking that moulds should always be run with chilled water. Those who have witnessed a variety of materials running will know that it is not that simple. General practice is to run the mould "as cold as possible" in order to speed up the cycle as much as possible. What are the limitations on what is "as cold as possible"?

VII. ANALYSIS USING NX

1)Simulation Modeling & Results Visualization

Reduce the time you spend preparing analysis models, and spend more time evaluating results. Quickly move from multi-CAD geometry data to a complete, run-ready analysis model using unique tools for:

- CAE Geometry Editing
- Comprehensive Meshing
- FE Assembly Management
- Multi-CAE Environments
- Simulation Results Post processing and

Reporting

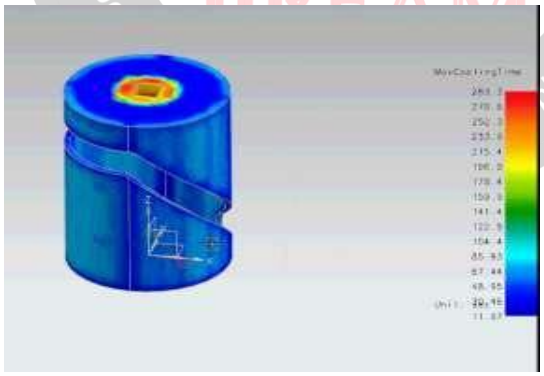

Fig7.2: cooling time calculation

The Average cooling time of liquid norly at time of mold is 45.02 sec. on basis of flow analysis which is done on UG-NX WINZAR Software.

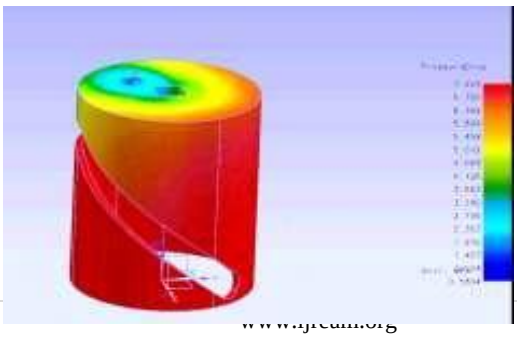

Fig7.3: Pressure drop calculation

Pressure Drop is most important Parameter at time of flow analysis. Because of exact pressure drop cavitation's will not occur in mold.

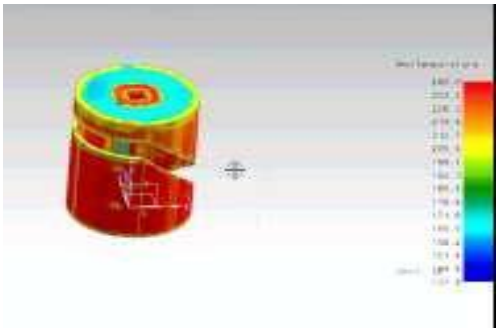

Fig7..4: maximum temperature.

At time of inject liquid norly maximum temperature will be 233 ^{o}c. at upper surface temperature will be 167^{o}c.

VIII. RESULT

Table.7.1: Result Table

Sr. No.	Parameter check	Mathematically	Analytically	Manufacturing time	Old Design	Remark
1	Cooling Time	35 sec.	45.02	46 sec	-	Satisfactory
2	Cycle Time	54 sec	-	67 sec	91 sec	Satisfactory
3	Pressure Drop	-	7.12 psi	8 psi	-	Safe
4	Max. Temperature	-	221^{o} c	234^{o}c	-	Safe
5	Product cost	-	-	43.9 Rs.	51 Rs.	Satisfactory

Result Discussion:

[1] On Basis of above table, it seen that cooling time for product is just 46 sec. so its judge as a satisfactory result.
[2] Cycle time of product get minimize up to 24 sec. production rate increases.
[3] Pressure drop also safe as per design.
[4] Max. Temperature of product also consider as Safe.

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