International Journal of Advance Research in Science and Engineering
Vol. No.5, Issue No. 02, February 2016
www.ijarse.com
IJARSE
ISSN 2319 - 8354

DESIGN & ANALYSIS OF PLASTIC INJECTION MOULD USING NX-UG & DELCAM SOFTWARE

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ABSTRACT

The injection moulding machine is a machine that melt plasticize the moulding material inside the heating cylinder and inject this into the mould tool to create the moulded product by solidifying inside it. There are several types in the injection machine. Ex. horizontal injection machine, vertical injection machine etc. In past Mould Design process was time taking as well as hectic. At first Drawing board and then 2D software were used after which patterns were made. But in this case the results were not convincing most of the times. Thus the design to market time increased immensely and also project cost required was on a higher side. Due to the technological advancement the process of Mould Design has fastened and also the results are convincing. With the help of 3D software we can create Parametric Design, which is editable. Also we can look at number of possibilities for designing a mould. Most importantly the process of Drawing Creation for Mould Design becomes very easy. In a 3D software Visualization of our creation is easy possible. Thus the design to market time shrinks immensely also the project cost required is on lower side. The paper aims at the awareness of advances of the new age technology of 3D CAD/Mould Wizard for Mould Design.

Keywords: 3D CAD/ Mould design software, Injection Moulding, Mould Design.

I. INTRODUCTION

Injection moulding is an extensive global manufacturing process for making simple to intricate plastic, ceramic and metal parts which vary greatly in their size, complexity, and application. Injection moulding converts wax, thermoplastics, thermo sets as well as powdered metals and magnesium into thousands of products.

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

Advanced CAD and CAM software package allow us the transition smoothly from Product Design, Mould design, to CNC Programming and CNC machining. A CAD Software includes a variety of Creation tools which allow us to create a 3D representation of the product. These allow creation of 2D lines, arcs, fillets and wire frames, and then allow us to use these 2D features to build 3D Surfaces or Solids. The basic 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 simulation of machining and codes are automatically generated. After the G and M codes are generated we send them to VMC Machine for Manufacturing.

II. INJECTION MOULDING OVERVIEW

Injection moulding is a manufacturing process for producing parts from both thermoplastic and thermosetting plastic materials. 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 mould 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.

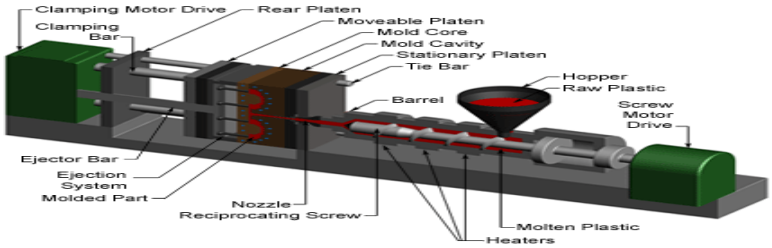

Fig. 1 Injection moulding overview

2.1 Fundamentals of Polymers

Polymers are a large macromolecule built up of repetition of small and simple chemical units called monomers. 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.

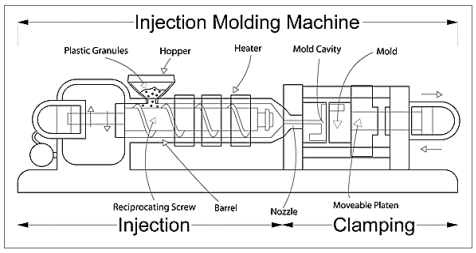

Fig. 2 Schematic Diagram of Plastic Injection Moulding

2.2 Thermoplastic Materials

The term plastics refer to a vast range of materials based on macro molecular organic components. Traditionally plastics have been divided into two major clarification attempts to categories plastic on the basis of 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.

2.3 Mould Fabrication

The machine must be accurate in giving correct injection pressure, moulded temperature control system, proper alignment between the two plates etc. A good injection moulding machine will definitely give consistent good quality products. The different types of plastics materials used for producing various products must be of good graded quality.

2.4 Process Characteristics

1. Utilizes a ram or screw-type plunger to force molten plastic material into a mould cavity.
2. Produces a solid or open-ended shape which has conformed to the contour of the mould.
3. Uses thermoplastic or thermoset materials.
4. Produces a parting line, spur and gate marks.

2.5 Advantages of Injection Moulding

1. Accuracy in weight of articles
2. Choice of desired surface finish and colors
3. Choice of ultimate strength of articles
4. Faster production and lower rejection rates
5. Faster start-up and shut down procedures
6. Minimum wastage
7. Stability of processing parameters
8. Versatility in processing different raw materials
9. Option in article sizes by changing the mould

III. METHODOLOGY

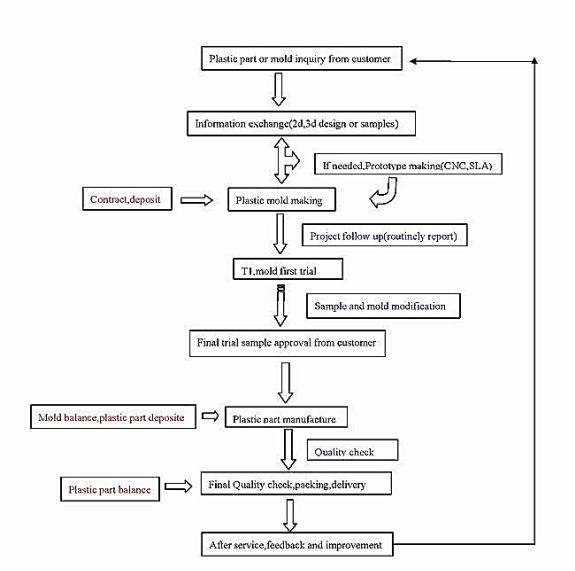

Fig. 3 Methodology

IV. PRODUCT DEVELOPMENT CYCLE

- **Modelling (CAD):** In 3D CAD i.e. Unigraphics NX (Siemens product) software we can design the product concept we can create drawing views automatically using the 3D model, we can create assembly and we can check for interferences and also we can check motion simulation.
- **Mould Wizard (MWZ):** Using mould Wizard module of Unigraphics NX (Siemens product) the process of mould Design can be done with ease as well as in least time. This wizard helps us in Creating Core & Cavity. Standard library helps us in selecting mould Base, Ejector pins, Sprue Bush, Locating Ring, Sliders, Runner gating, Cooling Lines etc. Also the Drawing Views of all the parts are created automatically which we can draft as per our requirement.
- **Mould Flow Analysis:** computer-aided engineering (CAE) simulation programs for plastics moulding processes. It is used widely by the plastics injection moulding industry. The MOULDFLOW injection moulding Simulation of polymers can provide information on the thermo-mechanical properties and residual stresses of the Part resulting from the manufacturing process.
- **Mould drawing:** In mould Wizard, there are options by selecting which we can create standard drawing views, Hole Table (Ordinate Dimensions) as well as part list as per our requirement. Also dimensioning the parts is easy. We can create section views as per our requirement.
- **Mould Manufacturing (CAM):** In CAM we can generate the CNC Codes, Specify the Tool Path, Specify Tools, Check for Collision, Check Simulation on the Part that we have designed using CAD. We can avoid the accidents that may be caused while manual programming on CNC or VMC Machines.

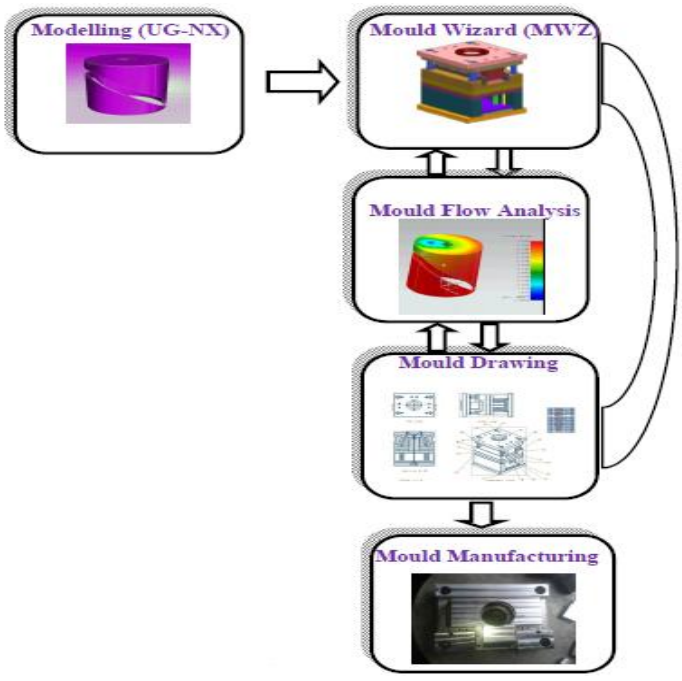

Fig.4. Product development cycle

V. MANUFACTURING OF PRODUCT

5.1 Injection Moulding Process Cycle

The process cycle for injection moulding is very short, typically between 2 seconds and 2 minutes, and consists of the following four stages:

a) Clamping

Prior to the injection of the material into the mould, the two halves of the mould must first be securely closed by the clamping unit. Each half of the mould is attached to the injection moulding machine and one half is allowed to slide. The hydraulically powered clamping unit pushes the mould halves together and exerts sufficient force to keep the mould securely closed while the material is injected. The time required to close and clamp the mould is dependent upon the machine - larger machines (those with greater clamping forces) will require more time. This time can be estimated from the dry cycle time of the machine.

b) Injection

The raw plastic material, usually in the form of pellets, is fed into the injection moulding machine, and advanced towards the mould by the injection unit. During this process, the material is melted by heat and pressure. The molten plastic is then injected into the mould very quickly and the build-up of pressure packs and holds the material. The amount of material that is injected is referred to as the shot. The injection time is difficult to calculate accurately due to the complex and changing flow of the molten plastic into the mould. However, the injection time can be estimated by the shot volume, injection pressure, and injection power.

c) Cooling

The molten plastic that is inside the mould begins to cool as soon as it makes contact with the interior mould surfaces. As the plastic cools, it will solidify into the shape of the desired part. However, during cooling some shrinkage of the part may occur. The packing of material in the injection stage allows additional material to flow into the mould and reduce the amount of visible shrinkage. The mould cannot be opened until the required cooling time has elapsed. The cooling time can be estimated from several thermodynamic properties of the plastic and the maximum wall thickness of the part.

d) Ejection:

After sufficient time has passed, the cooled part may be ejected from the mould by the ejection system, which is attached to the rear half of the mould. When the mould is opened, a mechanism is used to push the part out of the mould. Force must be applied to eject the part because during cooling the part shrinks and adheres to the mould. In order to facilitate the ejection of the part, a mould release agent can be sprayed onto the surfaces of the mould cavity prior to injection of the material. Once the part is ejected, the mould can be clamped shut for the next shot to be injected. After the injection moulding cycle, some post processing is typically required. During cooling, the material in the channels of the mould will solidify attached to the part. This excess material, along with any flash that has occurred, must be trimmed from the part, typically by using cutters. For some types of material, such as thermoplastics, the scrap material that results from this trimming can be recycled by being placed into a plastic grinder, also called regrind machines or granulators, which regrinds the scrap material into pellets. Due to some degradation of the material properties, the regrind must be mixed with raw material in the proper regrind ratio to be reused in the injection moulding process.

VI. INSPECTION REPORT

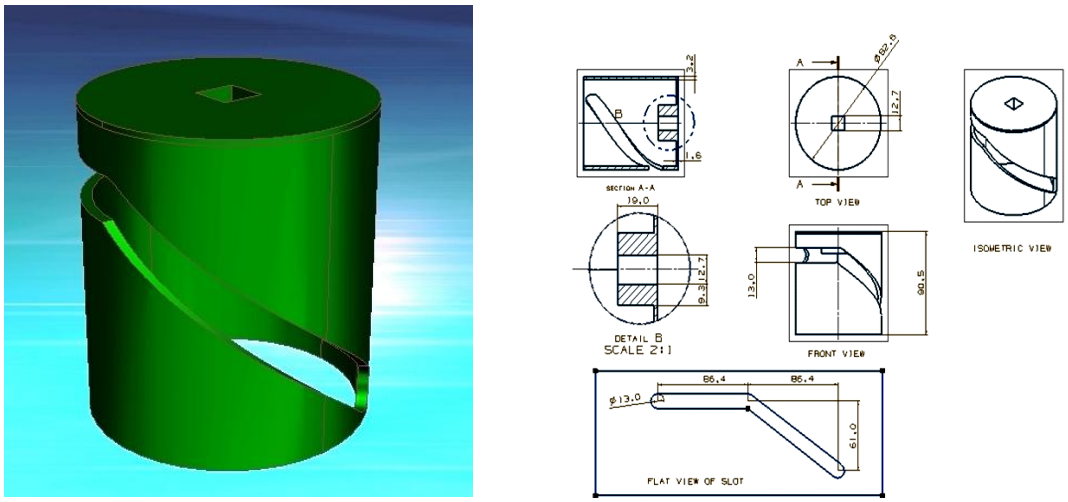

Fig.5 Inspection Report

VII. CONCLUSION

The design of the product using Unigraphics (NX 6) software is done and the analysis using NX-Mouldflow software and design of the mould using NX-Mould Wizard. The manufacture of the mould using Delcam-PowerMILL software.

From this new design of mould following results are obtained-Increase in quality of product, Reduction in design time, Production cost per unit decreased, Increase in profit, Material saving, Reduction in design cost.

The results reveal that the new age technology of 3D CAD/Mould Wizard along with the CAE makes Complex Mould Designs, Drawing Creation, Material Flow Simulation easier and fast.

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