DESIGN AND SIMULATION OF PLASTIC INJECTION MOLDING PROCESS BY USING ANSYS

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ABSTRACT:
This paper presents the design and simulations of plastic injection mould for producing a plastic products. The plastic part was designed into two different types of product, but in the same usage function. One half is exploitation clip function and another half is exploitation tick function. Within the Computer-Aided designing (CAD), 2 plastic parts were drawn in three completely different dimensional views (3D) by exploitation SIEMENS eight.0 parametric software. Computer-Aided Manufacturing (CAM), DELCAM 12.0 software was used to develop the simulations in machining program. For mould design, the product was designed into two changeable inserts to produce two different types of plastic product in one mould base. Before proceeding to injection machine and mould design, this part was analyzed and simulated by using ANSYS 15.0. From the analysis and simulation we can define the most suitable injection location, material temperature and pressure for injection.

Keywords: *Changeable insert mould, injection pressure, air traps, injection location, mould design.*

INTRODUCTION
Due to the many inherent advantages in using plastic materials, there is an ongoing trend of replacing metal with injection-molded plastic parts in a wide variety of applications. More and more parts with critical end-use application requirements are becoming candidates for conversion to plastics. Plastics ar light-weight, sturdy and corrosion-resistant; have a high strength-to-weight ratio; and, once employed in transportation applications, for instance, provide one amongst the best ways in which to extend fuel savings by making vehicles additional light-weight. As plastics replace metals, the elements must be designed to take into account the properties of the preciseicular plastic relative to the appliance requirements the orientation direction and also the degree of orientation of the fibers verify the mechanical properties of the shaped part. In areas where the fibers are more randomly oriented, the material will not achieve maximum strength, though the strength properties will not depend as much on the loading direction, creating a more isotropic like material.

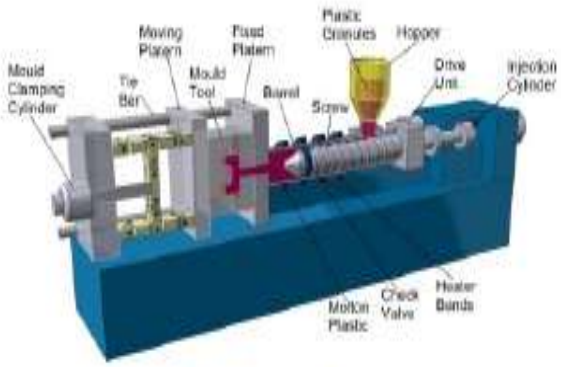


Fig. 1.1 Injection Moulding Machine

UNI-GRAPHICS Siemens 8.0:

Uni-graphics software is one of the world's most advanced and tightly integrated CAD/CAM/CAE software package developed by Siemens PLM Software, offers several pre-packaged Mach Series solutions for NC machining. Available in a range of capability levels, these solutions accelerate programming and improve productivity for a variety of typical manufacturing challenges, from basic machining to complex, multiple-axis and multi-function machining, as well as mould and die manufacturing it also merges solid and surface modeling techniques into one powerful tool set. The packages include complete capabilities for geometry import, CAD modeling and drafting, full associatively to part designs, NC tool path creation, verification and post processing, along with productivity tools that streamline the overall machining process.

OBJECTIVES

1. Study about the preparation of core inserts.
2. Preparation of single mould base for multi-purpose usage with the change of insert.
3. Design of component and mold base by using Siemens 8.0 mold wizard.
4. Manufacturing simulations and programming generation of mold bases and inserts by using Delcam10.0.
4. The flow analysis will be observed and simulations will generate with different temperatures and pressures by using Ansys.

LITERATURE SURVEY

Y.K. Shen, Y. J. Shie, and W. Y. Wu [7]: Microinjection is a branch of micro system technology. This paper employs analysis software to simulate three plastic materials (PP, PA, and POM) and four injection process parameters (injection time, mold temperature, injection temperature, and injection pressure) and applies them in simulation microinjection with the assistance of the Taguchi method, which is adopted in this paper. Further, the influences of these three plastic materials and four injection process parameters on microinjection moulding are analyzed. Through the simulation results, it is known that among the microinjection process parameters mold temperature is the most important moulding parameter. Also, during the microinjection process, mold temperature must be raised to be higher than the traditional mold temperature to prevent short shot that occurs when the melt 11 cools down too rapidly or when the melt's temperature is insufficient.

Y. K. Shen and W. Y. Wu [8]: Micro system technology enables product miniaturization, diversifies product functions, and improves quality, reliability and added value. This paper employs mold flow software to analyze three plastic materials (PP, PA, POM) and four injection moulding parameters (injection time, mold temperature, injection temperature, and injection pressure) and applies them in simulation microinjection moulding. During the process, the Taguchi method is used alternatively. All these are to obtain a better understanding of the relation between the three plastic materials as well as the four injection moulding parameters and microinjection moulding. Through the simulation results, it is known that mold temperature is the most important factor among the injection moulding parameters. Moreover, the mold temperature of microinjection moulding should be raised to be higher than the glass transformation temperature of the plastic material to avail the injection moulding of products. Y.

K. Shen, S. L. Yeh, and S. H. Chen [9]: Microinjection moulding is a branch of micro electro-mechanical system technology. This paper employs mold flow analysis software and draws a plan of simulation experiment items: three plastic materials (PS, PC, PMMA) and four moulding parameters (injection time, mold temperature, injection temperature, and injection pressure). The finite element method is used with the Taguchi method in microinjection moulding mainly to analyze the critical factors in the relation between the three plastic materials as well as the four injection moulding parameters and microinjection moulding. Two points about microinjection process are known through the simulation results: First, among the injection moulding parameters, mold temperature is the most important factor, and the next in importance is injection temperature

Nelida Gracia, Esther Gonzalez, Juan Baselga, and Julio Bravo [10]: This paper uses ABS plastic materials of different levels and designs different values of thickness. C-MOLD is employed with the Taguchi method to simulate and find out the values of the injection temperature and injection pressure of the three plastic materials. The results of these three plastic materials differ according to their inherent characteristics. However, these plastic materials of different levels have one characteristic in common—that is, when thickness falls between 0.36~0.39mm, temperature variations are most in quantity.

L. Sridhar and K. A. Narh [11]: Industrial plastic polymers fall into two types—PS and 13 PET. PS is a plastic material that has low shrinkage rate, so products of precise size can be obtained. However, if the product to be made is small and high-precision, PET is the one to be used. This is because most precision products need to undergo the SMT manufacturing process and endure temperature higher than 250℃, and PET is famed for its high impact strength, tensile strength, flexural strength, and broad temperature range. It is suitable for products that are small and high-precision.

MATERIALS AND METHODOLOGY

<u>Component 2d drawing with NX8.0 design</u>

The efficient simulation of a given process requires knowledge from the application discipline (natural sciences or engineering), from mathematics (analysis and numerical mathematics) and from computer science. A number of very successful techniques for the solution of partial differential equations (PDEs), especially adaptive mesh refinement and multigrid methods have been developed by mathematicians in the past decades. The enormous advancement of computer technology, especially the development of large parallel computers leads to new possibilities.

However, the usage of all these techniques in complex applications has not been so easy. This is due to the enormous complexity and the interdisciplinary knowledge that is required to combine all these methods. Finally the software implementation became increasingly complex to the order that it cannot be managed by a single person.

DESIGNING PROCEDURE

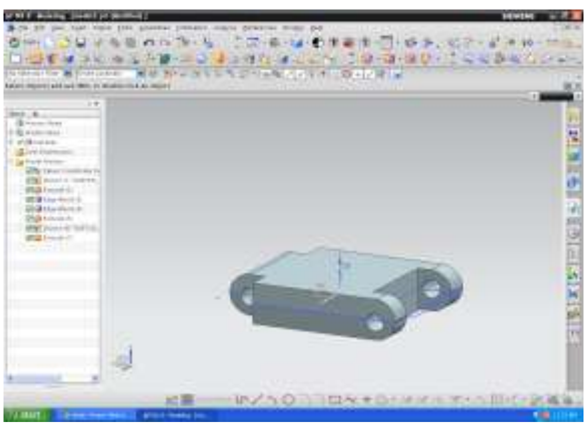


Fig 2 shows the 3d component with model tree

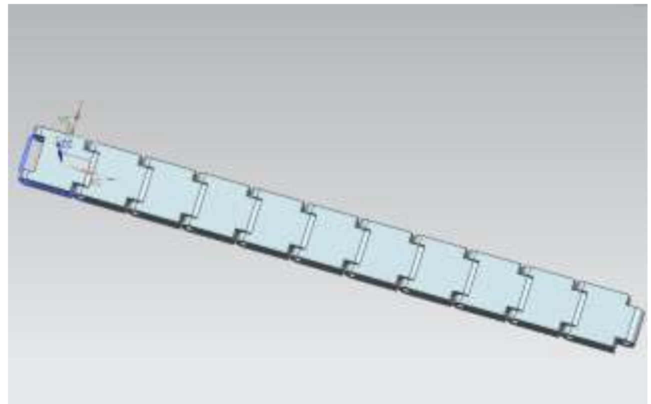
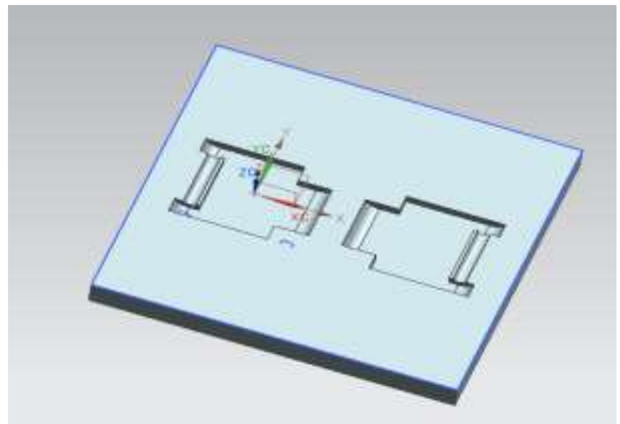


Fig 3 3d assembly of conveyor chain



`Fig 4 . mold cavity

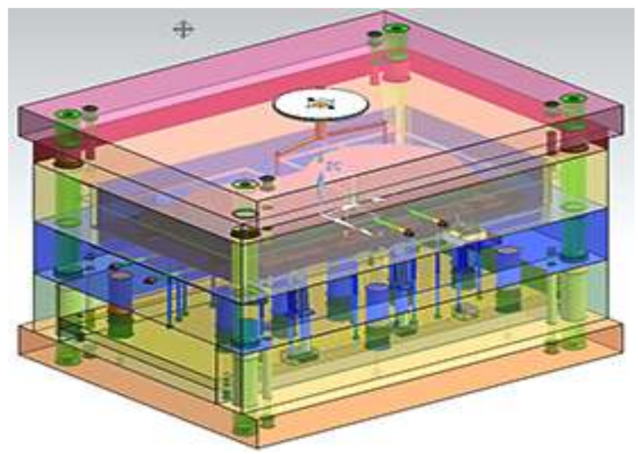


Fig 7shows the assembly of Mold with ejection

Introduction to CNC machining

Numerical control (NC) is the automation of machine tools that are operated by precisely programmed commands encoded on a storage medium, as opposed to controlled manually via hand wheels or levers, or mechanically automated via cams alone. Most NC today is computer numerical control (CNC), in which computers play an integral part of the control.

In modern CNC systems, end-to-end part design is extremely machine-controlled victimisation computer-aided design (CAD) and computer-aided manufacturing (CAM) programs. The programs produce a data file that's interpreted to extract the commands required to work a selected machine via a post processor, and so loaded into the CNC machines for production. Since any particular part would possibly need the utilization of variety of various tools drills, saws, etc. trendy machines typically mix multiple tools into one "cell". In alternative installations, variety of various machines area unit used with an external controller and human or robotic operators that move the part from machine to machine. In either case, the series of steps required to supply any part is extremely automated and produces a part that closely matches the original CAD design.

CNC like systems area unit currently used for any process that may be described as a series of movements and operations. These include laser cutting, welding, friction stir welding, ultrasonic welding, flame and plasma cutting, bending, spinning, hole-punching, pinning, gluing, fabric cutting, sewing, tape and fiber placement, routing, choosing and placing (PnP), and sawing.

Some of the CNC Machines

Mills

CNC mills use computer controls to cut different materials. They are able to translate programs consisting of specific number and letters to move the spindle to various locations and depths. Many use G-code, which is a standardized programming language that many CNC machines understand, while others use proprietary languages created by their manufacturers. These proprietary languages while often simpler than G-code are not transferable to other machines.

Lathes

Lathes are machines that cut spinning pieces of metal. CNC lathes are able to make fast, precision cuts using index able tools and drills with complicated programs for parts that normally cannot be cut on manual lathes. These machines often include 12 tool holders and coolant pumps to cut down on tool wear. CNC lathes have similar control specifications to CNC mills and can often read G-code as well as the manufacturer's proprietary programming language.

Plasma cutters

Plasma cutting involves cutting a material using a plasma torch. It is commonly used to cut steel and other metals, but can be used on a variety of materials. In this process, gas (such as compressed air) is blown at high speed out of a nozzle; at the same time an electrical arc is formed through that gas from the nozzle to the surface being cut, turning some of that gas to plasma. The plasma is sufficiently hot to melt the material being cut and moves sufficiently fast to blow molten metal away from the cut.

Electric discharge machining

Electric discharge machining (EDM), sometimes colloquially also referred to as spark machining, spark eroding, burning, die sinking, or wire erosion, is a manufacturing process in which a desired shape is obtained using electrical discharges (sparks). Material is removed from the work piece by a series of rapidly recurring current discharges between two electrodes, separated by a dielectric fluid and subject to an electric voltage. One of the electrodes is called the tool-electrode, or simply the 'tool' or 'electrode', while the other is called the work piece-electrode, or 'work piece'.

When the distance between the two electrodes is reduced, the intensity of the electric field in the space between the electrodes becomes greater than the strength of the dielectric (at least in some point(s)), which breaks, allowing current to flow between the two electrodes. This phenomenon is the same as the breakdown of a capacitor. As a result, material is removed from both the electrodes.

CNC Machine Programming

The way an operator tells the machine what exactly to do is through specialized programming. The program is written with a bunch of sentence like commands. Every single command is composed of particular CNC words which have both a letter and number element. The letter describes the "kind" and the number describes the "value." These instructions are literally step-by-step guidelines on what the machine should do at any given point in the machining process.

Someone called a CNC programmer must first visualize the entire process as it would happen during implementation. Then they would need to insert those steps into the program via the different available commands/words.

INTRODUCTION TO UG CAM

Application-specific software significantly improves the productivity of the NC programmer compared to the use of generic functions. Turbo-machinery milling With NX, you can reduce programming effort by applying specialized 5-axis NC programming operations for complex multi-bladed rotational parts, such as blisks and impellers. Simultaneous 5-axis roughing enables you to efficiently remove material between the blades by specifying parameters, such as cut level offsets, drive pattern and tool axis.

CAD-CAM-CNC process chain

To maximize the value of a machine tool, you need to optimize the process that drives it. A tightly connected overall process leads to faster deployment of a new machine and greater production efficiency.

CAD

The manufacturing process starts with input from the part design data – usually a 3D CAD model, but in some instances from a 2D drawing. 3D CAD software often is needed to prepare or adjust the part design model to make it ready for NC programming. CAD applications can also be used to design and assemble fixtures. NX CAM packages are available with fully integrated CAD functions – all in the same NX system.

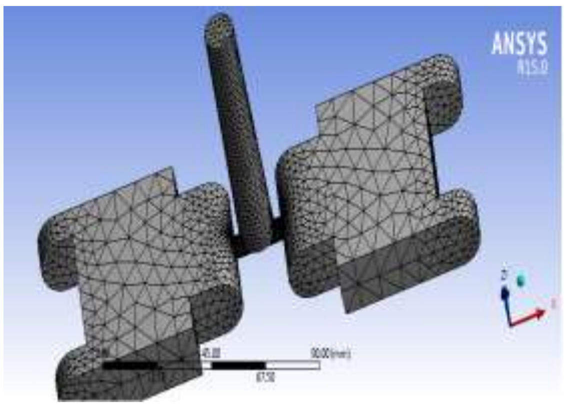
CAM

NX CAM includes NC programming, post-processing and machine tool simulation. In an optimized process chain each of these CAM elements is configured to match the target machine tools.

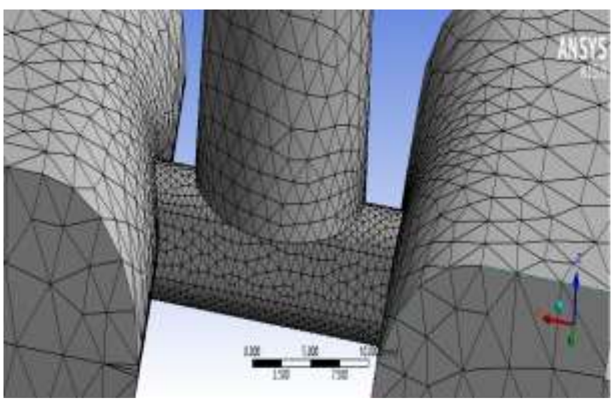
Table 1: Mesh Report

Defaults	
Physics Preference	CFD
Solver Preference	Fluent
Sizing	
Use Advanced Size Function	On: Curvature
Relevance Center	Coarse
Initial Size Seed	Active Assembly
Smoothing	Medium
Transition	Slow
Span Angle Center	Fine
Curvature Normal Angle	Default (18.0 °)
Min Size	Default (0.104460 mm)
Max Face Size	Default (10.4460 mm)
Max Size	Default (20.8920 mm)
Growth Rate	Default (1.20)
Minimum Edge Length	0.314290 mm
Patch Conforming Options	
Triangle Surface Mesher	Program Controlled
Patch Independent Options	
Topology Checking	Yes
Advanced	
Number of CPUs for Parallel Part Meshing	Program Controlled
Shape Checking	CFD
Element Midside Nodes	Dropped
Straight Sided Elements	
Number of Retries	0
Extra Retries For Assembly	Yes
Rigid Body Behavior	Dimensionally Reduced
Mesh Morphing	Disabled
Defeaturing	

Pinch Tolerance	Default (9.4013e-002 mm)
Generate Pinch on Refresh	No
Automatic Mesh Based Defeaturing	On
Defeaturing Tolerance	Default (5.223e-002 mm)
Statistics	
Nodes	11310
Elements	53919
Mesh Metric	None



Meshed model



Zoomed Meshed Model at the Gates

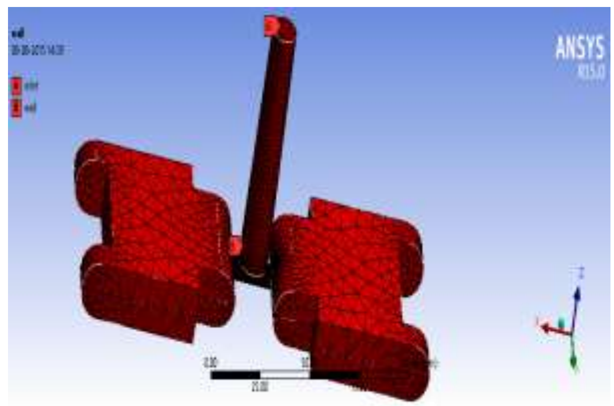
A 3-Dimension tetrahedron mesh element was used for meshing the Mold

BOUNDARY CONDITIONS

Flow inlet and wall has been defined as boundary conditions.

Mass Flow rate of 0.05kg/sec was assigned and no slip stationary wall for the wall.

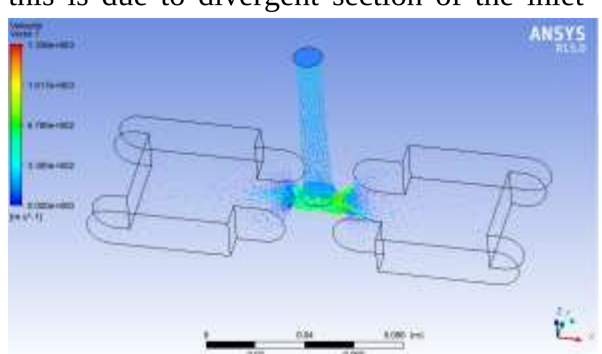
Inlet temperature of 400K was used.



Boundary Conditions

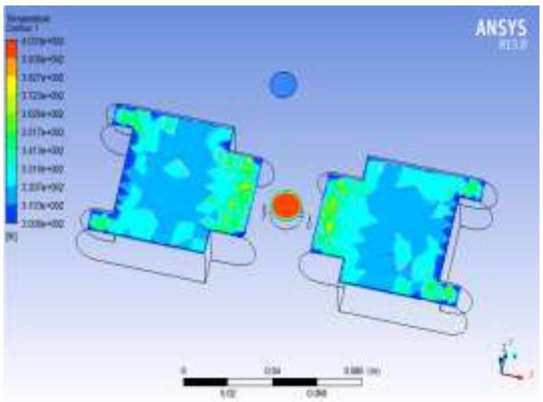
ANSYS RESULTS AND DISCUSSIONS

Figure shows the velocity vectors across the mold. The velocity was initially decreased and then increased at the mouth of the mold this is due to divergent section of the inlet



Velocity Vectors across mold

Figure shows the temperature contours across the horizontal plane defined at the Top of the mold, Maximum temperature of 403K was observed at the exit of the inlet and was reduced to 300K at the walls.

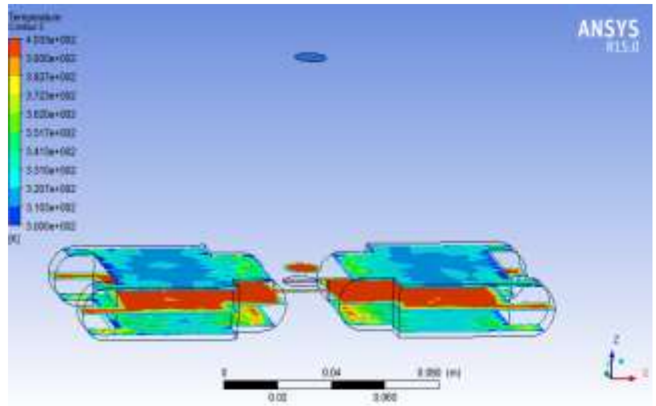


Temperature Contours in the horizontal plane at the Top section of the mold

Figure shows the variation of temperature across the horizontal plane at the midlle section of the Mold , The area of maximum temperature was found to be more at this section. Maximum temperature as previously said it was found to be 403K.

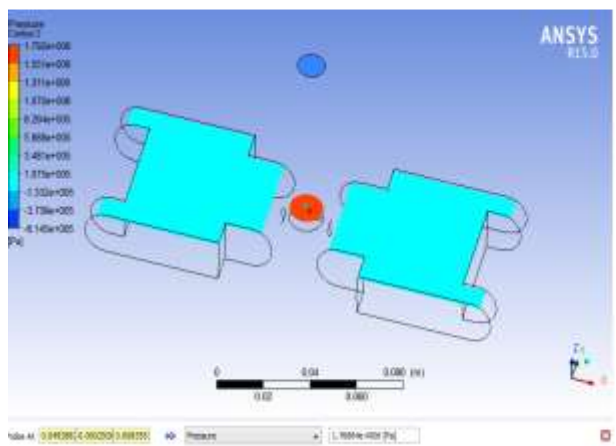
Figure below shows the temperature contours at the horizontal planes For the 3 sections at top bottom and centre of the mold.

It was observed that the Maximum temperature area was more at the center plane then in the bottom plane then in the top plane. This was due to the placing of the inlet exit at the center plane of the mold.



Temperature Contours in the horizontal plane at the Top middle and bottom section of the Mold

Figure shows the presuure variation at the exit of the inlet, The maximum pressure of injection was found to be 1.792Mpa at the exit of the inlet. A Probe is used to measure the pressure at the point in ansys workbench



Pressure Probe at the gate of the Mold

RESULTS

Research shows that the integrated using software ANSYS Workbench as injection molds stiffness and strength analysis tools, which can comprehensively reflect the cavity' s force and distortion situation in injection molding process, thus providing scientific and reliable theoretical foundation for mold design and condition for subsequent development of injection mold stiffness and strength analysis system.

CONCLUSIONS

1. In making the mold it was necessary to have the best possible product design So that it won't complicate the mold designing process.

2. With all the necessary dimensions and by the help of UNI-Graphics product design was achieved. In this phase there were lots of ups and downs in trying to figure out what the best closing system for the wallet might be, a lot of designs were drawn due to the fact that wallet closing system complication complicates the mold design which intern complicates the manufacturing process of the mold, In this thesis it was crucial to find out if there were any defects in the product design and also finding out some important values like material selection, Fill time, Fill pattern and Clamping force.

3. By using the simulation and analysis software Mold flow the above values have been achieved and there were no defects found on the product design.

FUTURE SCOPE

Further researches can be done on the above designs stage to put the layout of a Cooling system for the mold. The function of the cooling system of a plastic injection mold is to provide thermal regulation in the injection molding process. As the cooling phase generally accounts for about two-thirds of the total cycle time of the injection molding process, efficient cooling is very important to the productivity of the process.

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