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EXPERIMENTAL INVESTIGATION OF PLASTIC SWITCH BOX BASE USED TO FIND OUT THE OPTIMUM SHRINKAGE VALUE

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Abstract:

As population increases with the expanding popular for delivering the plastic items in various and sizes with high accuracy. A contextual analysis on plastic Electrical switch box is considered to research on creating best nature of items to fulfill the requests from the clients.

In this theory, the emphasis on the streamlining of process parameters (temperature, weight, time) is done for injection molding machine. Design approach, Delivery of manufacturing techniques and Nature of trademark (shrinkage) of the injection moldings product is made by polycarbonate material is ascertained by utilizing MINITAB programming for the information got. Correlation of the Experimental information and Analytical outcomes demonstrate that there is no noteworthy contrast in artificial neural system, and TAGUCHI strategy was utilized certainly. An Analytical approach is (static, Fatigue, Thermal and CFD investigation) talked about by utilizing Ansys programming and the model of part configuration, cooling profile, Assembling, Runner and gate area is done in 3D demonstrating software in CREO.

1. INTRODUCTION

The plastic enterprise plays very foremost role within the financial process of any nation. Seeing that steel and their alloys are mostly rarely available on the planet. Hence, to produce plastic products and add-ons, Polymer substances offer a colossal type of advantages similar to excessive force-to-weight ratio, excessive transparency, excessive flexibility, recyclability, corrosion resistance, and quick processing times, which make them very attractive components. A principal utility of polymer refers back to the obvious products in auto and aerospace industries, for illustration automobile window, plane windshield, and astronaut viewing window. In these distinctive applications, the destruction of merchandise precipitated by using making use of immoderate pace impacting is likely one of the most long-established threatens. In view that that fifty% plastic products are manufactured by way of injection molding process. For creation of higher quality product, we have got to control satisfactory qualities and efficiency of the product.

1.1 Position of Injection molding computing

The approach begins with a specific plastic compound which is most traditionally provided as pellets. These pellets are put into a hopper on the injection molding computing device and the pellets are then transferred to the electrically heated barrel. Inside the barrel, a screw is placed and when the screw is rotating, the pellets are melted because of the warmness generated with the help of the friction between the barrel wall and the screw. The rotation of the screw feeds the partly molten pellets ahead, and the screw is even as moved backwards by way of the accumulation of the melt in entrance of the screw tip.

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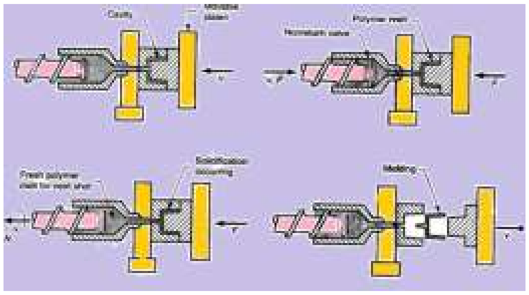

Fig1: Injection moldings computing device procedure

2. LITERATURE SURVY

Alireza Akbarzadeh and Mohammad Sadeghi et.Al.[1] was once recounted that Parameter be informed in Plastic Injection Moulding technique utilising Statistical approaches and IWO Algorithm. In these mathematical items is picking outcome of key system input variables on shrinkage for polypropylene (PP) and polystyrene (PS) components are investigated.

The relationship between input and output of the method is studied using regression system and analysis of Variance (ANOVA) method. To do this, present knowledge is used. The chosen enter parameters are melting temperature, injection pressure, packing pressure and packing time. Effect of these parameters on the shrinkage of above stated components is studied utilizing mathematical modeling. To verify validity of the PP and PS fabric, correlation coefficient of every model is calculated and the fine mannequin is chosen. Ultimately, most appropriate levels of the input parameters that diminish shrinkage, for each and every material are decided. The optimization outcome exhibit that the proposed units and algorithm are amazing in fixing the stated shrinkage foremost issue.

3. IDENTIFICATION AND RECTIFICATION

Many of the injection moldings machine industries faces the quandary of shrinkage defects brought about due to wrong design of dies, or due to fallacious parameters corresponding to material decision, injection stress, melting temperature, cycle time, cooling circuits and other such parameters.

The defects after the manufacturing and production is a loss to the corporation due to the fact it results in the turn out to be of mildew design and manufacturing which taken once more time there by means of growing the overall lead time. If the lead time increases, there is a likelihood of purchaser dissatisfaction for extra collaboration. These varieties of problems are confronted at on the whole manufacturing of injection moulds and die-casting die items.

Procedure /planning sheet

S.no	Type of work	Using software/equipment	Working period	Remarks/ Status
1.	Model Design	UNIGRAPHICS	4 to 6 days	NX-9
2.	Analysis	ANSYS (Workbench-14)- software		
		Static Analysis - stress, strain, deformation	1-2 days	-------
		Thermal Analysis – Heat flux	1-2days	Transient
		CFD Analysis – melting and cooling temperatures	2-3 days	Fluent
3.	Manufacturing process	CNC, EDM, wire-cut Conventional machines etc....	25-30 days	At Industry
4.	Production process	Injection moulding machine	1-2days	120 ton M/c
5.	Applying principle	ANN - Taguchi method (MINITAB Software)	3-4 days	Analytical results
6.	Test results	Coordinate Measuring Machine (CMM) Machine	2-3 days	CMM Inspection
Total duration of time			55-60days	

4. DESIGN PROGRAM REQUIREMENT AND USES

Mould

A mould or mildew is a hollowed-out block that is full of a liquid or pliable material like plastic, glass, steel, or ceramic uncooked materials. The liquid hardens or items in the course of the mould, adopting its form.

Molding or moulding is the method of producing by means of making use of shaping liquid or pliable raw fabric utilizing an inflexible body known as a mildew or matrix. This is itself could have been made utilizing a sample or model of the superb object.

Modeling method

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The 3D model of element Electrical change field Base is modeled inside the parametric application UNIGRAPHICS. The aspect Base is likely one of the predominant section used within the PCB controlling and monitoring of the switches. The detail material is Polycarbonate. Wall- thickness of the part is 2.5mm Element material is Polycarbonate. Wall- thickness of the aspect is 2.5mm

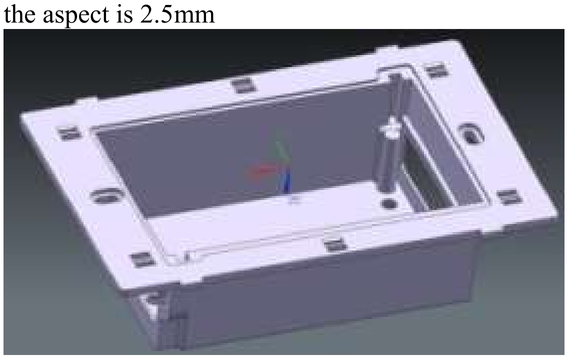

Fig 4.1 - Top view of model

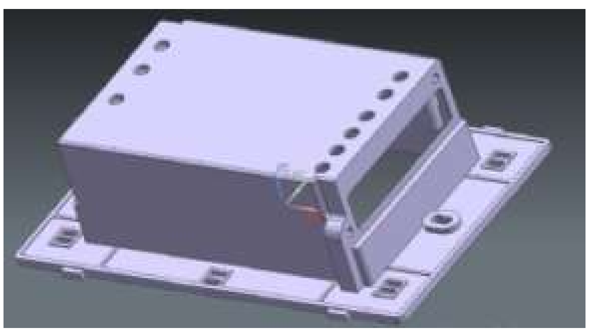

Fig 4.2 - Bottom view of model

Basic mould construction

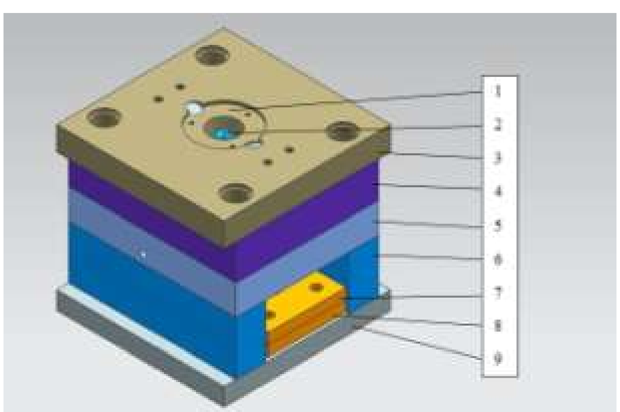

Fig 4.3 - The Basic mould construction

Shrinkage allowance

With the intention to perform the design of molds for plastic injection molding, it is vital to examine the molding shrinkage ratio. On this course, tough guides of the molding shrinkage ratios are defined for the common plastic materials utilized in injection molding.

Plastic material name	Shrinkage ratio (%)	Cavity surface temperature (℃)	Injection molding pressure	
			(kgf/cm²)	Mpa
Acrylonitrile Butadiene Styrene polymer (ABS)	0.4-0.9	50-80	550-1750	53.97-171.7
Polystyrene (PS)	0.4-0.7	20-60	700-2100	68.69-206.1
Poly propylene (PP)	1.0-2.5	20-90	700-1400	68.69-137.8
PP with 40% glass fibers	0.2-0.8	20-90	700-1400	68.69-137.8
High density polyethylene (HDPE)	2.0-6.0	10-60	700-1400	68.69-137.8
Polyamide (Nylon 66)	0.8-1.5	30-90	350-1400	34.34-137.4
Polycarbonate (PC)	0.5-0.7	80-120	700-1400	68.69-137.8

5. INTRODUCTION TO ANSYS

ANSYS is common-rationale finite detail analysis (FEA) software bundle. Finite facet analysis is a numerical method of deconstructing a complex method into very small parts (of man or woman-targeted dimension) often called causes. The appliance implements equations that govern the behavior of these factors and solves all of them; making a complete rationalization of how the approach acts as a whole. These results then will also be offered in tabulated, or graphical types. This type of evaluation is absolutely used for the design and optimization of a system some distance too complicated to research by way of hand. Procedures that can healthy into this classification are too complex as a result of their geometry, scale, or governing equations.

CFD evaluation of change field base

The molten metal glide behavior is analyzed utilizing analysis software ANSYS Fluent. FLUENT can be

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used to remedy fluid go with the flow problems involving solidification and/or melting taking situation at one temperature (e.g., in pure metals) or over a variety of temperatures (e.g., in binary alloys).

The foremost inputs to be offered for analysis are

1. Thermo bodily homes similar to density, distinct warmth, thermal conductivity, die material, and temperatures.

2. Boundary stipulations corresponding to inlet velocity, fill time, die temperature and molten metal temperature. The molten metal is Polycarbonate. The residences of the molten steel used in the analysis are shown below within the table:

Table - Polycarbonate Material Property

PROPERTY	VALUE
Density (g/cm^3)	1.20-1.22
Specific Heat (J/kg K)	1200
Thermal Conductivity (W/mK)	0.19 – 0.22
Viscosity (psi)	6894.757

The input parameters which effects the flow behaviour of molten metal considered in this analysis are molten metal temperature, die temperature and velocity of flow, fill time. In these parameters, the molten metal temperature and velocity of flow are kept constant. The die temperature and fill time are varied. The parameters specified are shown in the below table:

Molten Metal Temperature (K)	573
Velocity (m/s)	55
Fill Time (Secs)	10, 12, 14
Die Temperature (K)	70,90,120

Table - Parameters

Steps for the Solidification/ melting (flow analysis) using fluent

Open Ansys Workbench – Double Click Fluent. in this using model from the UNIGRAPHICS software is converted to IGES format and imported in to the Ansys Workbench. Edit the Mesh details in the workbench environment.

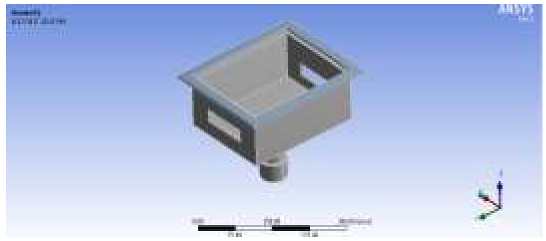

Fig 5the geometry of the component

Meshing is generated using fine mesh to divide in to no. of finite elements. The density of the mesh is specified by no. of nodes and elements are entered

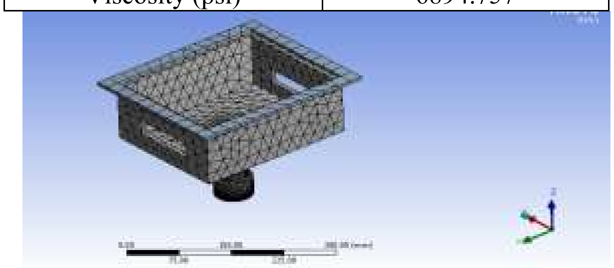

Fig 5.2 Meshed model

After meshing, the geometries are to be selected for the inlet, convection. The molten metal inlet is given at the top of the sprue bush, convection is on the outer. The respective figures are shown in fig

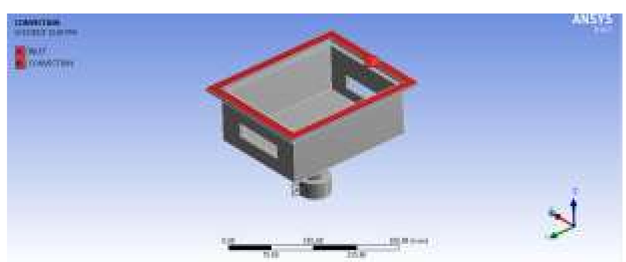

Fig 5.3 Boundary Conditions

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Entering the fluent environment for running the fluid analysis

Double click the Setup in the Workbench Environment to enter in to the fluent environment. When the fluent environment is opened, select pressure based and transient to calculate results based on the time.

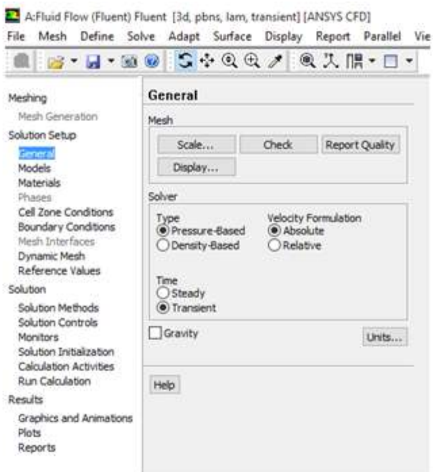

Fig 5.4 - Entering the fluent environment for the fluid analysis

Prompt the Solidification/Melting in units and Enter smooth parameter as one zero five. The enthalpy-porosity manner treats the soft region (partially solidified region) as a porous medium. The porosity in every telephone is about equal to the liquid fraction in that mobile. In thoroughly solidified regions, the porosity is equal to zero, which extinguishes the velocities in these areas. The momentum sink due to the lowered porosity in the soft zone takes the next type:

where is the liquid volume fraction, is a small number (0.001) to prevent division with the aid of zero, is the soft zone regular, and is the solid velocity as a result of the pulling of solidified material out of the domain (additionally referred to as the pull speed).

The gentle zone steady measures the amplitude of the damping; the higher this value, the steeper the transition of the speed of the fabric to zero because it solidifies. Very gigantic values may just intent the option to oscillate. Enter the material homes of the molten metallic. The properties are distinctive above. Set the boundary conditions.

Select Inlet – Velocity – 30m/s and Temperature – 573K.

Select Convection – Select Walls – Select thermal and Enter Die Temperature, which is varied. Initialize the solution with the filling time and run the calculations. The no. of iterations run by solving the analysis is shown in fig:

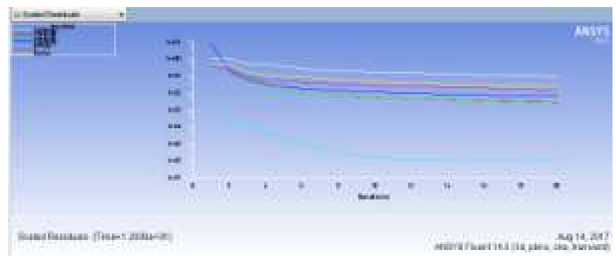

Fig 5.5 iterations graph

Results & Discussions

The molten metal flow behavior after analysis is investigated by extracting the outputs temperature distribution during filling, pressure and liquid fraction. The Table specifies the different cases performed in the analysis. The following are the figures of the specified outputs at different cases.

FILL TIME(Secs)	MELTING TEMPERATURE (K)
14	573
12	573
10	573

The following are the figures of the specified outputs at different cases.

CASE A – Temperature – 573K, Fill time – 14secs

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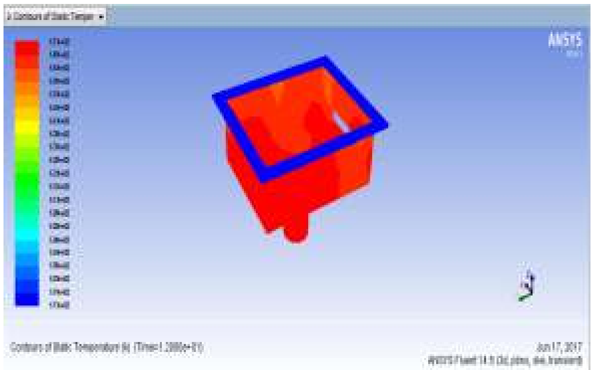

Fig 5.6 Static Temperature

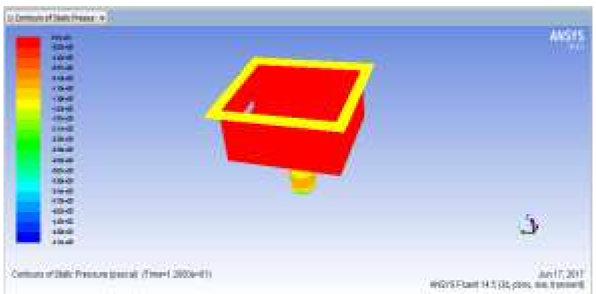

Fig 5.6.1 Pressure

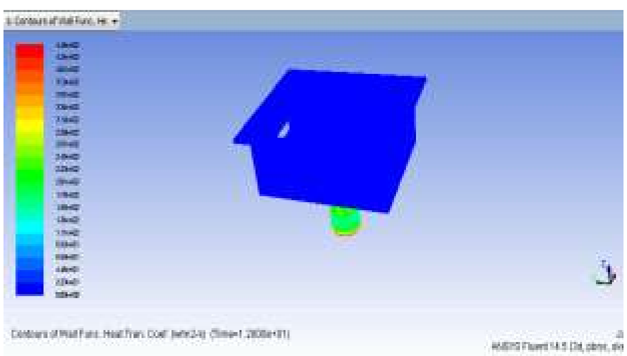

Fig 5.6.2 Liquid Fraction at 14seconds

Results Table

The Input parameters Molten Metal Temperature – 300^0C (573K)

Input Velocity - 30m/s

FILLING TIME (Secs)	TEMPERATURE (K)	PRESSURE (Pa)
14	573	$3.51e^{+01}$
12	573	$3.56\ e^{+01}$
10	573	$3.47\ e^{+01}$

Table - Results of Pressure at different filling times and die temperatures

In this Results, the optimum filling time, injection pressure and die temperature for better solidification of the filling material are analyzed by taking the input parameters molten metal temperature, velocity at sprue , injection time and die temperature.

Solidification analysis is done in Ansys CFD. From the results, the following conclusions can be made:

The better solidification occurs at 12secs injection time, 3.56 e^{+01} Pa pressure and 300^0C die temperature. Solidification of molten metal at high pressure and less die temperature

Thermal analysis of heat transfer rate by varying cooling fluid

Switch box base products are usually made of polyvinylchloride, nylon, derlin, poly oxy-methylene, acrylonitrile butadiene styrene , polycarbonate etc. The main objective of the project is to conduct Transient thermal ansys on the muti materials to study the heat and temperature distribution of the material. The results were compared for better material and both results provide better understanding on the thermal characteristic of current material is used to industry in developing such a good product to having better life.

Transient Analysis for Different Material

Material name	Density p g/cm^3	Thermal conductivity W/mk	Specific Heat Cp J/K kg
Polycarbonate	1.2-1.22	0.19-0.22	1200
ABS	1.0-1.05	0.14	1300
Derlin	1.42	0.37	1470

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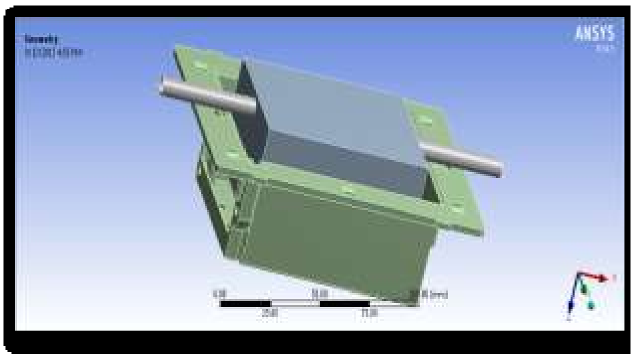
PVC	1.3-1.45	0.12-0.25	1000-1500
Nylon	1.15	0.24-0.28	1700

Table - Material properties

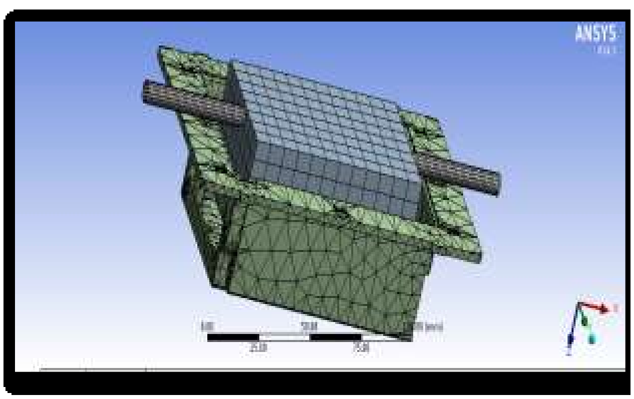
Specific Capabilities on Analysis

Case: 1 material -polycarbonate

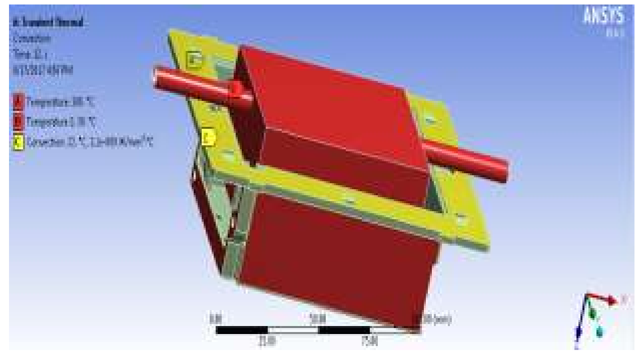
Imported model



Meshed model

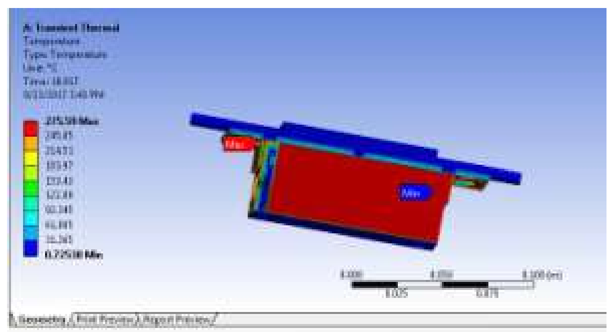


Boundary conditions

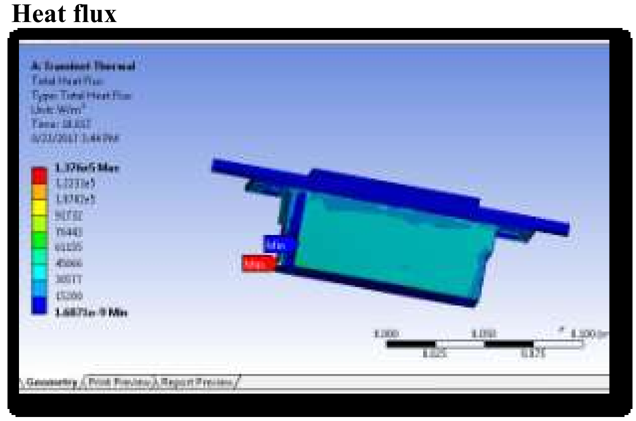


Time 10 seconds

Temperature



Heat flux



Result Table

Thermal analysis is done for all the four materials. The material for the original model is consideration of their densities and thermal conductivity.

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By observing the thermal analysis results, thermal flux is more for Nylon than other three materials, but compare to polycarbonate it is having high shrinkage and non stable for different atmospheric temperatures. So we can conclude that using Polycarbonate material and taking wall thickness of 2.5mm is better.

MATERIAL	TIME	TEMPERATURE		HEAT FLUX
		MIN	MAX	
POLYCARBONATE	10	0.725	275.58	1.375e^5
	12	1.223	285	1.4196e^5
	14	4.4409	303.51	1.5189 e^5
ABS	10	1.376	271.69	1.033 e^5
	12	0.842	279.45	1.061 e^5
	14	0.339	302.16	1.1528 e^5
NYLON	10	1.1838	267.58	1.7976e^005
	12	1.8436	283.68	1.8053e^005
	14	2.9082	301.12	1.924e^005
PVC	10	1.115	267.84	90161
	12	1.8575	284.17	90466
	14	3.0726	300.99	96222

6. MANUFACTURING TECHNIQES

Tooling

The injection molding procedure uses molds, in most cases made from metal or aluminum, as the custom tooling. The mould has many components, but will also be cut up into two halves. The 2 foremost accessories of the mold are the mould core and the mould cavity. When the mold is closed, the space between the mildew core and the mold cavity types the phase cavity to be able **to be stuffed with molten plastic to create the desired phase.**

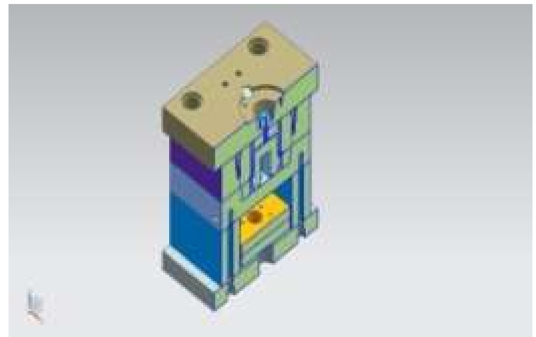

Fig 6.1 Mold Assembly – Closed Cross Section View

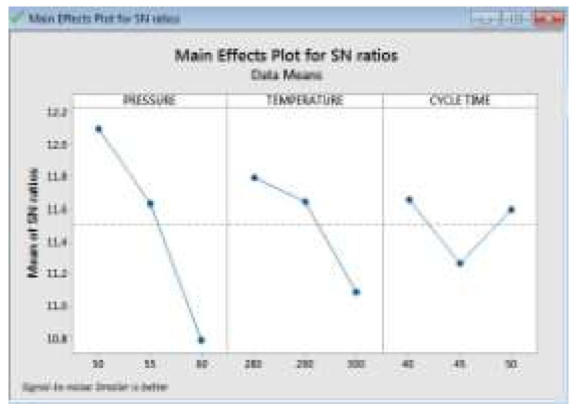

Fig 6.2 Effect of turning parameters on force for S/N ratio

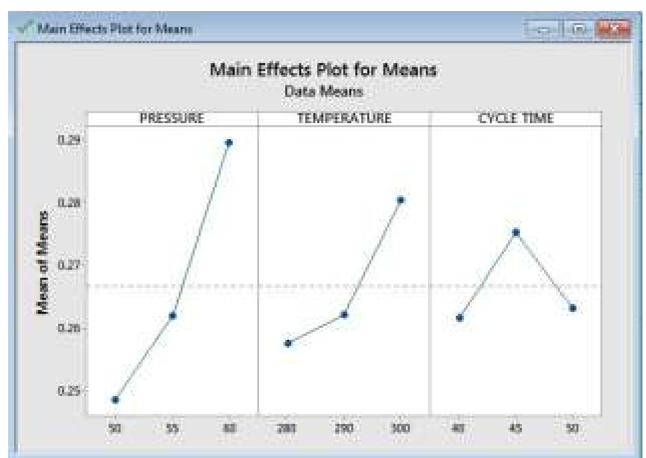

Fig 6.3 Effect of Injection Molding machine parameters on force for Means

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RESULTS

Taguchi method stresses the importance of studying the response variation using the signal–to–noise (S/N) ratio, resulting in minimization of quality characteristic variation due to uncontrollable parameter. The cutting force is considered as the quality characteristic with the concept of "the smaller-the-better". The S/N ratio for the smaller-the-better is:

$$S/N = -10 * \log(\Sigma(Y^2)/n))$$

Where n is the number of measurements in a trial/row, in this case, n=1 and y is the measured value in a run/row. The S/N ratio values are calculated by taking into consideration above Eqn. with the help of software Minitab 17.

The force values measured from the experiments and their corresponding S/N ratio values are listed in Table

	C1 PRESSURE	C2 TEMPERATURE	C3 CYCLE TIME	C4 SHRINKAGE	C5 SHRINKAGE1	C6 SNRA1	C7 MEAN1
1	50	280	40	0.2430	0.2431	12.2861	0.24305
2	50	290	45	0.2450	0.2452	12.2131	0.24510
3	50	300	50	0.2572	0.2576	11.7878	0.25740
4	55	280	45	0.2601	0.2603	11.6939	0.26020
5	55	290	50	0.2626	0.2627	11.6125	0.26265
6	55	300	40	0.2632	0.2635	11.5893	0.26335
7	60	280	50	0.2695	0.2696	11.3872	0.26955
8	60	290	40	0.2786	0.2789	11.0957	0.27875
9	60	300	45	0.3206	0.3205	9.8821	0.32055

Analysis and Discussion

Regardless of the category of the performance characteristics, a greater S/N value corresponds to a better performance. Therefore, the optimal level of the machining parameters is the level with the greatest value.

CONCLUSION

In this thesis, the optimum filling time, injection pressure and die temperature for better solidification of the filling material are analyzed by taking the input parameters molten metal (Pc) temperature, Pressure, and Cycle time.

Solidification analysis is done in Ansys. From the results, the following conclusions can be made:

The better solidification occurs at 45secs injection time, 55 Psi pressure and 280^{0}C die temperature. Solidification of molten metal at high pressure and less die temperature increases the physical properties such as impact strength, tensile strength and hardness.

These parameters can be applied practically in experimental investigation. From this thesis, trail and error methods in manufacturing process of pressure injection molding methods can be avoided thereby reducing total cycle time and also material wastage in manufacturing process. The problems faced in the Manufacturing the Molding industries can be rectified by this method.

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