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"A REVIEW ON DESIGN OPTIMIZATION OF AUTOMOBILE WIPER CASTING DIE"

Rajeev Ranjan Tiwari [1], Mr. Satbeer Singh Bhatia [2], Mr.Vikas Sharma [3]
[1]*M.Tech. Scholar, Dept. of Mechanical Engineering, Malwa Institute of Technology,Indore, MP, India*
[2,3] *Assistant Professor, Dept. of Mechanical Engineering, Malwa Institute of Technology,Indore, MP, India*

ABSTRACT

This paperdeals with elimination of defects in aluminium alloy castings of automobile wiper motor produced by pressure die casting process by optimizing die design. The main intention of work is to investigate the defects and improve quality of a pressure die cast component. Pressure die casting process involves producing accurately dimensioned parts, by forcing molten metal under pressure in to split metal dies, which are later on opened to allow the casing to be ejected. The main goal of project involves modelling of aluminium castings and to compare with old model and also developing the Die Design for "Automobile Wiper Motor" using NX 12.0.

Keyword: *PDC,Casting Defects,NX 12.0,Catching,Core and Cavity etc*.

I. INTRODUCTION

Die-casting is a fast, versatile and cost-effective manufacturing process for producing complex-shape metal components by injecting liquid metal at a high pressure in a steel mould called a die. Die-castings are among the highest volume, mass-produced items manufactured by the metalworking industry, and they can be found in thousands of consumer, commercial and industrial products. The die-casting process typically uses a non-ferrous alloy, such as aluminium and zinc, which is melted in the furnace and then injected into the die; the die is installed on a die-casting machine.

Computer-aided design (CAD) can be defined as the use of computer systems to assist in the creation, modification, analysis, or optimization of a design. Computer aided manufacturing (CAM) can be defined as the use of computer system to plan, manage, and control the operations of a manufacturing plant through either direct or indirect computer interface with the plant's production resources.

The design of a die-casting die is a crucial step in between the design of a part and its subsequent manufacturing. The research focus of the thesis, computer-aided design of multi-cavity die-casting dies from part product model, constructs a valuable bridge for achieving design-manufacturing integration for the die-casting process. Important steps of the die-casting die-design and manufacturing with role of CAD/CAM tools at each step are shown in below Figure, which are briefly explained in the following paragraphs.

- The die-design activities instantiates from the design of part, where CAD tools are used to make its part product model.
- Various die-design steps such as layout design, gating system design, parting design, side-core design, cooling design and ejection system design require CAD and CAE tools.
- When the design of a die-casting die is ready, CAE tools, such as filling simulation are used for its validation.
- A validated die-design is ready for manufacturing, and CAM tools are employed for process planning and die manufacturing activities.

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Design consideration:

Moulds:-

- Material used for the component, its applications.
- Shrinkage of the material.
- Calculate the weight of the component.
- Study the detail of the component, projected area of component.
- Type of mould required for the component to be produced.
- Machine available for the component.
- Injection pressure required
- Runner system & gate required.
- Ejection system weather blade, stripper etc.
- Split and side core considerations
- Cycle time required for the component for complete fill.
- Efficient cooling in a short duration is required.
- Cooling channels must be lick proof.
- Selection of better material for core & cavity.
- Additional shrinkage required for core & cavity dimensions.
- Parts in the assembly must not foul with each other in operation.

Gating System Design:-

Gating systems normally are classified according to where the metal is allowed to enter the mold cavity. Patterns can be top, bottom or side gated.

Top gates have the fastest filling times and actually require the fastest pouring to avoid collapse. Side gates results in the slowest filling while bottom gates are somewhere in between. It is difficult to control the flow of falling metal in top or side gating to avoid the entrainment of some plastic residue. Bottom gating gives the most control over filling the mold cavity with liquid metal during pouring. The metal falls in the most controlled way in the sprue and then rises in a regular fashion in the mold cavity. The flow of the metal into the mold cavity must displace the form pattern. Head pressure can help reduce porosity in the casting. At least one process uses 3-10 bar pressure on the flask during solidification to improve soundness during pouring and solidification.

Multiple castings can be assembled on one gating system. Care must be taken to ensure that each casting will fill as expected, especially as the head pressure and the resulting flow rates in the higher castings decrease. Also castings must be so close to each other as to cause excessive gas pressure, which can result in sand fluidization and ruin the cluster.

II. LITERATURE REVIEW

S.J. swillo et al.(april 2013) presents a vision based approach and neural network techniques in surface defects inspection and categorization. Depending on part design and processing techniques, castings may develop surface discontinuities such as cracks and pores that greatly influence the material's properties, the developed vision system uses an advanced image processing algorithm based on modified Laplacian of Gaussian edge detection method and advanced lighting system. The defect inspection algorithm consists of several parameters that allow the user to specify the sensitivity level at which he can accept the defects in the casting advanced learning process has been developed, based on neural network techniques. Finally, as an example three groups of defects were investigated demonstrates automatic selection and categorization of the measured defects, such as blowholes, shrinkage porosity and shrinkage cavity. [1]

Z. Ignaszak et al.(jan-2015) concerns the problem of discontinuity in high pressure die castings (HPDC). The compactness of their structure is not perfect, the discontinuities present in these castings are the porosity as follow: shrinkage and gas (hydrogen and gas-air occlusions) origin. The mixed gas and shrinkage nature of porosity makes it difficult to identify and indicate the dominant source. The selected parameters of metallurgical quality of AlSi9Cu3 alloy before and after refining. This alloy was served to cast the test casting by HPDC method

- The hydrogen concentration in the liquid alloy is possible to estimate using the "density index" - DI (solidification of test cup at 80mbar). DI factor for the well refined alloy should be less than 3.0 %. This guarantees the good metallurgical quality of alloy.

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- The most effective reduction of hydrogen content is possible by means of the rotor and argon blowing
- In the high-pressure Die casting (HPDC) the degassed liquid Al-Si alloy does not ensure the complete elimination of gas porosity
- The distribution of porosities depends on the turbulence of jet stream and free surface jet face. [2]

Mahesh N Adke et al.(dec-2014) reports on an optimization of Pressure die-casting process parameters to identify optimized level for improving the cycle time using Taguchi method for DOE. AlSic132 up to 20tonn machine capacity is used to calculate cycle time. There are four machining parameters i.e. melting temperature, Injection pressure, Plunger speed, cooling phase. Different experiments are done based on these parameters. Taguchi orthogonal array is designed with three levels and four process Parameters with the help of software Minitab 15. In the first run nine experiments are performed and Cycle time is calculated. Taguchi method stresses the importance of studying the response variation using the signal–to– noise (S/N) ratio, resulting in minimization of cycle time variation due to uncontrollable parameter. The Cycle time was considered as the quality characteristic with the concept of "the larger-the-better". The S/N ratio for the larger-the-better where n is the number of measurements in a trial/row.
Software predicated Cycle time is 34 for set of Melting Temp 700 deg C, Injection Pressure 900 bar, Plunger speed 3m/s & cooling time 8 sec. This suggested set of parameter which gives optimum performance of porosity.[3]
Javed Gulab Mulla et al.(march-2014) research that Die casting is a manufacturing process that can produce geometrically complex metal parts through the use of reusable moulds, called dies. The die casting process involves the use of a furnace, metal, die casting machine and die. The metal typically a nonferrous alloy such as aluminum or zinc, There are two main types of die casting machines hot chamber machines (used for alloys with low melting temperatures, such as zinc) and cold chamber machines Statistical Modeling for the historical data over factors and the levels, The software Minitab would be deployed for arriving at the optimized levels for the factors. The hypothesis shall be validated by producing the component as per the results determined by the Analytical method (DOE/ Taguchi Methods) without adversely affecting the quality norms. Visual inspection will be done while attempting to identify the defects.[4]
Yoshihiko Hangai et al.(april-2014) In the die-casting process, the formation of pores in components is unavoidable. This porosity has a harmful effect on the strength and pressure tightness of die castings. To eliminate the porosity in components, its predominant cause has to be identified as being due to either shrinkage or gas. In practice, however, it is frequently difficult to tell the difference between porosity due to shrinkage and that due to gas from observing die castings. Accurate identification enables die casters to take corrective action. To identify the porosity accurately and to take corrective action in the die-casting process, the quantitative estimation of the morphology of pores such as their shape or spatial distribution can be a source of useful information. In this study, two types of fractal analyses are proposed to characterize the porosity in terms of the shape of individual pores and the spatial distribution of multiple pores

- The distributions of Dp were significantly different in the surface region (gas-origin-rich pores) and inner region (pores of both origins). Therefore, Dp appears to be an indicator of the predominant cause of porosity formation, shrinkage or gas.
- The relationship between the fractal dimension Dp and the cumulative frequency of porosity has a fractal nature.
- It was shown that Dp s quantitatively expresses differences in the distribution of Dp Therefore, Dp appears to be an indicator of whether the predominant cause of porosity formation is shrinkage or gas. That is, Dp s indicates the extent of porosity formation due to shrinkage, and thus, the action that should be taken by die casters to manufacture pore-free die castings.[5]

III. Problem Identification

Due to its large volume production, it is only logical that optimization of the PDC Die for wiper motor for its weight or volume will result in large-scale savings. It can also achieve the objective of reducing the weight of the vehicle component and also make easy and defects free part with smooth production.
During the discussion with managers and supervisors staff following issue was reviled:
1. Catching issue in Core insert.

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2. Heavy weight of Die.
3. Sharp corners inside the cavity.
4. More Filling time to cavity.

IV. Objective of work

The objectives of the work are:

1. To Model new PDC Die for automobile wiper motor using NX 12.0 after changes consider in design.
2. To Manufacturing new modified wiper motor component.
3. Reduce weight of Die.
4. Eliminate catching issue in core insert.
5. To Change gate position for reduce filling time.

V. Modification Proposal

Casting 2D:

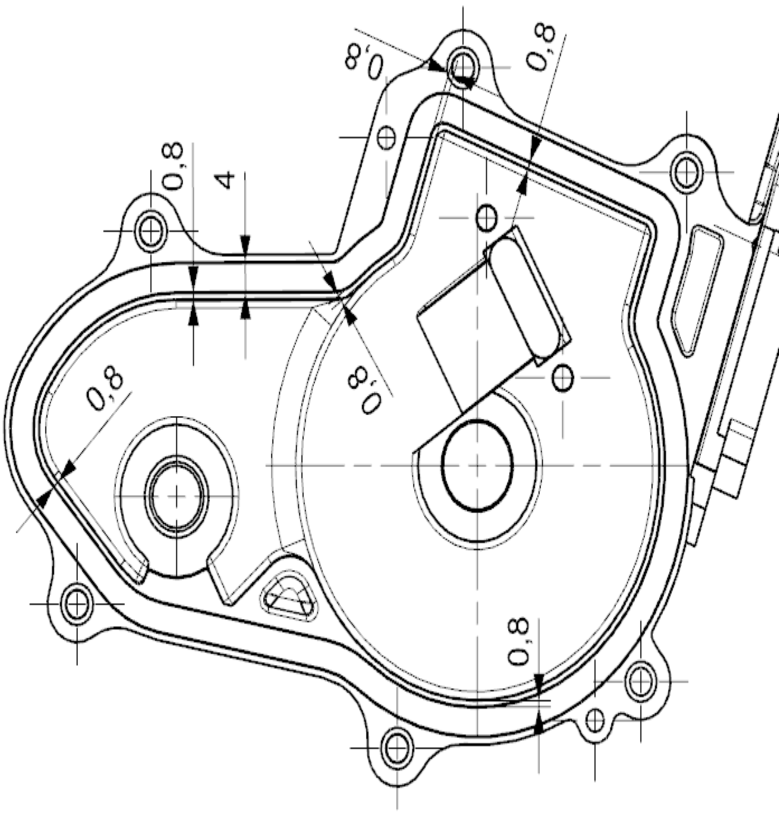

Fig.1: Modification Proposal Casting 2D

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Casting 3D:-

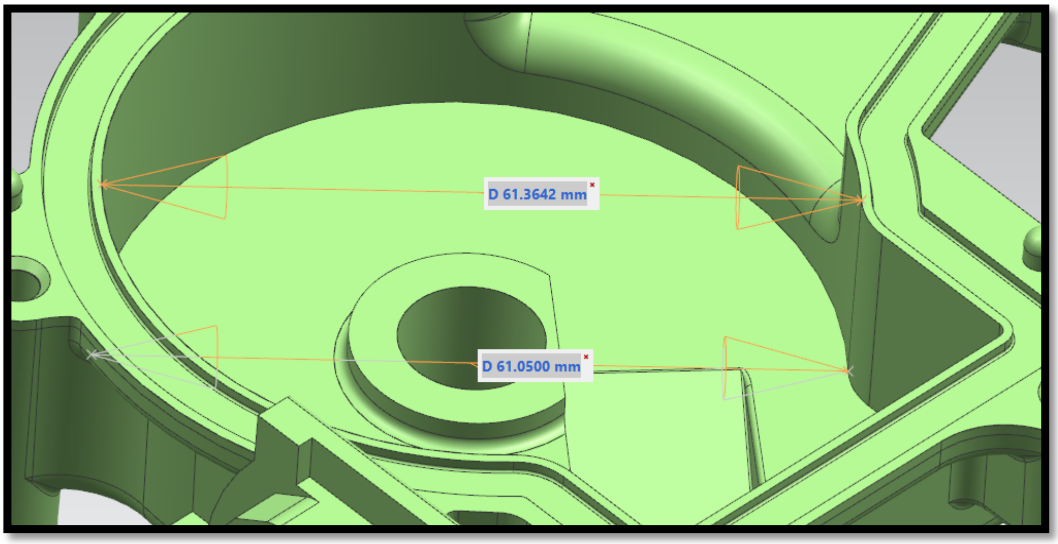

Fig.2:Modification Proposal Casting 3D

Note:- Ø 61.05 maintained at bottom with 0.5° plus draft. Top edge will be Ø 61.36mm. In this condition we can achieve the rib width as 0.8mm.

VI. METHODOLOGY

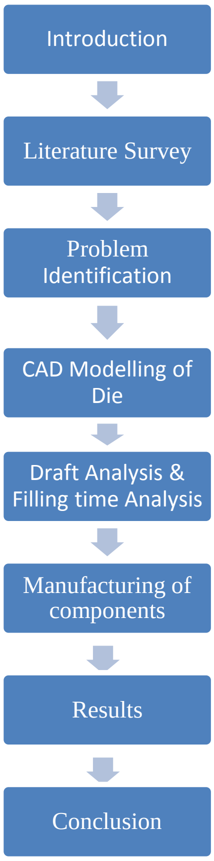

Fig.3: Flowchart of Methodology

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VII. Conclusion

The paper gives a brief introduction about the work accomplished in design including the explored applications in Unigraphics & with design related information. This project is basically dependent upon pressure die casting. It also gives a view of design consideration involved in Mould & Die-casting-Dies. It gives the idea of the flow of project from the stage of take delivery to till dispatch of the tool.

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