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Improving the Yield and Quality of Casted Clamping Gland by Optimizing Gating System

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Abstract: ***Casting is a production technique in which the molten metal is poured into the mould to get desired product. The shape of the mould is same as that of the casting to be produced. It is then allowed to solidify and after solidification the casting can be taken out by breaking the mould. In casting process, large numbers of steps are involved, due to which, chances of defects formation in casted parts increases. For good quality and defect free casting, gating system and feeding system designs plays an important role. Casting simulation software is a tool which is used to visualize mould filling, mould solidification and cooling. Also it is used to predict the location of internal defects such as shrinkage porosity, sand inclusions and cold shuts in the casted parts. AutoCAST X-1 software is used for simulation. In this study, by optimizing the gating system design all the defects are minimize and also yield of casting increases. Total casting yield is increased by 6.07% and gating yield is increased by 14.81%.***
Keywords: **Casting Simulation, AutoCAST X1, Gating yield, Casting defects, Casting yield**

I. INTRODUCTION

Casting is a production technique in which the molten metal is poured into the mould to get desired product. The shape of the mould is same as that of the casting to be produced. It is then allowed to solidify and after solidification the casting can be taken out by breaking the mould. In order to survive and excel in the current competitive market trial-and-error method of producing defect free casting products is uneconomical and time consuming. The component casted before casting simulation contains various types of defects, such as blowhole, shrinkage porosity and hard zone. Therefore, computer aided simulation software are used to analyse the various physical phenomena occurring during casting processes. “AutoCAST-X1” software is used for finding the location of various hotspots in the part models and helps in finding optimum positions for risers (feeder) and gating system with optimized dimensions. It gives information about mould filling, solidification with different colour coding, defects and its optimization. In this study, a clamping gland (sand casting component) is selected for yield improvement and also to improve the quality of casting. Therefore by using casting simulation software generation of good quality casting with higher yield is possible, due to which productivity increases.

Yield Ratio: (Total weight of casting) / (Total weight of casting + Total weight of gating system+ Total weight of feeding system).

II. LITERATURE REVIEW

Suresh Chittewar et. al study is divided into three section. First they studies casting design calculation of Aluminium component (Al alloy A356), then numerical simulation using AutoCAST-XI simulation software and preparation of pattern using 3D printing (FDM) technique. The study concluded that the solidification rate have impact on the microstructure of casting material which further affects the mechanical properties.[1] Sachin Nimbulkar et.al studied use simulation technique to optimise gating and feeding system used for sand casting of wear plate. The study has four stages. First, the design of feeder and gating system is determined. The numerical simulation using AutoCAST software is performed to get optimised results. Then experimental validation and testing of casted parts using ultra sonic testing machine is performed to get required results.[2] Mohammed Mohiuddin et. al studied AM technique which is used for pattern development and casting simulation technique to analyse mould filling and casted parts solidification aspects. Various simulations are carried out for varying pouring temperature of casted metals and various gating system designs. Simulation is carried out for Top gating system as well as for Bottom gating system also.[3] A.K.Gajbhiye et. al study focuses on minimizing the casting defect of shrinkage porosity in a sand casting process by performing simulations in AUTOCAST-X Software. Simulation study of castings is performed to determine the hot spot locations, to calculate solidification so that shrinkage porosity defect can be minimized. Casting trials are performed without feeder in gating system, with feeder in gating system and feeder with exothermic sleeve in gating system.[4] Pranjal Jain et. al studied FDM method which is used for making pattern for casting a product. A case study involving middle disc of Oldham coupling is performed in this study. In this study the disc is produced by both the new investment casting process and the usual sand casting process. “AUTOCAST-X” software is used for designing the gating system and simulating that system to get zero defect casting.[5]

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III.PROBLEM IDENTIFICATION

Optimization of gating and feeding system of clamping gland, in order to increase yield and quality of casting part using AutoCAST X1 software is performed. Part weight is 292.57 g and part volume is 104.67 cm^3.

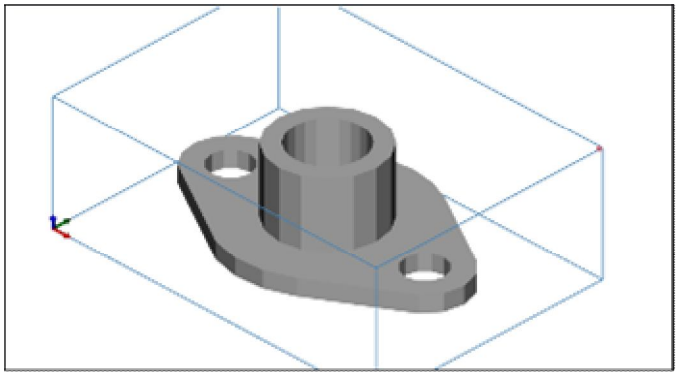


Fig. 1 Actual Part (Clamping Gland)

IV.METHODOLOGY

For optimization of gating system and feeding system of casting, in this study, AutoCAST X1 simulation software is used. As per the drawing details the design of clamping gland is drawn using CATIA software. Then the file is converted into .stl format. Then this .stl file is imported into the software. Gland is simulated for sand casting process. The AutoCAST software contains different module such as, start module, part module, mould module, feed module, gate module, flow module and report. In the start module, the part is loaded into the software. In the part module different properties of casing material are selected. In the feed module, location of feeder and required dimensions of feeder are determined. Gate module gives information about entire gating system, i.e. dimensions of pouring basin, sprue, runner, ingate etc. In the flow module, actual mould feeling and solidification of casting process is visualized. This module also gives information about defects. Last module is report which gives detail information about yield % and costing of casting.

V. SIMULATION

In order to optimize the gating system and feeding system of casting, with the help of AutoCAST software, numbers of iterations are performed. By using this simulation software the way of mould filling by molten metal and solidification of casting is analysed. Also to produce good quality, defect free casting, the software gives the dimensions of components of gating system accurately.

A. Simulation 1

When the part is loaded in the software, the material properties, as per the dimensions of the part the mould box, the dimensions of the gating system are selected. Then the simulation gets started automatically. The simulation is carried out without feeder.

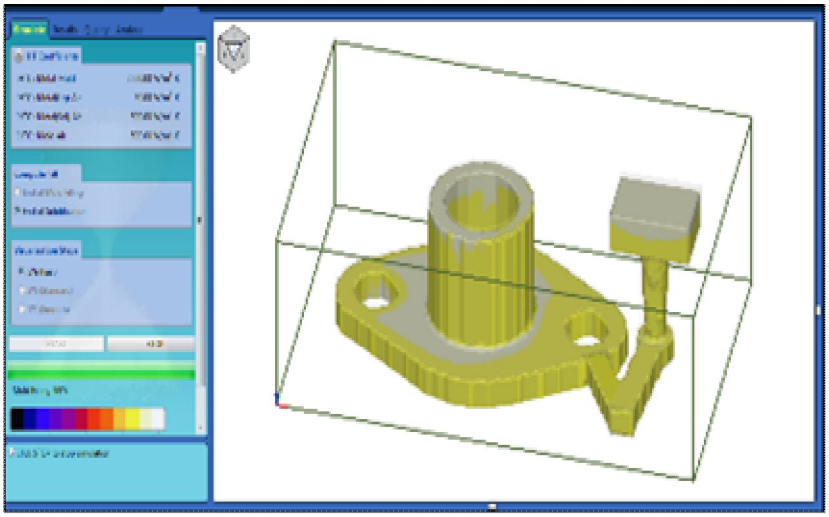
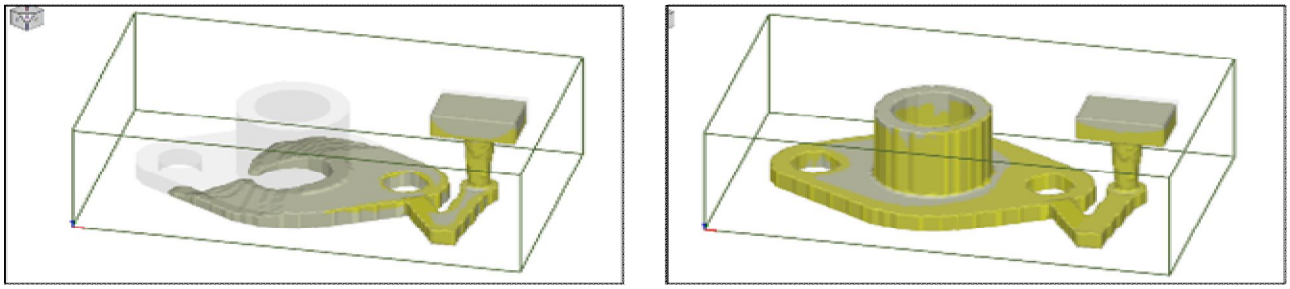


Fig. 2 Simulation 1 in AutoCast X1

1) *Mould Filling:* When the entire gating system is designed, next module is flow module. In the mould filling process, the molten metal actually fills the mould cavity.

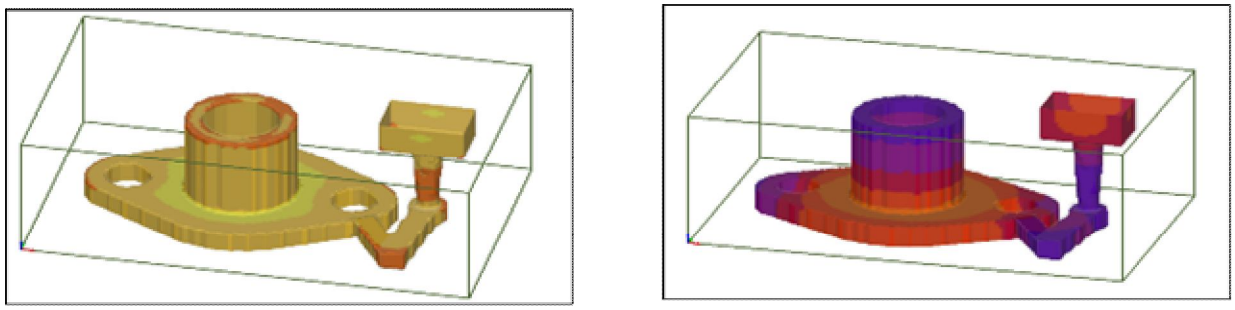


50 % Mould filling 100 % Mould filling

Fig. 3 Mould filling in simulation 1

Fig. 3 shows the mould filling process using molten metal at different level of percentage of filling. The process gives careful observation at corner or circular part because for defect free casting it is necessary to fill each and every part of the casting component.

2) *Solidification of Casting:* When the mould is filled completely, the solidification of casting gets started automatically. In AutoCAST software, the temperature changes during solidification are also observed with different colour codes.

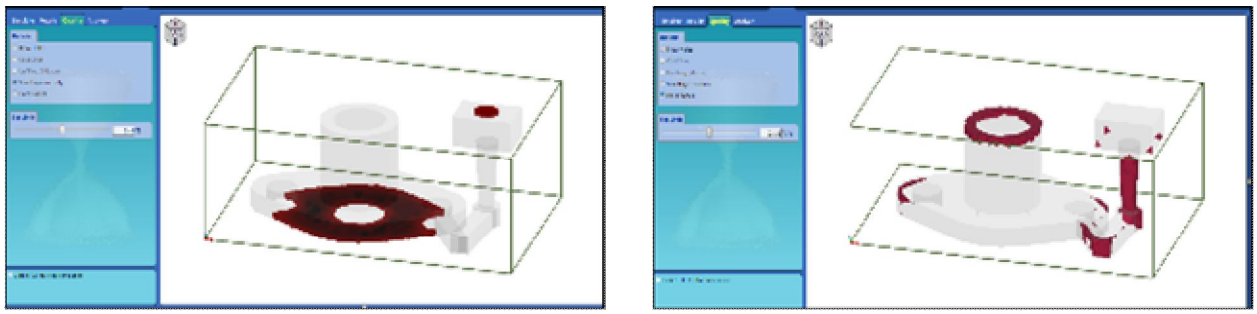


50 % Solidification 100 % Solidification

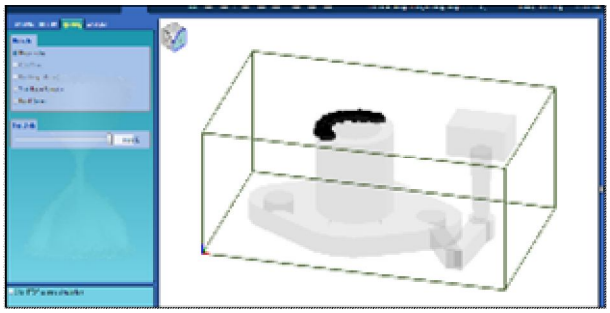
Fig. 4 Solidification in simulation 1

Fig. 4 shows the solidification of gland at different percentage level. Above figure shows that, the solidification takes place from outer side of casting to the inner side of casting. The portion of the base plate near the washer solidifies lastly. That means the temperature at that part is high. Due to this uneven temperature distribution defects get generated in the part.

3) *Simulation 1 Result:* After conducting simulation 1, the defects generated in the part are shrinkage porosity, hard zone and blow holes. The simulation 1 is carried out without feeder. The feeder supplies molten metal continuously, therefore it compensate the contraction of metal during solidification. Due to unavailability of feeder the shrinkage porosity defect is generated in part. Also due to uneven temperature distribution, the solidification of part is also uneven. Due to this hard zone and blow hole defect is generated. Here the total yield of casting is 80.28 %, the gating yield is 79.17%.



Shrinkage Porosity Hard Zone



Blow Holes

Fig. 5 Defects in simulation 1

B. Modification in Simulation 1

It is observed that in the first simulation due to unavailability of the feeder, the shrinkage porosity defect is generated. Also due to incorrect design of gating system the filling and solidification of casting becomes uneven. Due to this blow hole and hard zone defect is observed. Due to large dimensions of gating component, the material wastage is more which affects the overall casting yield. Thus main modification in gating system is addition of feeder and all the dimensions of gating system get reduced to improve the yield. Fig 6 shows modification in gating system. After modifying gating system simulation 2 is performed.

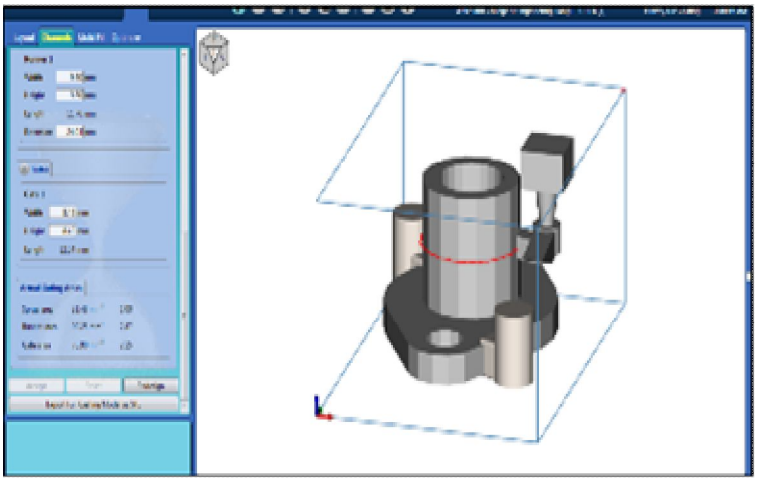
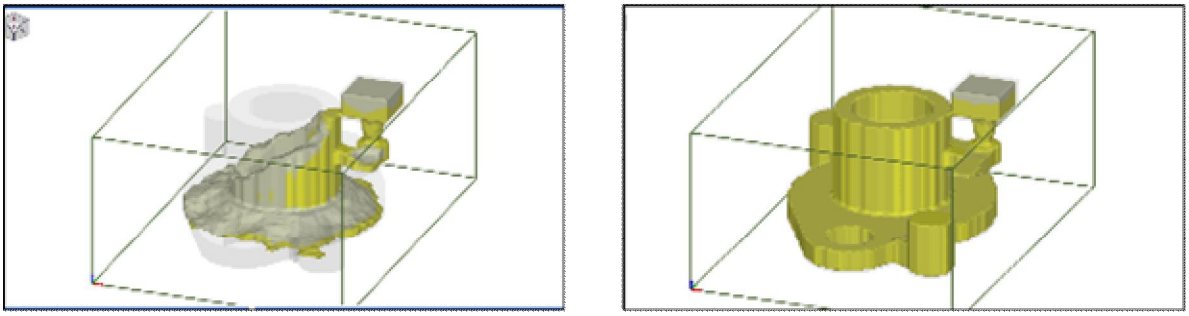


Fig. 6 Modification in gating and feeding system (Simulation 2)

1) Simulation 2: After the modifications in simulation 1, the second simulation was performed to obtain results.

a) Mould Filling: Fig 7 shows the mould filling in simulation 2 at 50% and 100% of filling. Here the mould is filled completely with molten metal.

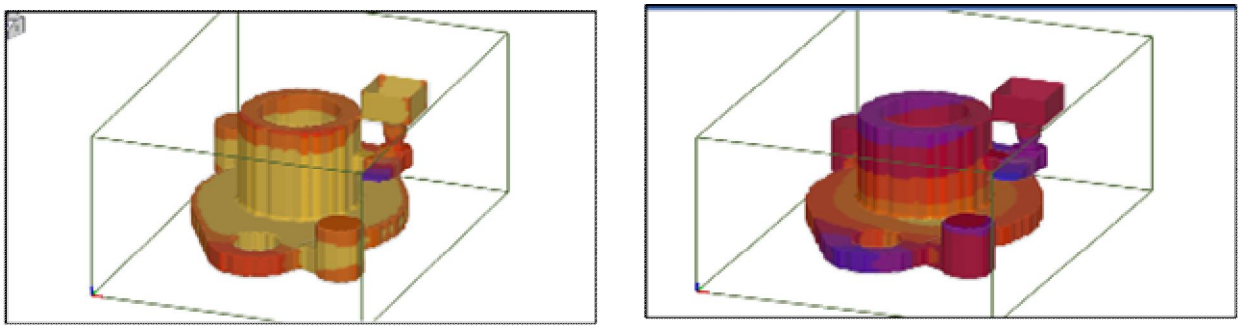


50 % Mould Filling

100 % Mould Filling

Fig. 7 Mould filling in simulation 2

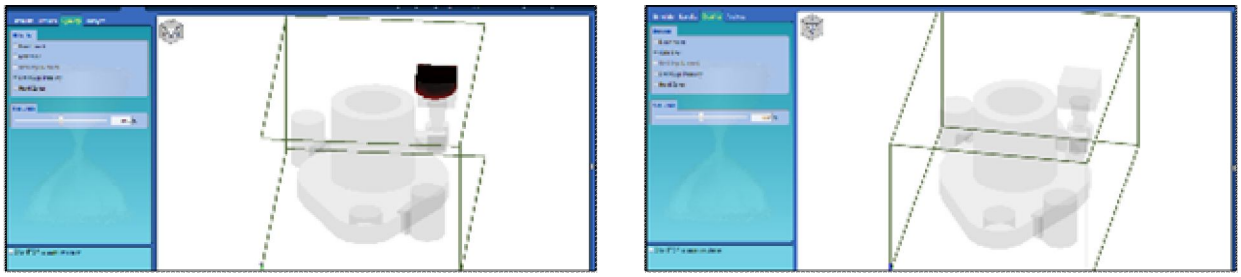
b) Solidification of Casting: Fig. 8 shows the solidification of casting in simulation 2. Here changes in temperature are observed with different colour code.



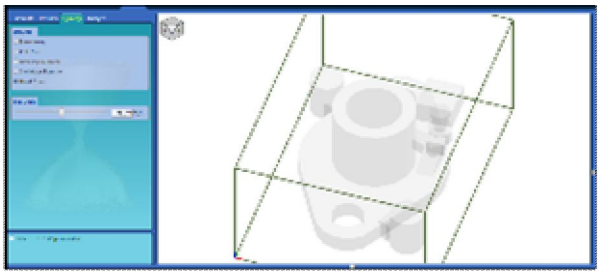
50 % Solidification 100 % Solidification

Fig. 7 Solidification in simulation 2

c) Simulation 2 Result: Fig.9 shows the defects in simulation 2. In simulation 2, two feeders are used at correct position, which eliminates the shrinkage porosity defect completely. The shrinkage porosity is observed in pouring basin. Means part is completely free from porosity. The hard zone which is seen in simulation 1 is completely eliminated in simulation 2. Also due to proper gating system design, the defects such as blow holes, cold shut also eliminated completely. Therefore the part is completely defect free. Also as the dimensions of gating system and feeding system are optimized, the material wastage in gating system is reduced. Hence the total yield of casting is increased up to 85.16 %. And the gating yield is increased up to 90.9 %. The feeding yield is 87.08 %.



Shrinkage Porosity Cold Shut



Hard zone

Fig. 8 Defects in simulation 2

VI. CONCLUSION

A. With the help of modified gating system and feeding system design, the clamping gland casting is optimized.

B. By using optimized gating system dimensions and proper location of gating system and feeding system, all the defects from the casted part are eliminated completely.

C. By using AutoCAST simulation technique, shop floor trials of generating casting are reduced. This saves the casting material and hence increases the productivity of company.

D. With optimized gating system design, total yield of casting is improved by 6.07% and gating yield is improved by 14.81%. The feeding yield in simulation 2 is 87.08%.

VII. ACKNOWLEDGEMENT

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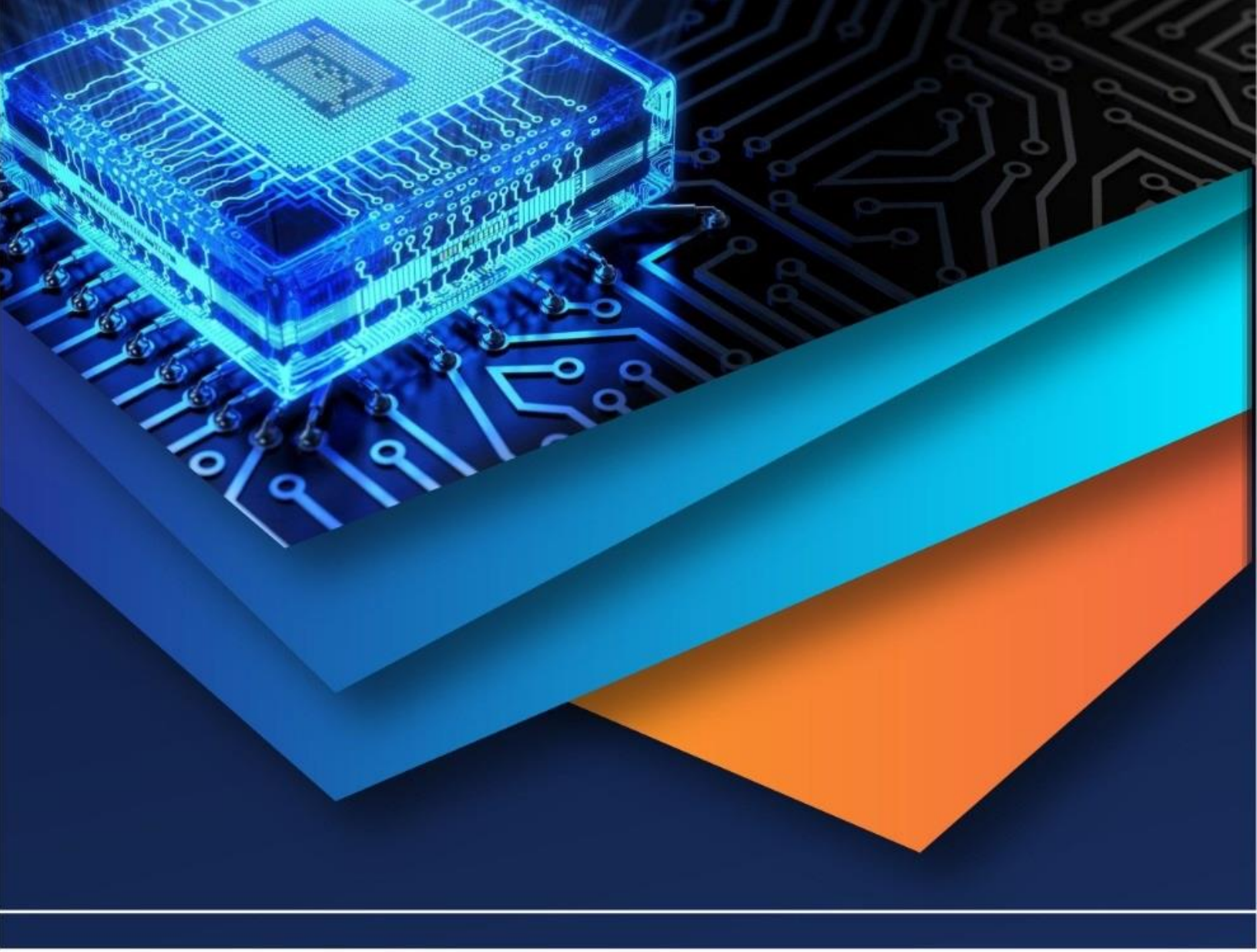

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