Importance of CAD Tool like Auto-CAST to the Foundry by Doing Simulation Analysis on the Case Study

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Abstract— In today's competitive age foundries are required to be more active and efficient. They need to respond fast. For that casting simulation has become a powerful tool to visualize mould filling, solidification, cooling, and to predict the location of internal defects such as shrinkage, porosity, sand inclusions, and cold shuts. It can be used for existing castings process or for developing new castings before shop-floor trials. The analysis has been carried out by considering the case study of the part CASTED PLUG which is used in casting manufacturing unit in vadodara. For analysis Auto-CAST software is used to find the hotspot which is compare with the actual defects present in the part by using the manufacturing data used by the industry for the production of the part.

Key words: Casting, Casted Plug, Auto-CAST, Simulation, Shrinkage Defect

I. INTRODUCTION

Casting processes are widely used to produce metal parts in a very economical way, and to obtain complicated shapes with little or no machining. The manufacture of a part involves several steps, the first of which is the design of the part and specification of the material to be used. This information is passed to the methods engineer, who will choose the casting process, and then design the rigging system necessary to get the molten metal into all regions of the part so as to produce a sound casting.

In the process of simulation, first create the solid model of casting and then a suitable methoding is used by using software. However, most of the simulation programs available today are not easy to use. They may take longer times depending upon the user expertise available and their accuracy is affected by material properties and boundary conditions specified by users. The problem is the preparation of 3D model of the casting along with mold, cores, feeders, gating, etc., which requires CAD skills and takes considerable time for even simple parts. Methoding is an important task in casting production, directly affecting casting quality and yield. It involves several decisions, such as the size of mold box and number of cavities, orientation of casting in the mold, location of the parting line, design of core prints, and the location, shape and size of feeders and gating elements.

The goal is to consistently produce castings with zero internal defects (such as shrinkage porosity, inclusions, blowholes, cold shuts and inadequate mechanical properties), while ensuring the maximum possible yield. The Auto-CAST software is advantageous in the term of user compatibility with the software. This software is very easy to use and one can learn very easily and quickly. For that the knowledge of process is required. Also the ability of the software is that it allows you to find out the hot spot region in the part by simply simulating the part only. So this flexibility allows user more comfortable with this software.

II. CASE STUDY

The product which is considered for analysis is the casted plug. This is used by chemical industry. The manufacturing of this product is done by one of the manufacturing unit located at Vadodara. The company is using sand casting process for the manufacturing of casted plug. Hence they are not using the simulation software; they have found the defect in the part. The defect is porosity and it is on the periphery of the part. This is shown below.

Fig. 1: Casted Plug [3]

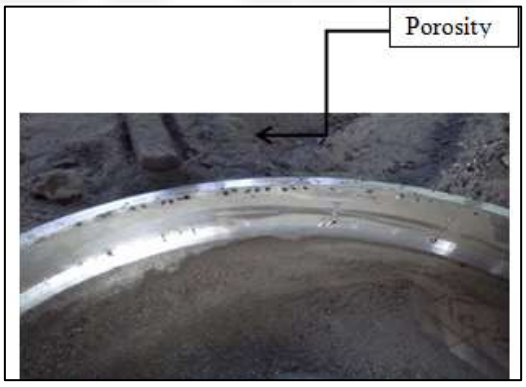

Fig. 2: Enlarged red box for clear view of defect [3]

The defects are identified in the part is shrinkage porosity. These defects are identified after final machining process on the plug. So the rejection is including final machining cost too. So to find these defect; the simulation of the part is carried out according to the methodology used to manufacture the part in the industry. The software used for the simulation is AutoCAST. The product descriptions are as under:

A. Selected Product:

1) Name of the product: Casted Plug
2) Material : Stainless Steel
3) Unit Weight : 70 kg

4) No of component in the casting box : 1
5) Size of the casting box:
6) 750mm × 750mm × 350mm
– Cope :
750mm × 750mm × 200mm
Drag :
– 750mm × 750mm × 150mm
7) Shape of the casting box : Rectangular
8) Type of gating system used : Pressurized gating system
9) Pattern material: Wooden.
10) Type of pattern: Single piece.
11) Type of moulding: Hand moulding.
12) Moulding sand : Silica Sand
13) No. of cores : None

B. Geometric Model:

The input for the AutoCAST is the geometric model created in the Creo-parametric software. This model is imported in the AutoCAST as the STL format. This is shown in figure

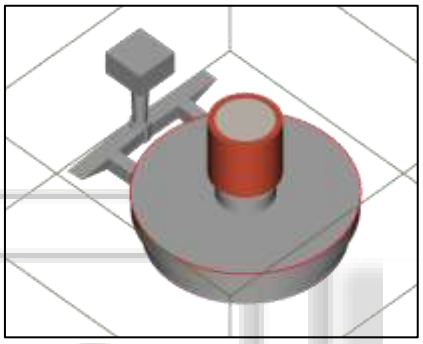

Fig. 3: Gating element design model input from Creo to the AutoCAST as STL format

C. Simulation Procedure:

The following steps were performed on AutoCAST software so as to get the Methodology for the casting i.e. Casted Plug

1) Import the solid model of the casted plug in the AutoCAST software. The 3-D model from Creo-parametric is converted in to the STL Format.
2) The model is assigned the material- Stainless Steel
3) The process selected as- Sand Casting.
4) The properties are calculated, which shows the surface area, volume, weight etc.
5) The parting line and parting plane is adjusted on the mating of cope and drag taking into consideration the ease of removing the pattern from the cope and drag part.
6) Next feeding function is carried out so as to know about the possible areas which are prone to shrinkage. Here the middle area of the casted plug has the highest massive thickness is the area for generation of shrinkage.
7) The analysis through it showed the two dominant areas which are prone to the shrinkage and porosities.
8) For these areas to be taken care of the feeders are provided.
9) The number of ingates is finalized and the locations also are finalized according to the company's methodology.
10) The runner bar is designed so as to feed the molten metal to the farthest point from point of metal pouring.
11) The sprue is designed.
12) The total model is created and the pouring is simulated.
13) The simulation result shows the hot spot region in the middle section and the periphery of the plug which is the where the porosity is found after machining process in the actual production. This is shown in simulation results.

III. RESULT AND DISCUSSION

The results of the simulation are shown in figure 3 and figure 4 bellow. By doing the observation of the result of simulation, found out that there are hot spots on the periphery of the plug and also in the thick section (middle section) of the plug. That hot spot can be seen in the figure 3 and in figure 4 by the yellow and white colour. This hot spot of the simulation indicating that, after solidification of the casted plug there are still some liquid metal present in the casted plug in the hot spot zone.

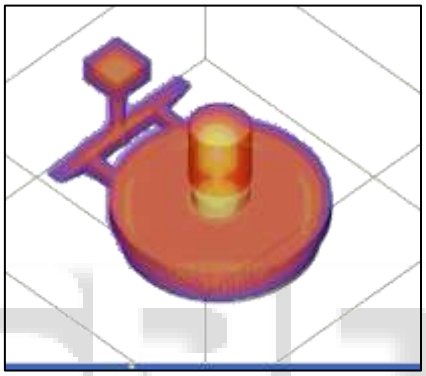

Fig. 4: Simulation result of the Part

Here after solidification process, the material that around the hot spot is in the solidified form and hot spot material is still in the liquid form. So after some time it will solidify but there is no material available for feeding in the space that is formed after solidification of the hot spot. And also the dissolved gasses are trapped in that region because it has no place to go out of the casted plug. So it will form the porosity in the part. So after solidification of that hot spot region, the porosity will be generated. That is found in the actual manufacturing of casted plug in the industry as shown in figure 2.

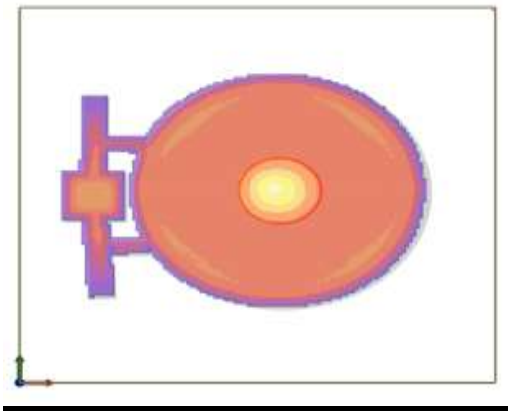

Fig. 5: Top View of the Simulation Result of the Part

Since the middle section defects are not visible in the actual manufacturing because this section is not machined as it is

not fitted in the vessel. Only periphery of the plug is fitted in the vessel so machining of the plug is done only at periphery of the plug.

So the defect is found out by Auto-CAST software that is actually happened in manufacture of the casted plug in the industry.

Now next step is to remove this defects from the part.

IV. RESIMULATION AND RESULTS

Resimulation is done by changing the gating element design as shown in figure 6. In that two types of feeder is used i.e. open and blind. The open feeder is located on the centre of the plug and the blind feeder is located on the periphery of the plug. The simulation results shows that the hot spot is shifted in the feeder and the plug is free from the hotspot as it can be seen from the figure 6 and figure 7.

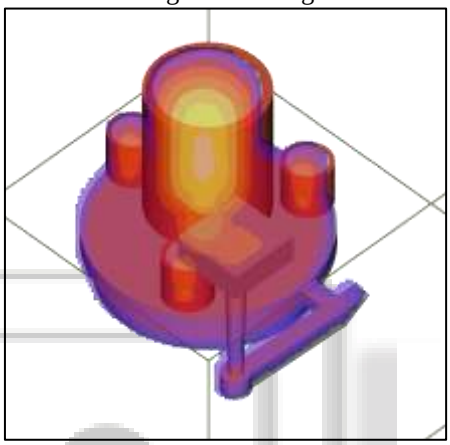

Fig. 6: Resimulation Result of The Part By Changing Gating Element Design

The result shows that the hot spot is clearly shifted outside from the casted plug. And also from the periphery of the part. It means that the defect is shifted/removed from the part and the part is defect free

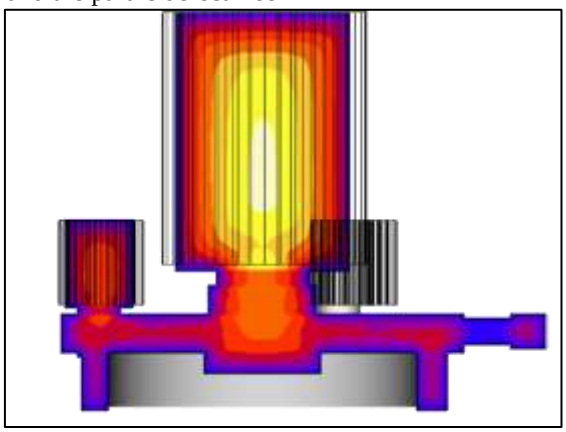

Fig. 7: Front View of Resimulation Result of the Part by Taking C/S at Centre

Here the section is taken at the mid portion of the plug to find out the exact location of the hot spot. This is shown in the figure 7. From that figure the hot spot can be identified clearly and that is in the feeder. Here the hot spot is shifted in the feeder from the casted plug and there is no hot spot in the casted plug that is identified in the previous simulations. So the casted plug produced by this gating element design s defect free.

V. CONCLUSIONS

The simulation results clearly shows that the hot spot are generated in the plug that is in the mid-section of the plug and on the periphery of the plug which matches the actual defects that produces in the industry that is shown in figure 2 and figure 5. And these hot spots are removed from the plug by resimulating the part. These can be seen from the figure 6 and figure 7. So this is very useful in terms of defect free products because defects are identified before the actual manufacturing of the product so rejection problem is minimized. This will very useful to the industry and hence the growth of our country.

By using simulation software intelligently it is possible to help foundries to reduce scrap rates even for defects which cannot be predicted. So the simulation tool is used to identify critical locations, filling pattern and solidification related problem areas in the casting.

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