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Analysis of Gating System of a Casting to Increase the Productivity and Yield

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Abstract: ***Gating system is one element of casting processes. Casting process is one of the manufacturing process in which the liquid metal is poured to casting cavity. After the solidification of part we will get actual part. Advantage of casting is it can manufacture more numbers of parts in less time. If the requirements of parts are more then the casting process is used. For this the time, money and material required is more and here productivity and yield should be increased. The limitation of casting is that the defects of the parts are not seen while producing it. Defects will be seen after the part is removed from mould therefore it is necessary to analyze the gating system. Analysis of the gating system will help identify the defects and prevent the losses of money, time and material. In this work ADSTEFAN software is used for analyze the gating system because it will give accurate result. Here first the design of gating system of four, twelve and twenty is done then analysis is done. The defects identified as a result of analysis help increase the productivity and yield.***

Keywords: gating system, yield, productivity, ADSTEFAN

1. Introduction

The term gating system refers to all passageways through which the molten metal passes to enter the mould cavity. By referring Figure 1. The gating system composed of Pouring basin, Sprue, Runner, Gates[2], fect

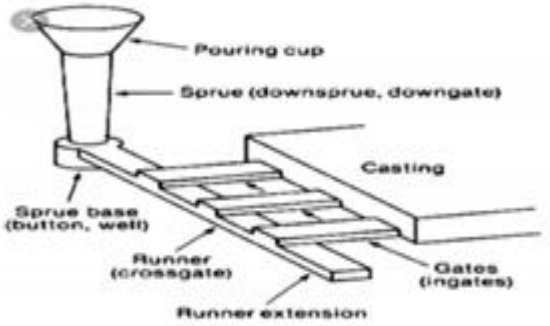


Figure 1: Elements of Casting

Whenever the requirements of parts are moiré the gating system is used to manufacture more parts and initially to manufacture more numbers of parts time, money and material is needed more. If more parts are manufactured then there are more defects and these defects are seen after parts are removed from mould cavity. Because of this there is huge loss of time, money and material. To prevent this the analysis of gating system is done by using ADSTEFAN software. In the literature review by usingCHEN Meng[1], YANG Jian-ming[2], YANGYi-tao[1*] "Establishment of Particular Methods in Casting Simulation" In this papergating system analyzing is done by using ADSTEFAN software [8]. With the help of analyzing hair identification of defects is done. By increasing the yield, manufacturing of more numbers of parts is achieved. Yield can be defined as a ratio of finish weight by bunch weight by numbers of cavities of casting. Basically it is outcome of process.

Yield = {[Finish weight ÷ Bunch weight]× numbers of cavities}× 100

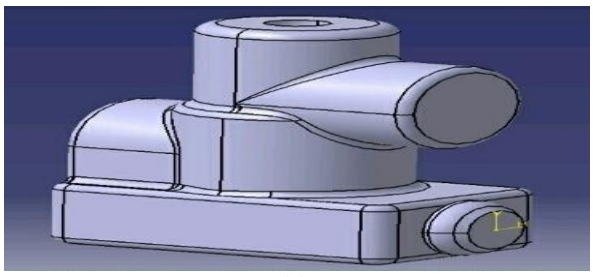
$$Therefore, Y=\{[W_f \div W_b] \times N\} \times 100 \quad (1)$$

Where Y is yield
W_f is finish weight in kg or gram
W_b is bunch weight kg or gram
N is numbers of cavities [2]

2. Procedure For Analyzing Of Gating System

Here first analysis of four cavity gating system is done and then to increase the yield the twelve cavity gating system is analyzed latter the results are compared. The procedure as follows

1) Here the design of casting component is initially according to requirement of customer by using modeling software Pro E or CAD. The design of component shown in figure 2.



(a)

(b)

Figure 2: Design of component

2) After design of component, design of four cavity gating system is done. Here initially feeder is design then with the help of assembly components are attached after design completed it is converted into STL file. The design of four cavity shown in figure 3

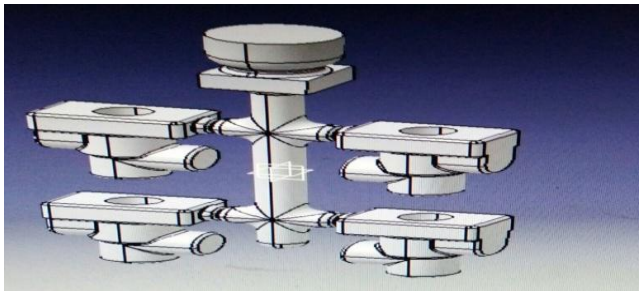


Figure 3: Four cavity gating system

3) After design analyzing by using ADSTEFAN software version 2016 is done. Here after design the modeling part is imported in the ADSTEFAN software
4) After imported the part into analyzing software all the inputs are entered. In figure 4 imported CAD modeling in ADSTEFAN software

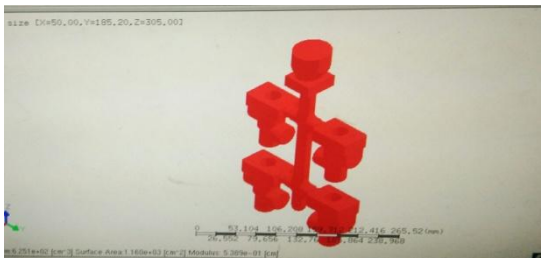


Figure 4: Imported CAD model in to ADSTEFAN software

5) Then mesh size will be entered. Here mesh size is 1.5mm. Figure 5 shows mesh size of four cavity gating system.

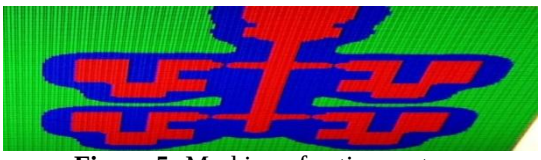


Figure 5: Meshing of gating system

6) Input all parameter like density Now, pouring temperature etc

Figure 6: Parameters required for experiment

7) After all parameter entry now go for analyzing process. It takes ten to twelve hours for analyzing the gating system.
8) After analyzing process the results will come out, the results will be in two conditions, that is fluid flow and solidification.
9) For analyzing twelve cavity gating system the same steps are followed. The design and analysis of twelve cavity as follows

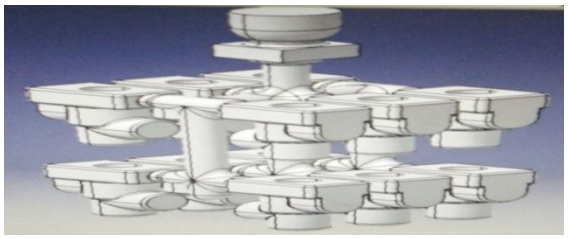


Figure 7: Design of twelve cavity gating system

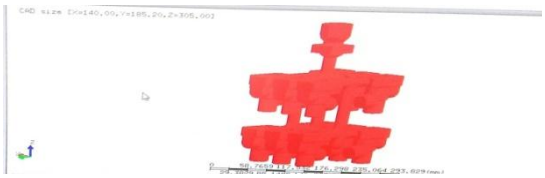


Figure 8: Imported CAD model in to ADSTEFAN software

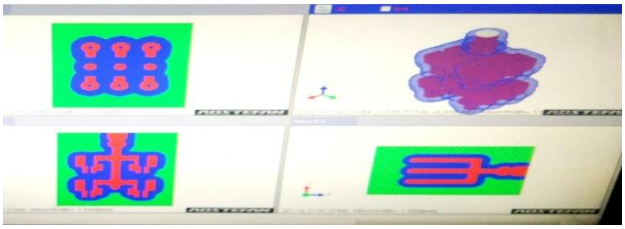


Figure 9: Meshing of gating system

3. Calculation of Yield

3.1 Calculation of Yield Of Four cavity gating system

From Literature Review Casting Yield = {[Finish weight ÷ Bunch weight]× numbers of cavities }× 100
Casting yield={ [W÷w]×N}×100
Where W= Finish weight (component weight)
W= Bunch weight
N= numbers of cavities
Therefore Y(4) = {[0.778 ÷ 4.523]×4]×100
= [(0.17200)×4]×100
= 0.6968×100
= 69.68%
= 70%

3.2 Calculation Of Yield Of Twelve cavity gating system

Casting Yield= {[Finish weight ÷ Bunch weight]× numbers of cavities }× 100
Casting yield={ [W÷w]×N}×100
Where w= Finish weight(component weight)
W= Bunch weight
N= numbers of cavities
Therefore Y(12) = {([0.778 ÷ 11.791)] × 12}× 100
= {[0.06598253×12]× 100
=0.79179×100
=79.17%

4. Results and Discussions

The results of analyzing gating system will be studied in two conditions, that is
1)Fluid flow and
2) Solidification

In the fluid flow condition following parameters are studied
a) Filling ratio
b) Filling temperature
c) Air contact
d) Filling velocity
e) Filling pressure
f) Air volume
g) Predict cold shuts

Solidification
a) Solidus ratio
b) Solidification start time
c) Degree of soundness

In this paper results of only one condition has explained. That is fluid flow conditions

4.1Results of Analysis of Four Cavity Gating System

4.1.1Fluid flow condition

(a) Filled Ratio

Figure 10: Filling ratio of four cavity gating system

Filling ratio process of four cavity gating system is shown in figure 10. The filling ratio of gating system (casting) should be 100% filled. With the help of this know the pouring time, the pouring time is 4.1086 sec. Here slag will be identified, the color of slag is bluish color

(b) Filling Temperature

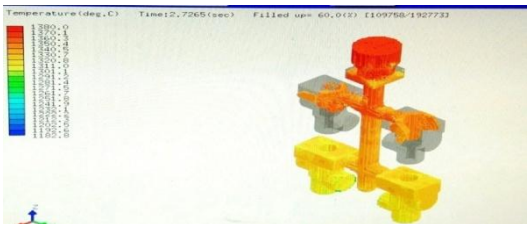


Figure 11: Filling temperature offour cavity gating system

The filling temperature of four cavity gating system is shown in figure 11. The pouring temperature should be 1380 0C, if the pouring temperature of gating system is less or more here it will be identified by color that is it acceptable up to yellow color. If temperature is dropping the cold shuts will be possible. Here 5% of cold shuts will be possible. Inthe above figure after 100% filling ratio all cavities are taken yellow color.

(c) Air Contact

Figure 12: Air contact of four cavity gating system

The air contact of four cavity gating system is shown in figure. Here light blue color shows the liquid metal and white color shows air contain. If more air is present then chances of occurring blows is maximum that is minimum air should be present. If more air is present then provide the vents. The air contact time for four cavity gating system is 3.186 sec.

(d) Filling Velocity

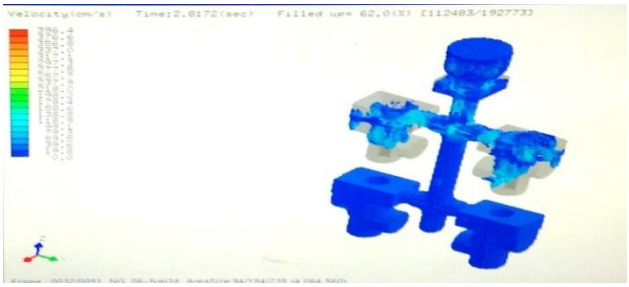


Figure 13: Filling velocity of four cavity gating system

The filling velocity of four cavity gating system is shown in figure 13 the filling velocity of four cavity gating system is 2.8172 sec that is according to this fig time required to fill four cavity is 2.8172 seconds. By according to color coding here blue color means the velocity is in the range of 0 to 19 sec that is it is acceptable.

(e) Filling Pressure

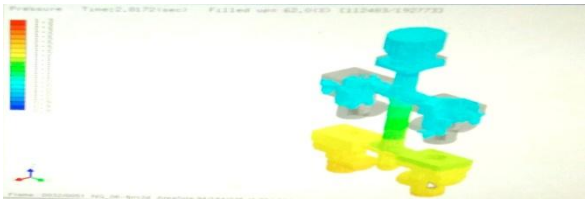


Figure 14: Filling pressure of four cavity gating system

The filling pressure of four cavity gating system is shown in the figure 14.The pressure is acceptable up to 1.1bar that is up 1 bar beyond this casting (gating system) will be rejected because if the pressure is beyond 1 bar then the sand will burn, by considering above fig up to yellow color it is acceptable that is up to 1.1bar. The pressure should be in the range of 0.5 to 1 bar. Because of this the defect like crack puncher will be occurs. To avoid this the sand thickness will be increase in the particular mold then crack will be not formed.

(f) Air Volume

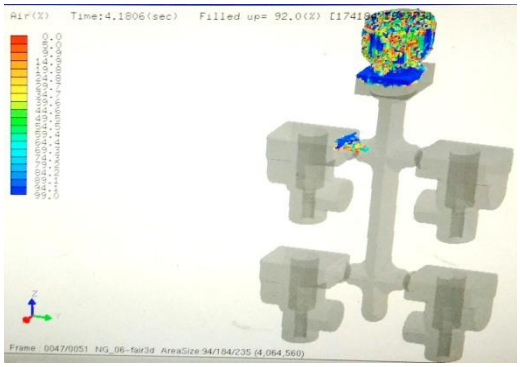


Figure 15: Air volume of four cavity gating system

An air volume of four cavity gating system is shown in the figure which help to indicate volume of air in the molten metal. Here blue color indicate air volume and gray color indicates volume of molten metal. An air should be in continues form which will removed by using chills. Figure 15 shows air volume of four cavity gating system.

(g) Predict To Be Cold Shuts

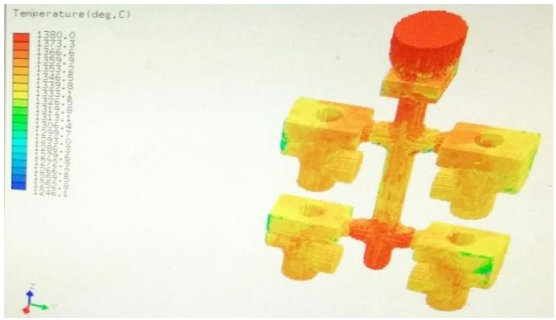


Figure 16: Predict to be cold shuts of four cavity gating system

The prediction to be cold shuts of four cavity gating system is shown in above figure 16. As the name indicate this parameter help to find out the exact location of cold shuts in the gating system of casting. Here green color indicates location of cold shuts.

4.2Results of Analysis Of Twelve Cavity Gating System

4.2.1Fluid flow condition

(a) Filled Ratio

Figure 17: Filling ratio of twelve cavity gating system

Filling ratio process of twelve cavity gating system is shown in figure 17The filling ratio of gating system (casting) should be 100% filled. With the help of this know the pouring time, the pouring time is 11.3352 all most equal to 12 sec, that is 1:3 by comparing four cavity gating system, because the pouring time for four cavity is 4.1086 sec. Here slag will be identified, the color of slag is bluish color.

(b) Filling Temperature

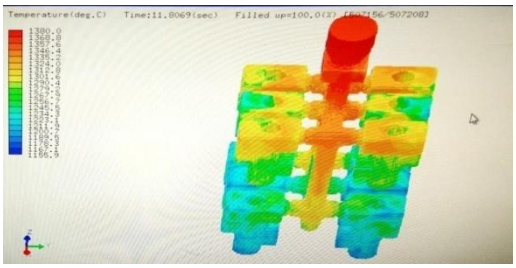


Figure 18: Filling temperature of twelve cavity gating system

The filling temperature of twelve cavity gating system is shown in figure 18. The pouring temperature should be 1380 degree C, if the pouring temperature of gating system is less or more here it will be identified by color that is it acceptable up to yellow color. If temperature is dropping the cold shuts will be possible. Here 5% of cold shuts will be possible. Here possibility of cold shuts is more, if cold shuts are more then reduce the gating system up to eight cavity.

(c) Air Contact

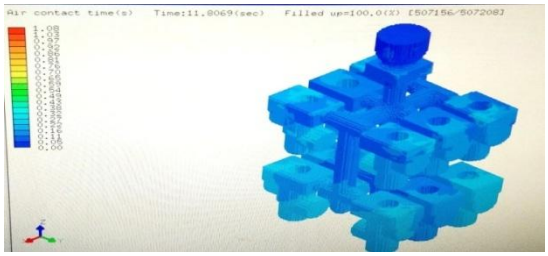


Figure 20: Air contact of twelve cavity gating system

The air contact of twelve cavity gating system is shown in figure 20. Here light blue color shows the content of liquid metal and white color shows air contain. If more air is present then chances of occurring blows is more that is minimum air should be present. If more air is present then provide the vents. The air contact time for four cavity gating system is 11.8069 sec. All most 3 times double y comparing four cavity gating system.

(d) Filling Velocity

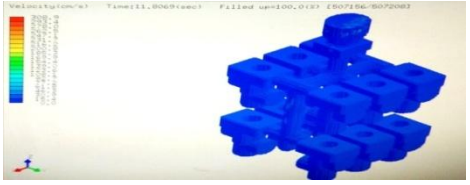


Figure 21: Filling velocity of twelve cavity gating system

The filling velocity of twelve cavity gating system is shown in the figure 21 the filling velocity of four cavity gating system is 11.8069 sec that is according to this fig time required to fill four cavity is 11.8069 seconds. By according

to color coding here blue color means the velocity is in the range of 0 to 19 sec that is it is acceptable.

(e) Filling Pressure

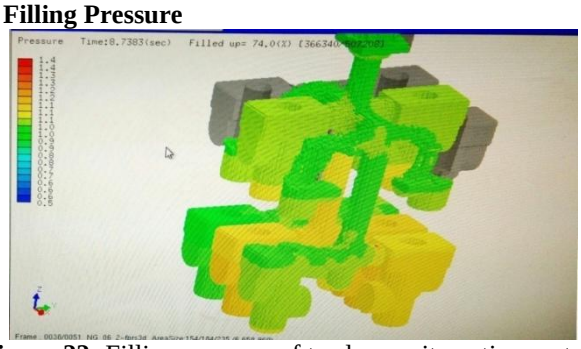


Figure 22: Filling pressure of twelve cavity gating system

The filling pressure of twelve cavity gating system is shown in the figure 22.The pressure is acceptable up to 1.1bar that is up 1 bar beyond this casting (gating system) will be rejected because if the pressure is beyond 1 bar then the sand will burn, by considering above fig up to yellow color it is acceptable that is up to 1.1bar. The pressure should be in the range of 0.5 to 1 bar. Because of this the defect like crack puncher will be occurs. To avoid this the sand thickness will be increase in the particular mold then crack will be not formed.

(f) Air Volume

Figure 23: Air volume of twelve cavity gating system

An air volume of four cavity gating system is shown in the fig which help to indicate volume of air in the molten metal. Here blue color indicate air volume and gray color indicates volume of molten metal. An air should be in continues form which will removed by using chills. Figure 23 shows air volume of twelve cavity gating system it is present in pouring cup. So this casting is acceptable.

(g) Predict To Be Cold Shuts

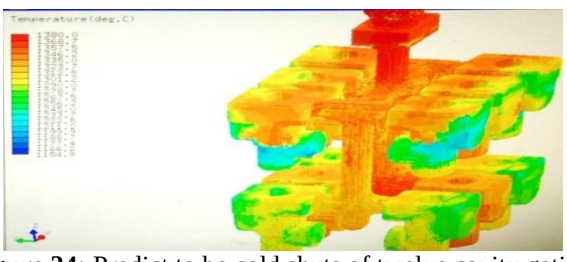


Figure 24: Predict to be cold shuts of twelve cavity gating system

The prediction to be cold shuts of twelve cavity gating system is shown in above figure 4.2.11g. As the name indicate this parameter help to find out the exact location of cold shuts in the gating system of casting. Here green color indicates location of cold shuts. By considering above fig the problem of cold shuts is more by comparing four cavity gating system that is almost end part of the casting.

5. Conclusion

In this study it is investigated that the yield of gating system of casting is increasing by increasing the numbers of cavities. But by increasing the numbers of cavities it as seen that the numbers of defects also increase. But by taking care of many defects that is by applying numbers of remedies it is possible of increase the yield and productivity of gating system. In this research work the ADSTEFAN software is used for analyzing the gating system, by comparing the reality it has given 90% accurate results and hence it will prevent loss of time and money. By taking remedies to reduce the casting defects the good results will be achieved.

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