Scientific Journal of Impact Factor (SJIF): 4.72
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 6, June -2017

TRANSIENT THERMAL ANALYSIS AND ADAPTIVE SINGLE OPTIMIZATION METHOD FOR OPTIMUM RISER DESIGN PARAMETERS

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ABSTRACT:- *Casting is that the one amongst the acceptable economical manufacturing method for manufacturing elements of various sizes and shapes. The metal casting method characterised by using sand because the mould material. Over 70% of all metal castings are made via sand casting method. The mould cavities, gating and risering systems are created by compacting the sand around models by the employment of patterns. The risering system design plays a crucial role within the quality. In present investigation, the thermal transient analysis has been done for validation comparison from literature. After validation, the optimization has been done using Adaptive single objective algorithm (ASO Tool). The Adaptive single objective method is effective tool, which is provided the optimum value. In this method, the response parameter taken were volume, temperature with various input parameters like riser diameter, riser height etc. After optimization, the optimum results are compared with before optimization results. Based on the simulation results the optimized risering system implemented to industries for production.*

KEYWORDS: *Casting, Transient Thermal Analysis, ANSYS, Adaptive Single Optimization.*

1. INTRODUCTION

Foundry industries in developing countries suffer from poor quality and productivity due to involvement of number of process parameters. Even in completely controlled process, defects in castings are observed and hence casting process is also known as process of uncertainty which challenges explanation about the cause of casting defects [3]. There is an increasing demand in manufacturing environment for the best quality of casting products at the right time and quantity. In order to survive in the competitive market and to achieve customer satisfaction trial-and-error method to produce defect free casting products from design to manufacturing is too costly and not effective. Modernization is the only key to improve casting quality and productivity [14]. In the current global competitive environment, there is a need for the casting units and foundries to develop the components in short lead time. Defect free castings with minimum production cost have become the need of foundry. The gating and riser system design plays an important role in the quality [15].

2. PROBLEM IDENTIFICATION

The better understanding of casting production and process performance in a foundry shop. It will also provide an insight on the drawbacks of foundry process and reasons behind high rejection rate due to improper understanding of solidification mechanism and riser design. The methodology adopted in these problems may be applied to almost all the foundries to produce good quality castings.

3. METHODOLOGY

From study of many literatures, various techniques have been used to determine the riser design as per as requirement to zero shrinkage castings such as Caine's method, Modulus method, Naval research laboratory method etc. In this investigation, it was considered that the plate casting (200mm X 200mm X 40mm) of aluminum alloy (LM6) metal.

The following materials types has been taken in this investigation as shown in Table 1 and Table 2.

Table 1. Properties of Sand [5]

Properties of Sand	
Conductivity	0.519 W/m K
Specific Heat	1172.304 J/kg K
Density	1495 kg/m3

Table 2. Properties of Aluminium [5]

Properties of Aluminium		
Temperature (K)	**Conductivity (W/mK)**	**Enthalpy (J/m3)**
273	234.43	0
820	216.01	1.5533x109
933	90.975	1.7769 x109
1043	94.786	2.0574 x109

4.1 Transient Thermal Analysis

Transient thermal analyses determine temperatures and other thermal quantities that vary over time. The variation of temperature distribution over time is of interest in many applications such as with cooling of electronic packages or a quenching analysis for heat treatment.

- First the geometry of the model to be analyzed is defined as show in Figure 1.

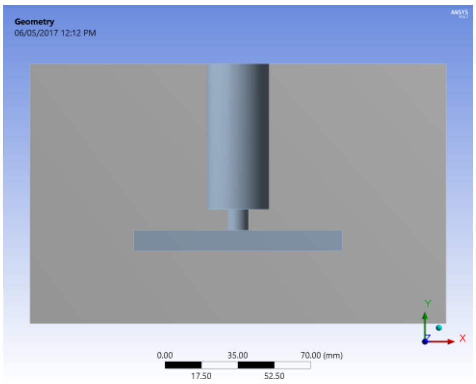

Fig 1. Symmetrically sectional view of casting mold assembly

- This is followed by specifying the boundary conditions (e.g. temperature, time, convection etc.) and the external temperatures are specified.

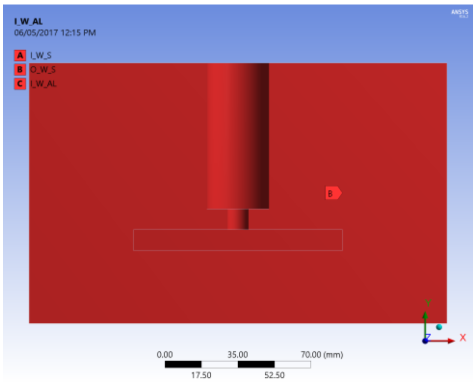

Fig 2. Boundary conditions apply on casting mold assembly

- The various results have been obtained after analysis. In this section will validation and comparison have been done.

4.2 DOE AND OPTIMIZATION

In this investigation, the Adaptive single objective optimization techniques are used for optimizing the parameter of riser in casting mold assembly. The response parameters has been shown in Table 3.

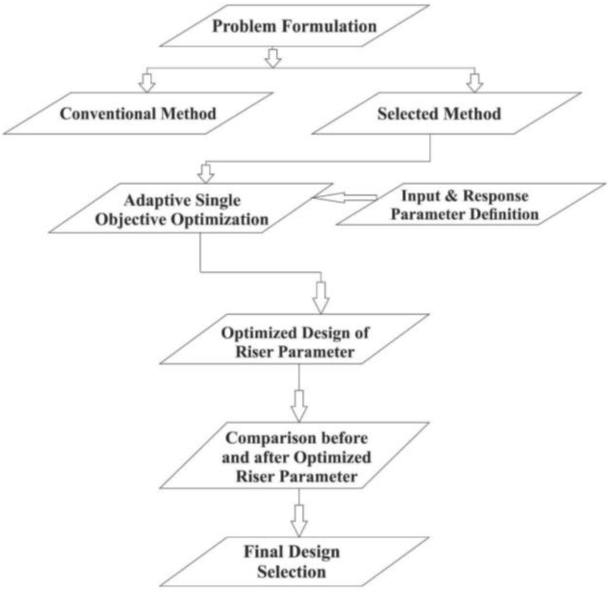

Fig 3. Flowchart of the methodology

Table 3. Optimization problem formulation for Riser parameters

Objective Function	**Minimization Parameters**	
Subject to Constraints	1	Temperature > 796.224 K
	2	Volume < 102384.01 mm^3
Input Parameters	1	30mm < Riser Diameter < 60mm
	2	60mm < Riser Height < 80mm
	3	9mm < Riser Neck Diameter< 20mm
	4	9mm < Riser Neck Height < 15mm

4. RESULTS AND DISCUSSIONS

4.1 Validation

In this section, the validation has been done for optimization work. The Figure 4, shows the validation of model and percentage between existing and present model is less than 1% hence it is validated.

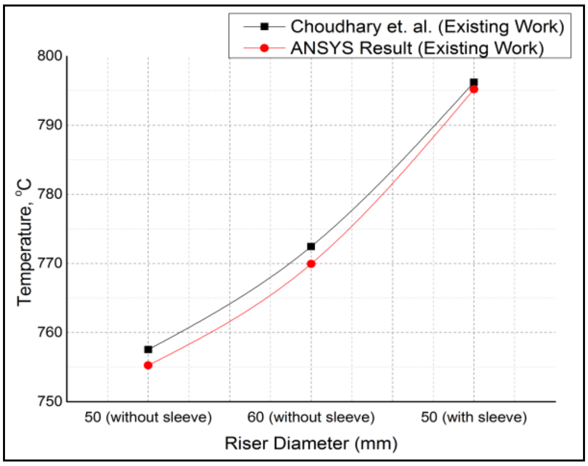

Fig 4. Graph plot between literature and ANSYS work for validation of model

4.2 Comparison

In this section, the comparison has been done between before and after optimized value of riser parameter.

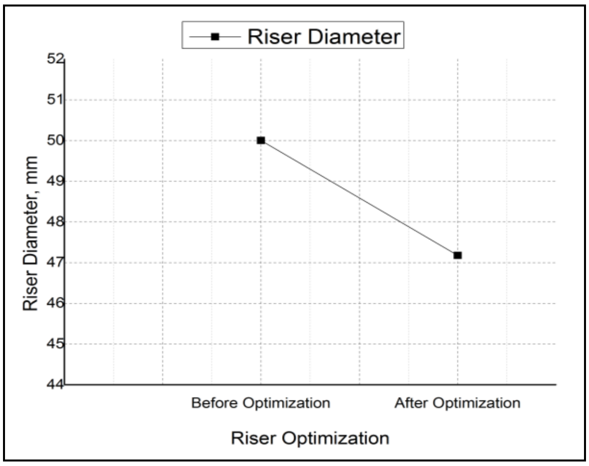

Fig **5.** Comparison of before and after optimized results of riser diameter when sleeve taken as 5mm

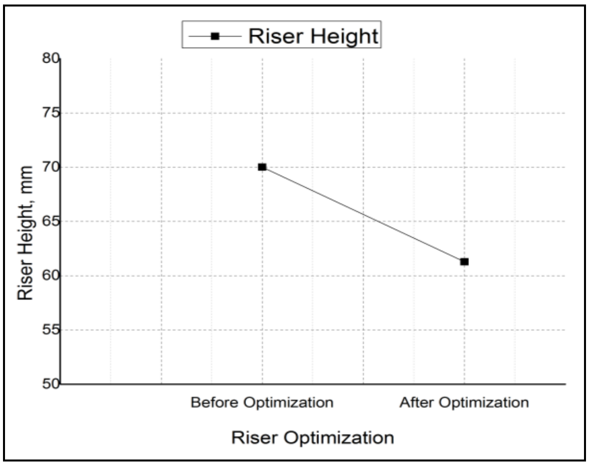

Fig 6. Comparison of before and after optimized results of riser height when sleeve taken as 5mm

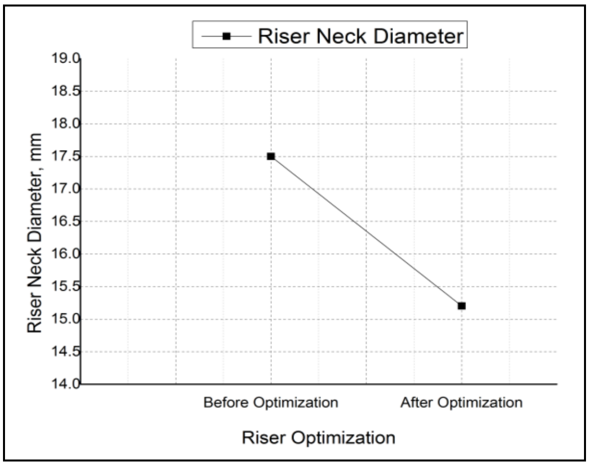

Fig 7. Comparison of before and after optimized results of riser neck diameter when sleeve taken as 5mm

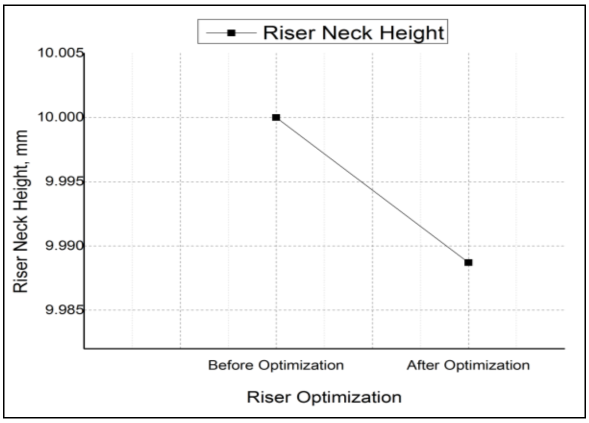

Fig 8. Comparison of before and after optimized results of riser neck height when sleeve taken as 5mm

The Figure 4-8, indicated that the results before and after optimization of riser neck height. The value of rise diameter, riser height, riser neck diameter and riser neck height of Choudhary et. al. [5] (before optimized) was 5.64%, 12.45%, 13.13% and 0.11% less than the ANSYS 16.2 optimized results respectively.

From all above results it is also find out the yield of riser will be gives more as compared to yield casting. Hence the design is the optimum and increase the yield.

5. CONCLUSION

- Casting feeding system design incorporates a direct influence on the standard and performance of overall quality of casting, because it takes look after majority of solidification defects, that accounts for optimum casting rejections.
- Casting defects elimination and thereby production of defect free casting, will be achieved by optimizing and controlling process parameters.
- Temperature gradient maps are generated by plotting temperatures on the top line of sections from hot spot partially to the riser, which provides a more robust image concerning directional set and analysis of various riser parameters and thereby improvement of feeding system.
- The topology primarily based improvement technique starts with associate over-designed riser dimension and step by step improves casting yield, at the same time ensuring defect free casting at every iteration of voxel removal.
- In present investigation, the riser yield strength increased approx. 90% to 94% after optimization, it helps to increase the yield.
- Growth of neck region is being ascertained in initial design is associate over-designed riser dimension, with feeder directly connecting to the part.
- The easy implementation of the methodology indicates a good degree for application it as a tool for automatic feeding system design and its improvement.

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