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Casting defect reduction and productivity improvement in Automotive Component

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Abstract- In this paper the design of experiments technique is used to analyze the sand related defects in shell mould casting. Several factors are contributing the sand related defects. An attempt has been made to obtain the optimal settings of the shell mould process parameters .The shell mould related process parameters considered are, AFS, Hot Tensile strength, Build Up. In this paper Taguchi based L9 orthogonal array was used for the experiment purpose and analysis was carried out with the help of Minitab software for Analysis of variance (ANOVA) and analysis of mean plot. ANOVA results indicate that the selected process parameters significantly affect the casting defect and rejection percentage.
Keywords—Casting defect, Shell mould casting, Taguchi method,ANOV

I. INTRODUCTION

Casting process is also known as process of uncertainty. Even in a completely controlled process, defects in casting are found out which challenges explanation about the cause of casting defects. The complexity of the process is due to the involvement of the various disciplines of science and engineering with casting. The cause of defects is often a combination of several factors rather than a single one. When these various factors are combined, the root cause of a casting defect can actually become a mystery. It is important to correctly identify the defect symptoms prior to assigning the cause to the problem. False remedies not only fail to solve the problem, they can confuse the issues and make it more difficult to cure the defect.
The defects need to be diagnosed correctly for appropriate remedial measures; otherwise new defects may be introduced. Unfortunately, this is not an easy task, since casting process involves complex interactions among various parameters and operations related to metal composition, methods design, molding, melting, pouring, shake-out, fettling and machining. The proper classification and identification of a particular defect is the basic need to correct and control the quality of casting. In this paper, Design of experiment (Taguchi Method) is used to the analysis of shell mould related defects.

II. LITERATURE REVIEW

B. Senthilkumara et al [1] have been studied Defects in castings lead to non-conformities and affect productivity. Pull-down is a kind of defect occurring in castings. Several factors contribute to pull-down defects. The identified factors were analyzed using 'Design of Experiments' approach. 'Signal-to-noise' ratio was estimated. Robust design factor values were estimated from the 'signal-to-noise' calculations. It was identified that the optimized values had improved the acceptance percentage from 86.22% to 96.17%.The improved acceptance percentage had enhanced productivity of the foundry.
Uday A. Dabade and Rahul C. Bhedasgaonkar[2] revealed that, the design of experiments and computer assisted casting simulation techniques are combined to analyze the sand related and method related defects in green sand casting. An attempt has been made to obtain the optimal settings of the moulding sand and mould related process parameters of green sand casting process of the selected ductile iron cast component. ANOVA results indicate that the selected process parameters significantly affect the casting defects and rejection percentage. In the second part, shrinkage porosity analysis is performed using casting simulation technique by introduction of a new gating system design .With new gating and feeding system design reduction in shrinkage porosity (about 15%) and improvement in yield (about 5%) is observed.
Rajesh Rajkolhe and J. G. Khan[3] revealed that, Foundry industries in developing countries suffer from poor quality and productivity due to involvement of number of process parameter. In order to identify the casting defect and problem related to casting, the study is aimed in the research work. This will be beneficial in enhancing the yield of casting.
Chokkalingam and Nazirudeen [4] has been analysis of casting defect through defect diagnostic study approach. They are present a systematic procedure to identify as well as to analyze a major casting defect occure in an automobile transfer case casting poured in cast iron grade FG 220. This casting was produce in a medium scale foundry using green sand process in machine moulding. The

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root cause for this major defect was identified through defect diagnostic study approach.

Prof. Kaskhedikar and Katore [5] revealed that, the quality management is an integrated management approach that aims to continuously improve the performance of products, process and services to achieve the surpass customer's expectation. Recognition of quality management is an important factor holds the key to competitiveness in the global market irrespective of the company.

III. METHODOLOGY

In this proposed method of casting defects analysis, the DOE (Taguchi Method) is used for analysis sand and shell mould related defects such as sand, sand fusion, extra material etc. Flow chart of proposed method of casting defect analysis is shown in Figure 1.

The literature review indicates that the Taguchi method is the best option for design of experiments when number of process parameter are involved in the process. Taguchi approach is suitable in experimental design for designing and developing robust products or processes irrespective of variation in process parameter (within set limits) and or variation in environmental conditions.

Taguchi Method involves identification of proper control factors to obtain the optimum results of the process.

Orthogonal Arrays (OA) are used to conduct a set of experiments. The present research as associated with shell mould process which involves various parameters at different levels and affects the casting quality. Considering these features of Taguchi method, it is used to reduce the % of rejection due to Shell moulding related defects by setting the optimum values of the process parameters of the shell mould casting.

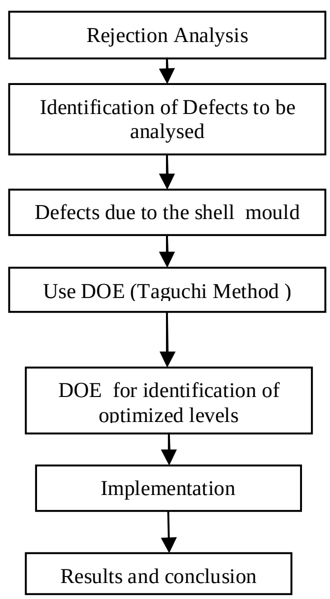

Fig. 1 Flow chart of analysis casting defect

A. Identifying the Control Factors and their levels

The factors and their levels were decided for conducting the experiment, based on the discussing with the group of people like Lab In-charge, Quality manager, Furnace supervisor, Worker working at furnace and mould checking supervisor. Figure shows the cause and effect diagram of shell mould related defect of sand, sand fusion and extra material Process parameters of the shell mould casting that influence in the indentified defects in casting Cylinder block of HMCL with their levels are shown in table no 1.

Table No.1 Process Parameters and levels

Factors	Level 1	Level 2	Level 3
A: AFS Number	60	65	70
B:Hot Tensile Strength(kg/cm2)	24	26	28
C: Build Up(%)	48	50	52

B. Selection of Orthogonal Array

The number of experiments to be conducted for three factors and three levels under full-factorial testing is 27. Any process will give the best possible output when all of the factors operate at the optimum level. If 'm' factors are selected with 'n' levels, the total number of experiments to be conducted is 'n^m'. If the total number of factors and levels involved is greater, the number of experiments to be conducted becomes very large. Taguchi suggested the use of an orthogonal array (OA), which is the basis for conducting 'fractional factorial' experiments. The most suitable orthogonal array for experimentation is L9 array as shown in Table no 2.

IV. EXPERIMENTAL WORK

Experiments were performed in a medium scale ferrous foundry producing cast iron components. From the collection of the data it's found that average percentage of the rejection per month in a foundry is 9.20%.Therefore, Total percentage of rejection = Percentage of Rejection + Line Rejection .So the Total percentage of rejection per month is 10 to 11%.

The quantity of production and quantity of rejection is major for the component Cylinders block (HMCL, TVS 74CC, Bajaj K70), Flange 5 port, Manifold. Also the percentage of rejection under the furnace and shell mould is higher as compare to others. So it required to control on the both furnace and shell mould related defect. There are many inter-dependent activities in the foundry process such as molding, core setting, melting, pouring, cooling, shot blasting and fettling. Table 2 shows the percentage of approved castings for 'L9' orthogonal array settings.

Table 2 Percentage of approved casting for orthogonal array setting

Experiment No	Signal Factor Level			Percentage of approved casting
	A	B	C	
1	1	1	1	98.33
2	1	2	2	99.17
3	1	3	3	98.75
4	2	1	2	99.58
5	2	2	3	99.58
6	2	3	1	98.33
7	3	1	3	99.17
8	3	2	1	98.33
9	3	3	2	98.33

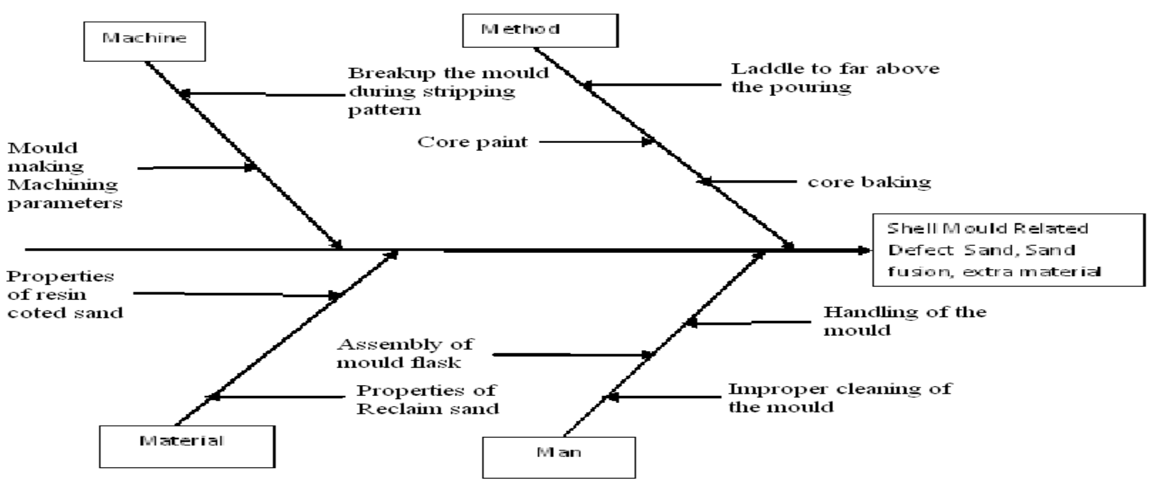

Fig 2. Cause and effect diagram

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A. Signal-to-noise ratio evaluation

As an evaluation tool for determining the robustness of the design, 'signal-to-noise' ratio (SNR) is the most important component of the factor design. In the Taguchi method, the term 'signal' represents the desirable target (higher percentage of approved castings) and 'noise' represents the undesirable value. A robust system will have a high SNR. SNR should be as large as possible for higher values of approved percentages. Table 3 shows the average SNR for each at the signal level and factors, respectively.The SNR for each factor level is calculated using the following:

$S/N = -10\log \times (\Sigma(1/Y^2)/n)$ (1)

Where, n= Sample Size, and y= Number of approved casting.

Table 3– Average SNR values for each signal values and factors

Signal level	Factor		
	A	B	C
1	39.89	39.91	39.85
2	39.93	39.91	39.91
3	39.88	39.87	39.93

B. ANOVA analysis

F-test value at 95 % confidence level is used to decide the significant factors affecting the process. The purpose of ANOVA is to investigate which casting process parameters significantly affect the percentage of rejection in casting. This is accomplished by separating the total variability of the S/N Ratios, which is measured by the sum of squared deviations from the total mean of the S/N ratio (Table 4). In the experimentation work, for S/N ratios, Build up($p = 0.032$) has the significant effect on rejection percentage of casting at a α-level of 0.05, other parameters AFS ($p = 0.075$) and HTS ($p = 0.061$) are non significant because their p-values are greater than 0.05.

Table 4-ANOVA for % rejection at 95 % confidence limit

Factors	DoF	SS	MS	F ratio	P value
A	2	0.49662	0.24831	12.37	0.075
B	2	0.61976	0.30988	15.43	0.061
C	2	1.20496	0.60248	30.01	**0.032**
Error	2	0.04016	0.02008		
Total	8	2.36149			

AOM plot in Figure 3 indicates that % rejection is minimum at second level of AFS (A2), second level of HTS (B2), and third level of Build up (C3).

4Confirmation experiments

Three confirmation experiments were performed at the optimized settings of the process parameters, results of which are shown in Table 5. Prior to the application of Taguchi method rejection due to sand related defects for component HMCL was which is reduced.

Table 5 Results of confirmation experiments

Experiment	Factor Level			Percentage of approved casting
	A	B	C	
1	1	3	2	99.58
2	1	3	2	99.58
3	1	3	2	99.17

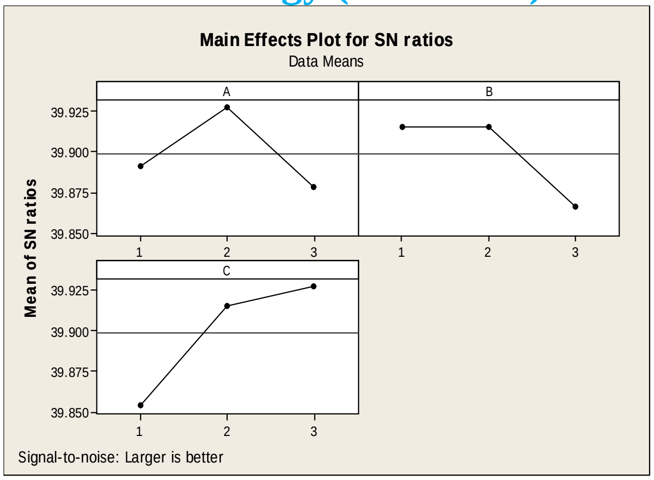


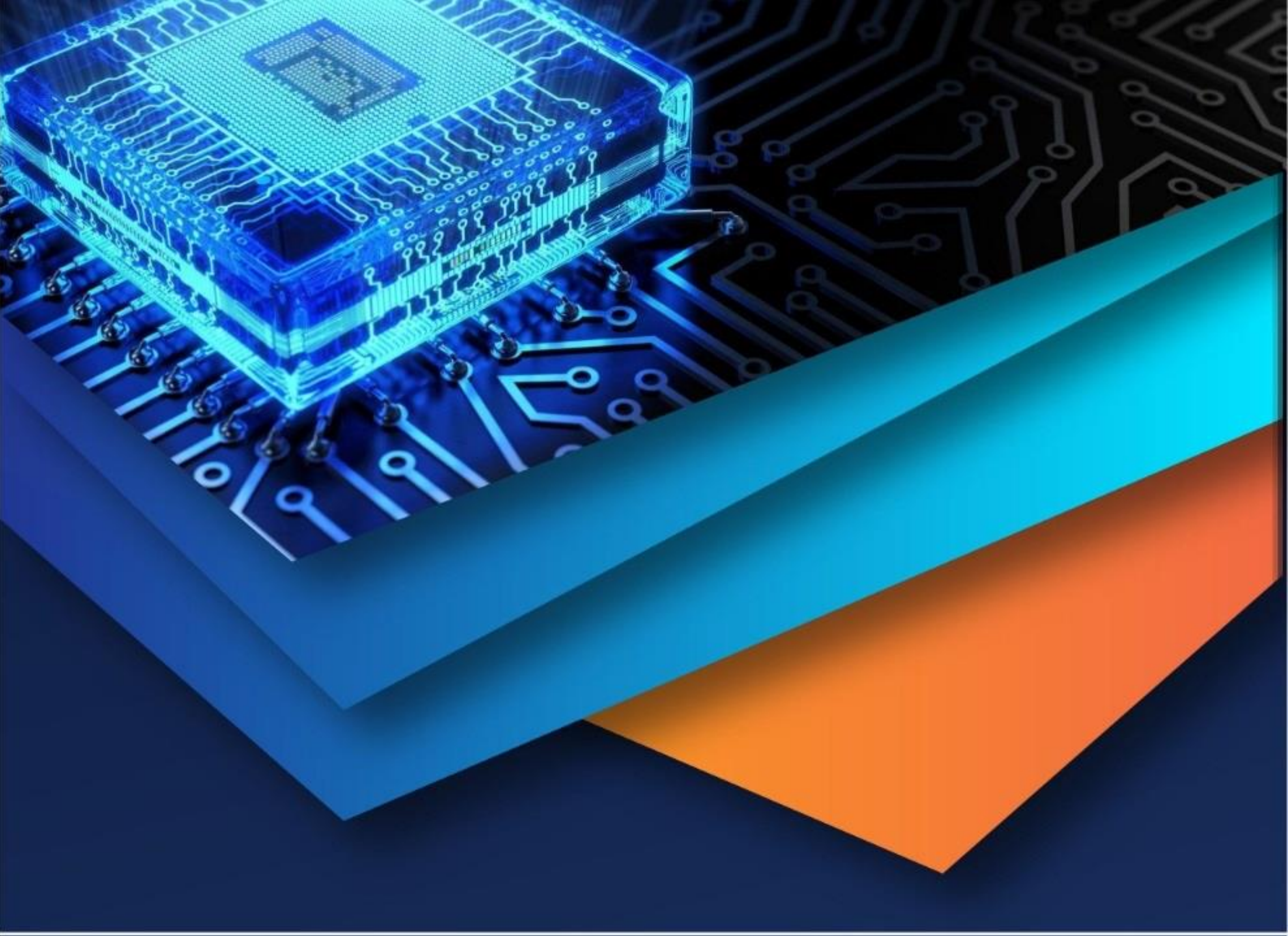
Fig. 3 Main effects plot for S/N ratio

V. CONCLUSION

The optimized levels of selected process parameters of the shell mould obtained by Taguchi method are:AFS(A): 65, HTS(B): 26kg/cm^2, Build Up:52%.With Taguchi optimization method the % rejection of castings due to sand related defects is reduced from 3.2 % to a maximum upto 1.5%.Design of experiments method such as Taguchi method can be efficiently applied for deciding the optimum settings of process parameters to have minimum rejection due to defects for a new casting as well as for analysis of defects in existing casting.

REFERENCES

[1] Senthilkumar, S.G. Ponnambalam,N.Jawahar, "Process factor optimization for controlling pull-down defects in iron castings "Journal of materials processing technology (2009), 554–560.
[2] Uday A. Dabade and Rahul C. Bhedasgaonkar,"Casting Defect Analysis using Design of Experiments (DoE) and Computer Aided Casting Simulation Technique", Forty Sixth CIRP Conference on Manufacturing Systems ,2013, 616 – 621.
[3] Rajesh Rajkolhe, J. G. Khan, "Defects, Causes and Their Remedies in Casting Process: A Review", International Journal of Research in Advent Technology, Vol.2, No.3, March 2014.
[4] B. Chokkalingam and S. S. Mohamed Nazirudeen, "Analysis of Casting Defect through Defect Diagnostic Study Approach", Journal of Engineering, Annals of faculty of engineering, Hunedoara. pp 209-212.
[5] Prof. K. Kaskhedikar and H. V. Katore, "Improvement of Quality and Productivity in Casting Industries",Vol.2, Issue.3,2013, ISSN: 2320-2491, pp 63-71.
[6] P. N. Rao, 1998, Manufacturing Technology-Foundry, Forming and Welding, Tata McGraw-Hill Publications, New-Delhi.



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