Research Paper

REDUCE CASTING DEFECTS IN FOUNDRY BY TAGUCHI METHOD

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ABSTRACT

In this paper the casting defects such as shrinkage, sand drop, blowhole are minimized by using Taguchi optimization techniques. The process parameters selected for the sand casting are Compression Strength (g/cm2), Moisture Content (%), Permeability Number, Mould Hardness number. The Taguchi approach is used to find the signal to noise ratio of the experiments based on the orthogonal array (L9) used to find the Optimum condition. A confirmation run is used to verify the result, which indicated that this method is more efficient in determining the best casting parameters.

Index Terms— Green sand casting, Taguchi Method

I. INTRODUCTION

Foundry industry is a mother industry for all the other engineering and automotive industries. The Taguchi method is powerful problem solving technique for improving the quality of the product and also productivity. A large number of experimental investigations linking green sand casting parameters with casting quality have been carried out by researchers and foundry engineers over the past few decades.

It has been recognized that green sand casting parameters design plays one of the key elements in casting quality. The casting process has a large number of parameters that may affect the quality of castings. Kumarvadivel et al. [1] Optimization of sand casting process variables a process window approach. The optimized parameters obtained using the Taguchi method. Saravan kumar et al. [2] Optimization of casting process parameters using Taguchi analysis and select suitable process parameters in casting industry to produce defect free casting. Sushil Kumar et al.[3] The quality can be improved by Taguchi's method of parameter design at the lowest possible cost and also optimize the process parameters of the green sand castings process which lead to minimized casting defects.

This paper summarizes the following:

i) Improving quality of green sand casting through process control. Keeping the effects of uncontrolled parameters at a minimum level.
ii) Analysis and select the most significant parameters that affect quality characteristics.
iii) Select an appropriate orthogonal array and suitable levels of parameters.
iv) Analysis the data using Minitab and generate interaction graphs, response graphs.
v) Decide on the optimal settings for the control parameters.
vi) Validate the optimum setting levels in reducing the levels of the Quality Characteristics (Casting Defects)

II METHODOLOGY

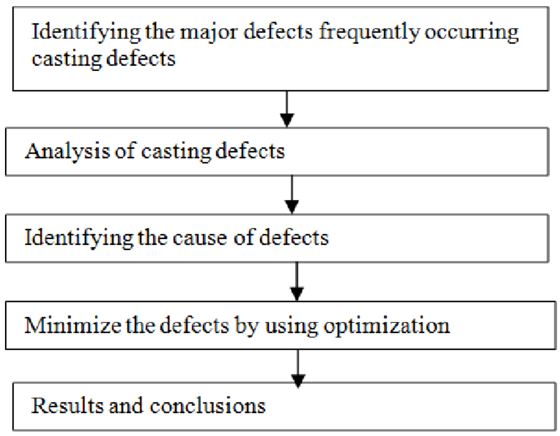

Figure 1: Methodology

A. Process parameters of Green sand Casting

Rajesh Rajkolhe et al.[4] The identified factors were analyzed using 'Design of Experiments' approach. 'Signal –to –Noise' ratio was estimated. The following process parameters are identified as significant and their levels are listed in Table 1:

TABLE 1 : PROCESS PARAMETERS AND THEIR LEVELS

S.N	Parameters	Designation	Range	Level 1	Level 2	Level 3
1	Compression Strength (g/cm2)	A	1000-1200	1000	1100	1200
2	Moisture Content (%)	B	3-4%	3	3.5	4
3	Permeability Number	C	140 -190	140	165	190
4	Mould Hardness	D	85-95	85	90	95

B. Quality Characteristics

Casting defects was selected as a quality characteristic to be measured. Prasan kinagi et al.[5] Design of Experiment and FMEA techniques are combined to analyze casting defects. To get optimal parameters setting for defects like cold shut and blow hole. The most common defects occurring in the foundry were monitored and recorded. The lower the better number of casting defect implied better process performance.

Lower is better : $S/N_{LB} = -10 \log [(\sum y2i)/n]$

TABLE 2: ORTHOGONAL ARRAY L9

Trial No	A	B	C	D
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	2	1	2	3
5	2	2	3	1
6	2	3	1	2
7	3	1	3	2
8	3	2	1	3
9	3	3	2	2

C. Selection of orthogonal array

III EXPERIMENTATION

The experimental Orthogonal array will look like as follows:

TABLE 3: EXPERIMENTAL ORTHOGONAL ARRAY

Trial No	A	B	C	D
1	1000	3	140	85
2	1000	3.5	165	90
3	1000	4	190	95
4	1100	3	165	95
5	1100	3.5	190	85
6	1100	4	140	90
7	1200	3	190	90
8	1200	3.5	190	95
9	1200	4	165	85

Lower the better S/N ratios were computed for each of the 9 trials and the values are given in the table 4:

For example, for trial no. 1 , the

S/N ratio is : $= -10 \log [(\sum y_i^2)/n]$

S/N ratio $= -10 \log [(9.2^2+9.7^2+9.6^2)/3]$

$= -10 \log [(84.64 + 94.09 + 92.16)/3]$

$= -10 \log [(270.89)/3]$

$= -19.55$

IV RESULT

Minitab worksheet:

Table 6 shows the average SNR for each at the signal level and factors, respectively.

Table 7 shows the robust design optimum value of factors for maximization of approved castings

TABLE 4: MEAN VALUE AND S/N RATIO OF CASTING DEFECTS AT DIFFERENT LEVELS

Trial No	Trial 1	Trial 2	Trial 3	Mean (% of Rejection)	S/N Ratio
1	9.2	9.7	9.6	9.5	-19.5545
2	7.5	7.8	7.9	7.7	-17.7298
3	8	8.2	8.3	8.1	-18.1697
4	8.3	8.1	8.2	8.2	-18.2763
5	7.8	7.5	7.9	7.7	-17.7298
6	6.8	6.4	6.9	6.7	-16.5215
7	7.3	7.6	7.8	7.5	-17.5012
8	8.3	8.5	8.8	8.5	-18.5884
9	8.3	8.5	8.2	8.3	-18.3816

TABLE 5: MINITAB WORKSHEET

A	B	C	D	Trial 1	Trial 2	Trial 3	Mean	SNRA1
1000	3	140	85	9.2	9.7	9.6	9.5	-19.5545
1000	3.5	165	90	7.5	7.8	7.9	7.7	-17.7298
1000	4	190	95	8	8.2	8.3	8.1	-18.1697
1100	3	165	95	8.3	8.1	8.2	8.2	-18.2763
1100	3.5	190	85	7.8	7.5	7.9	7.7	-17.7298
1100	4	140	90	6.8	6.4	6.9	6.7	-16.5215
1200	3	190	90	7.3	7.6	7.8	7.5	-17.5012
1200	3.5	140	95	8.3	8.5	8.8	8.5	-18.5884
1200	4	165	85	8.3	8.5	8.2	8.3	-18.3816

TABLE 6: AVERAGE SNR VALUES FOR EACH SIGNAL VALUES AND FACTORS

LEVEL	A	B	C	D
1	18.48	18.44	18.22	18.55
2	17.50	18.01	18.12	17.25
3	18.15	17.69	17.80	18.34

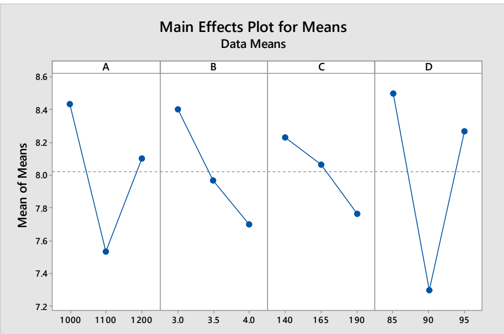

Figure 2: Main Effects Plot for Means

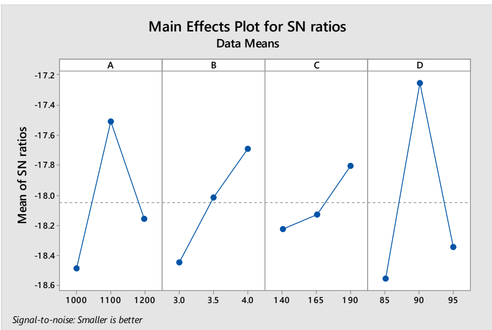

Figure 3: Main Effects Plot for SN ratios

TABLE 7: ROBUST DESIGN OPTIMUM VALUE

FACTOR	SNR	LEVEL	OPTIMUM VALUE
A	17.50	2	1100
B	17.69	3	4
C	17.80	3	190
D	17.25	2	90

V CONCLUSIONS

The optimum conditions for the parameters are given below as

Compression Strength (g/cm^2)	1100	Level 2
Moisture Content (%)	4	Level 3
Permeability Number	190	Level 3
Mould Hardness	90	Level 2

The improvement expected in minimizing the variation is 10-15 % of casting defects in the foundry. By using Taguchi method the factor levels when optimized will result in reduction of casting defects and increase the yield percentage of the accepted casting without any additional investment. Quality of casting can be improved by aesthetic look, dimensional accuracy, better understanding of noise factor and interaction between variables, scrap reduction, reworking of casting and process control.

REFERENCES

1. Kumarvadivel. R, “Optimization of sand-casting process variables a process window approach” Advanced science technology (2012), Procedia Engineering 50, 88-94.
2. Saravana kumar. M, Jeya prakash. K, “Optimization of casting process parameters using Taguchi analysis” International Journal of Mechanical Engineering and Research, ISSN 0973-4562 Vol 5 No.1 (2015).

3. Suhil kumar. P. S , D.R. Prajapati, " Optimization of green sand casting process parameters of a foundry by using Taguchi's method" International Journal of Advanced Manufacturing Technology (2011) 55 : 23-34.
4. Rajesh Rajkolhe, J.G. Khan, " Process factor optimization to enhance productivity of green sand casting process by using Taguchi methodology" International Journal of Research in Advent Technology, Vol 2, No 6, June 2014.
5. Prasan Kinagi, Dr. R. G. Mench, "A development of quality in casting by minimizing defects", International Journal of Recent Research in Civil and Mechanical Engineering (IJRRCME) Vol.1, Issue 1, pp: 31-36, Month : April 2014-September 2014.
6. M. Narasimha, R. Rejikumar, K. Sridhar, "Statistical Methods to optimize process parameters to minimize casting defects", International Journal of Mechanical Engineering and Technology (IJMET) Volume 4.Issue 3, May-June (2013), pp.11-23.
7. Adarsh Kumar, Jagjit Singh, " Optimization of sand casting process parameter for Ferrous Material by using Design of Experiments", International Journal on Emerging Technologies 2 (2) : 122-127 (2011).
8. Mr. Deepak Kumar, Optimization of sand casting parameter using Factorial Design ; Volume 3, Issue 1, January 2014, ISSN No 2277-8179.
9. Guharaja S, "Optimization of green sand casting process parameters by using Taguchi's method" ISSN (1897-3310) Volume 12 Issue 1/2012 13.