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Effects on Mechanical Properties of Cast Iron by Varying the Sand Parameters in Casting by Design of Experiment Approach

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ABSTRACT

Casting is the most importance process in the world. The sand casting is very common for all industries but the sand casting have low yield and not sufficient quality of mechanical properties like hardness and surface roughness. To estimate the quality characteristics of grey CI (ASTMA48) rigid coupling castings we use this analysis. During the optimization of the green sand casting process, some parameters like green strength , moisture content and clay content are required to finally examine the experiment and in out-turn it achieve surface , hardness & as well as its roughness .The characteristics which are estimated depend upon the optimum staging of green sand casting at the optimum stage of parameters is done in this paper and by confirming results are done with the practical experiential.

Keywords: Green strength, Hardness, Surface roughness, Design of experiment

I .INTRODUCTION

Taguchi's method has simplified the work for a practitioner. Also it gives clarity to understand the variation nature and the economic consequences when it comes to quality engineering in the manufacturing world. Taguchi introduces his approach in experimental design mainly for designing products/processes robust to component variation, environmental condition and minimizing variation around a target value.

There are three levels in process developments

1. System level
2. Parametric level
3. Tolerance level

System level is the process of applying scientific and engineering knowledge to produce a basic functional prototype design .Parameter is an investigation conducted to identify the settings of the design parameter that optimize the performance characteristics and reduce the sensitivity of engineering design to sources of variation (noise).

Tolerance level is the process of determining tolerances around the nominal settings identified in the parameter design process. Green sand casting technique is the most widely used manufacturing process. The quality of a green sand casting is the result of a great number of parameters .The Taguchi's techniques for optimizing green sand casting technique seems to be the easiest ,fast and highly productive in today's competitive international markets . The focus of this paper is based upon the robustness of the green sand casting process. The elementary steps for achieving the above target are condensed below.

1. Hardness and surface roughness are selected the appropriate parameters that results in the difference with the quality of casting and its quality features.
2. Form the green sand casting process under the appropriate exploratory conditions which oppress by chosen orthogonal array (OA) and parameter stage. Depend upon the experimental state, collect the data.
3. Study the data .An analysis of variance (ANOVA) table can be created to find the statistical import of the parameters. Response graphs are plotted to examine the preferred stage for each parameters.

4. Resolve regarding optimum surroundings of the control parameters and finally judge of the results of each parameter to their contemporary optimum levels.
5. Confirm the reduction of casting defects with Radiographic test.

II LITERATURE REVIEW

The majority of the presented articles in the maximization of the casting process parameters established on the Taguchi's method are given below. Barua et al. [5] used the Taguchi's method to maximize the mechanical properties of Vacuum (V) casting process. This paper, they recognize the effects in the selected process specification on the mechanical properties of the cast iron casting and resulting maximum settings in the parameters, which are practiced using Taguchi's method parameter design. Syrcos [7] analysed different significant process parameters in the die casting process of grey cast iron . He made an trial to obtain optimum settings in die casting process parameters in order to return the maximum casting density of grey cast iron castings. Masters et al. [8] describe a strong design process for decreasing cost and improving the quality in the grey cast iron remelting process. An experimental analysis into the casting process parameter effects is display to determine the maximum configuration of the design specification for the performance, quality and the cost. G.Mahesh et al. [9] made a study in the maximization of a hardness casting process using Taguchi's strong design technique. In this study, they determine that the casting process involves a vent hole parameters that affecting the variant in casting quality of features product. The decrease in the weight of the casting is compared with target weight is taken to be comparative to the castings weakness. Shaji and Radhakrishnan [10] performed an investigation of the process parameters in the surface grinding with the graphite as lubricant based on Taguchi method. This paper according with the evalution of process parameters like speed, and feed, in the mode of dressing as controlling factors on force component and the surface finish optimized based on Taguchi's design methods.Ghani et al. [11] used Taguchi method in maximization of end milling process and machine parameters. They applied to maximum cutting force in machine parameters in the end milling machine when machining the hardened steel with tin-coated carbide tool under semi-finishing conditions of machine with high cutting speed. George et al. [12] employed Taguchi's method in the EDM machining of carbon and the carbon composites.

III PROCESS PARAMETERS OF GREEN SAND CASTINGS:

In order to estimate the various factors that influence the outcome of the green sand castings, the causes and effects flow chart (An Ishikawa diagram) was constructed as shown in Fig 1 and the process was thoroughly studied for further progress. And as a result, the critical parameters that affect the performance of greensand castings are categorized as follows:

1. Mould-machine-related parameters
2. Cast-metal-related parameters
3. Green-sand-related parameters
4. Mould-related parameters
5. Shake-out-related parameters

From Ishikawa diagram (Fig.1), some of the most crucial parameters that triggers the mould of greensand castings are moisture content (%), green strength (g/cm2), permeability (number) and mould hardness (number). Through the process performance charts, the effective ranges of these parameters are concluded as, the range of moisture content was selected between 4%–5%, the green strength was selected as 50–70, the Clay content was to be chosen in the range of 5–7. The selected green sand casting process parameters, along with their ranges, are given in Table 1. The hardness are taken by various experimental run in Brinell hardness tester as shown ion figure 1. The surface roughness are taken by surface roughness tester is shown in figure 2.

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Figure: 1 Brinell Hardness Tester (BHN)

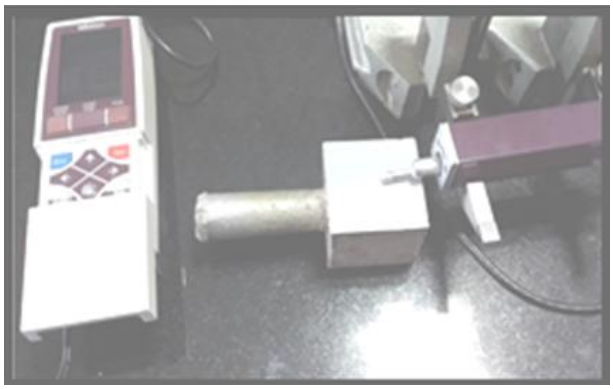

Figure 2: Surface Roughness Tester

IV SELECTION OF ORTHOGONAL ARRAY

The each number of control of the parameter level is defined in the experimental region, two are three levels are selected from each control factor one level is always be a starting level. To avoid the small changes in control factor setting so the sufficient level should be chosen to cover the wide experimental region. From this part we can able to find a good and bad experimental region for the control factor.

Based on the behavior the each process parameters will analyze by different levels. The three levels of values are given in the table1.

There should be a consideration of the significant interaction from the selected parameters. It is inferred the moisture content with green strength and permeability by significant interaction. Therefore, there will a change occurs in the moisture content in green strength and it will also affect the permeability of the sand. Therefore, the interaction is 9 by the total degrees of freedom, only 3 degrees of freedom is needed it has totally 9degrees of freedom, the L9 orthogonal array is selected, it has 3columns and it specify 9experimental runs. The input parameters are moisture content, clay content and green strength and output responses like hardness and surface roughness. The input levels and output responses are shown in table 1.

Table: 1 Levels of L9 orthogonal Array

Sl no	Input Parameters	units	Levels		
			1	2	3
1	Moisture Content	%	6	7	8
2	Clay Content	%	4	5	6
3	Green Strength	Shore-A	50	60	70

V EXPERIMENTAL WORKPIECES

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L9 orthogonal array of experimental run is completed experimentally in standard sand casting shop and the work pieces are shown in figure 3.

Figure 3: L9 Experimental Work Piece in Cast Iron

VII RESULT AND DISCUSSIONS

Taguchi has accommodated two apparatus to aid in the errand of factors and pendant to arrays the apparatus are: the main effect graph and interaction plots. The various factors and their pendant are allocated in each column of the L9 orthogonal array. The allocated L9 orthogonal array is shown in Table 2.

Table 2: Experimental run for L9 orthogonal array

Exp Run	Moisture Content	Clay Content	Green Strength	Hardness	Surface Roughness
	%	%	Shore-A	BHN	microns
1	6	4	50	162	3.786
2	6	5	60	166	3.723
3	6	6	70	160	3.765
4	7	4	70	161	3.865
5	7	5	50	159	3.89
6	7	6	60	166	3.711
7	8	4	60	167	3.766
8	8	5	70	158	3.876
9	8	6	50	168	3.786

In this section, the part of experimental investigation contains Moisture content, Clay content, Green Strength, Hardness and surface Roughness. The experimentation was conducted for 9 run. From the table 2, the green strength for aluminum and brass are similar to each other. The surface roughness of brass obtained from the experimentation is also very much similar to that of Cast iron.

VI ANOVA

The rigid coupling casting study has been done ,ANOVA is fetch out using the results of experiments and interpretation methods is nearly obtain the contribution with a percentage and its optimum level of parameters in each stages is shown in table 3.

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Table: 3 ANOVA various parameters in Cast iron

Cast Iron										
	Hardness					Surface Roughness				
Source	**SS**	**DOF**	**MS**	**F**	**p**	**SS**	**DOF**	**MS**	**F**	**p**
Model	201.75	6	33.63	3.92	0.0281	0.3	9	0.033	0.87	0.5858
A-Moisture Content	3.12	1	3.12	0.36	0.5596	0.019	1	0.019	0.48	0.5096
B-Clay Content	18	1	18	2.1	0.1781	2.11	1	0.042	.048	0.9819
C-Green Strength	78.13	1	78.13	9.11	0.0129	0.011	1	0.011	0.27	0.6169
AB	72.25	1	72.25	8.42	0.0158	0.012	1	0.012	0.31	0.5953
AC	0	1	0	0	1	0.13	1	0.13	3.42	0.1067
BC	30.25	1	30.25	3.53	0.0898	0.03	1	0.03	0.78	0.4078
Residual	85.78	10	8.58			0.27	7	0.038		
Cor Total	287.53	16				0.57	16			

Cast Iron material from the Table 3 it is observed that the Green strength has additional significance (9.11) on hardness, Moisture Content has a smaller amount implication (0.36).For to achieve Good Surface Roughness Moisture Content has extra implication (0.48),then Clay content has not as much of significance (0.048).

Main effect Plot

Main effect plot is used to represent the optimum level of input process parameters for this experimental investigation. The optimal level of input parameters for this experimental investigation is represented as the highest value of each level in the main plot

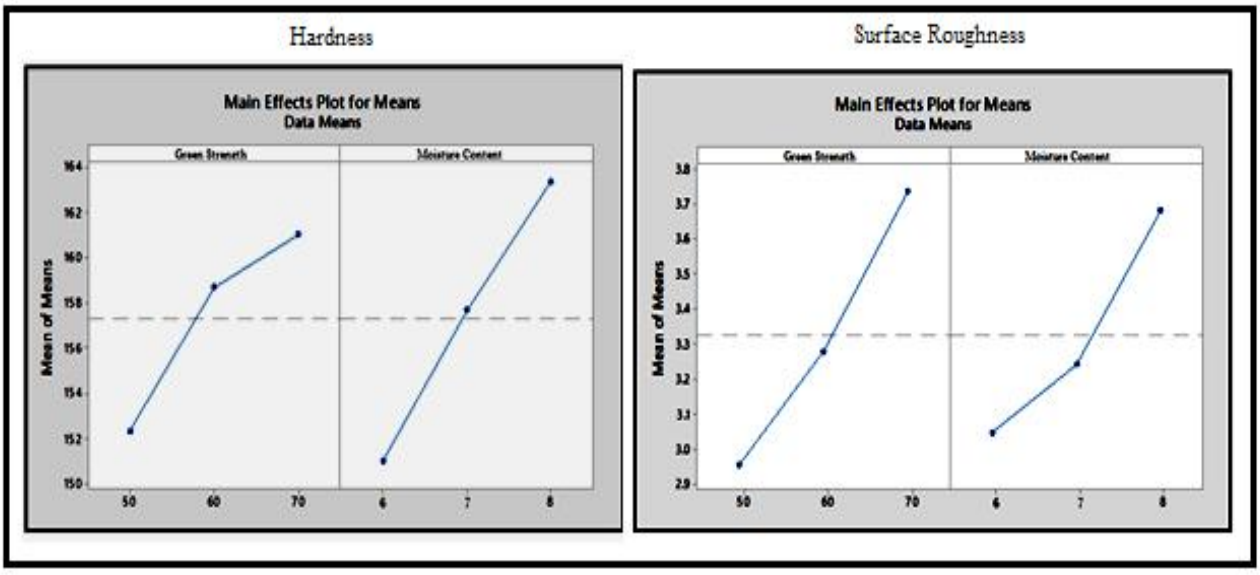

Figure 4 SN ratio for hardness and surface roughness in Cast iron

The optimal level of input parameters for this experimental investigation is represented as the highest value of each level in the main effect plot. From Figure 4.4, it is observed that the effect of input parameters increases with increase in the level. The optimal level of parameters for this experimental work is melting temperature 1200 ºC, Green strength 50and Moisture Content 8%. For surface roughness, is melting temperature 1200 ºC, Green strength 50 and Moisture Content 5%..

CONCLUSION

From the above examination, it is been manifested that, by the process of ameliorate the quality by Taguchi's method of parameter design at the lowest possible cost, it is possible to distinguish the optimum levels of signal factors at which the noise factors' effect on the response parameters is less. The outcome of this paper is the optimized process parameters of the green sand castings process which leads to minimum casting defects. The optimized parameter levels are moisture content–5%, green strength–50 and Clay content 5 Also, the experiments give a clear picture of every factor's contribution to the variation in the green sand casting process, and the level can be improved without additional expenditure.

REFERENCES

1. Ross PJ (1988) Taguchi techniques for quality engineering. McGraw Hill, New York
2. Taguchi G (1986) Introduction to quality engineering.Asian Productivity Organization, Tokyo, Japan
3. Enright TP, Prince B (1983) Offline quality control parameter estimation and experimental design with the Taguchi method. AFS Transactions, pp 393–400
4. Byrne DM, Taguchi G (1987) The Taguchi approach to parameter design. QualProg 19–26
5. Barua PB, Kumar P, Gaindhar JL (1997) Optimization of mechanical properties of V-process castings by Taguchi method.Indian Foundry J 17–25
6. ASM International Committee (1990) Metals Handbook for Castings, vol 15, 10th edn
7. Syrcos GP (2002) Die casting process optimization using Taguchi methods. J Mater Process Tech 135:68–74.
8. Masters I, Khoei AP, Gethin DT (1999) The application of Taguchi methods to the aluminium recycling process. In: Proceedings of the 4th ASM Conference and Exhibition on the Recycling of Metals, Vienna, Austria, June 1999, pp 115–124
9. G. Mahesh,K. Murugu Mohan Kumar, S. Bharathi Raja, N. Baskar and M. Ganesan ; Experimental Investigation and Optimization of Hardness in Sand Casting Process by Using the Design of Experiments Approach, Appl. Math. Inf. Sci. 11, No. 3, 931-938 (2017)
10. Shaji S, Radhakrishnan V (2002) Analysis of process parameters in surface grinding with graphite as lubricant based on the Taguchi method. J Mater Process Tech 51–59
11. Ghani JA, Choudhury IA, Hassan HH (2002) Application of Taguchi method in the optimization of end milling parameters.J Mater Process Tech
12. George PM, Raghunath BK, Manocha LM, Warrier AM (2002) EDM machining of carbon-carbon composite—a Taguchi approach. J Mater Process Tech.
13. Jain RK (1995) Production technology, 15th edn.Khanna Publishers, India
14. Barker TB (1986) Quality engineering by design: Taguchi's philosophy. QualProg 33–42.