Experimental Investigation of Response Parameters in Surface Grinding of EN31 Steel by Using Taguchi Method and Artificial Neural Network

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ABSTRACT - In present-day the En-31 steel discover a frequentuses in automotive industries like axle shaft, roller bearing, shear blades, spindle, ball bearing, moulding dies, punches, bolts etc.This current work income the following process parameters such as no of passes, feed rate, and depth of cut. The foremostintention of this work is to forecast the grinding performance and come through the optimumoperation process parameters. A software system is also exploited that assimilates these frequent models to simulate what succeeds throughout surface grinding process. The estimation from this work is examined by with actual work. Many variables are involves in this work such as depth of cut, feed rate, no of passes. The core objective of this work to maximize the metal removal rate andminimize the surface roughness and elevate these values by using Taguchi method and ANN.

Keyword: ***EN 31 Alloy Steel, surface grinding, Taguchi Method, ANN.***

I. INTRODUCTION

Surface finish plays a dynamic role in the manufacturing sector. To attain the essential surface finish, grinding process frequently used in manufacturing industries. Grinding is a machining process in which grinding wheel is used as a cutting tool which is prepared by the abrasive particles to achieve the required surface finish on the object. In grinding process metal is disinterested with the help of abrasive grinding wheel. There are altered types of grinding processes used in industries in existing time i.e. surface grinding, cylindrical grinding, centerless grinding and creep-feed grinding. Surface grinding machine is used for attain high metal removal rate on planespecimen in this exertion [1].

The grinding is costlyprocess that must to be used underoptimal conditions, when equated with other machining process. In the surface grinding process the major processes parameters that influence the output parameters metal removal rate, surface roughness, surface damage and tool wear etc. are grinding wheel grain size, wheel grade, structure, binders, etc. work piece parameters such as mechanical properties and chemical properties etc. process parameters work speed, no of passes, federate, depth of cut, dressing situation and machine parameters like spindle system,, static and dynamic conditions etc.

In this work the following input parameters used such as no of passes, depth of cut, and feed rate. The EN31 is ordinarily used in shear blades,moulding dies; punches etc. and this application needs perfect finishing. . A software system is also exploited that assimilates these frequent models to simulate what ensues throughout surface grinding process. The leading objective of this work to maximize the metal removal rate and elevate these values by using Taguchi method and artificial neural network. [2]

II.LITERATURE REVIEW

Arvind V. Lal et. al [3] executed experiments on surface grinding machine with consist of the machining parameters such as grinding wheel type, hardness of work piece**,** and the depth of cut, which manipulate the output parameters such as surface roughness and temperature at the tool work piece interface. They chose the material Hardening Non Shrinking (ONHS) Die steel for machining. They used the analysis of variance (ANNOVA) for analysed the surface roughness.

Mustafa Kemal Kulekci et. al [4]evaluated the surface grinding process parameters such as grinding wheel speed, Feed rate, and depth of cut to find the optimal surface roughness. The material was selected AISI 1040 steel plates using EKR46K grinding wheel and the methodology applied to attain the finest parameters are Taguchi Method L_9 OA, Signal to noise (S/N) ratio and analysis of variance (ANNOVA). They conclude that the (R_a) significantly exaggerated by the wheel speed and depth of cut and feed rate has lower effect on it.

Balwinder Singh et.al [5] inspected the effect of input parameters such as grinding wheel speed, work piece speed, and nozzle angle on the surface roughness. The material was designated Mild Steel and machining completed on surface grinding machine. For the measurement of surface roughness the perthometer roughness tester was used. The

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above experiment they conclude that all the input parameters i.e. table speed, wheel speed, and nozzle angle have affect the feature of finished Mild Steel work piece and the minimum value of surface roughness (0.77μm) achieved at wheel speed (2800 rpm), work piece speed (1.5m/min), and nozzle (angle 6º).

Binu Thomas et. al [6] displayed an experiment on Silicon carbide ceramic material at surface grinding machine considering the input parameters such as feed rate, depth of cut, wheel speed. Response Surface Methodology in Design Expert Software and analysis of variance (ANNOVA) used for optimized the results. They accomplish that the surface roughness developed throughout the process, inclined by the table feed, depth of cut, and wheel speed.

Pawan Kumar et. al [7] implemented an experiment on EN24 steel at CNC grinding machine with the surface grinding process parameterssuch as grinding wheel speed, table speed, and depth of cut in terms of surface quality and metal removal rate. The methodology adopted in this study (RSM) Response Surface Method was employed to determine the optimum machining parameters trends to minimum (R_a) and maximum MRR in grinding process.

III. PROBLEM IDENTIFICATION

The identification of machining and grinding problems for EN31 alloy steel which cannot be undertaken using conventional technique because of following problems occur in grinding.

TABLE 1 LAYOUT OF EXPERIMENTAL DESIGN ACCORDING TO L16 ARRAY

No. of exp.	No of passes	Feed rate	Depth of cut
1	A	A	A
2	A	B	B
3	A	C	C
4	A	D	D
5	B	A	B
6	B	B	A
7	B	C	D
8	B	D	C
9	C	A	C
10	C	B	D
11	C	C	A
12	C	D	B
13	D	A	D
14	D	B	C
15	D	C	B
16	D	D	A

- Deprived chip breaking
- Extraordinary work hardened
- Tendency to sticky
- Alterationprompted plasticity
- Passive surface is affected
- Machining alteration

The overheadcomplications are toooverwhelmed during surfacing grinding and attaining good surface finish and dimensional accuracy.

IV. METHODOLOGY

For this experimental work Taguchi Method can be used. Slight arrays can be drawn out manually but large arrays can be imitative from deterministic algorithms. The arrays are nominated by the number of parameters and the number of levels.To elevate the performance distinctive the investigation of variance on the composed information from the Taguchi Design of Experiments can be used to select new parameter values.

A. Taguchi Method of Orthogonal Arrays

Parameters-3

1. No of passes
2. Feed rate
3. Depth of cut

There are total four levels for each parameter.

Therefor refer Taguchi table of orthogonal array L16

A total number of 16 experiments have been carried out with varying grinding no of passes, depth of cut and feed rate.By the Design of Experiments and the N- Factorial Method the process variables, levels and the number of experiments have been decided.

TABLE 2 CONTROL FACTOR LEVELS

Control factor	Units	Levels			
		(i)	(ii)	(iii)	(iv)
No of Passes	Nil	1	2	3	4
Feed Rate	mm/min	30	60	90	120
Depth of Cut	mm	0.02	0.04	0.06	0.08

V.EXPERIMENTAL DETAILS

Three parameters that are deliberated significant in the process of surface grinding i.e.no passes, feed rate and the depth of cut are occupied in this experimental work. The effect of machining parameters on the metal removal rate of the specimen has been carried out in this experimental work. A total number of 16 experiments have been carried out with varying grinding no of passes, depth of cut and feed rate. For this projecta constant speed surface grinder from Perfect Union has been used. By the Design of Experiments and the N- Factorial Method the process variables, levels and the number of experiments have been decided.

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Fig. 1 Surface grinding process

The experiments are carried out using a surface grinder from B. M. T shown in Fig. no. 1.The following steps were undertaken in this present work.

- The machine tool to be used for the experiments and also selection of the material of the specimen.
- The machine chosen on the basis of selection of suitable machining parameters.
- Design of Experiments for conducting experiments.
- The experiments are conceded out in the prearranged order and equipment set up for measuring metal removal rate.
- The values of the MRR are tabulated along with the process parameters and are exposed to ANOVA to regulate the most significant parameter.

The equation use for measure metal removal rate.

$$MRR = \frac{WB - WA}{Time}$$

Where

W_B = Weight of specimen before machining

W_A = Weight of specimen after machining

T = Time taken during machining

TABLE 3 Wheel Parameters

S No	Detail	Description	Specification
1.	Structure	5	Dense
2.	Grade Size	K	Medium
3.	Bond	V8	Vitrified
4.	Shape	1	Straight
5.	Dimensions	Diameter×Width×Bore (All in mm)	150×25×31 (mm^3)
6.	Material	Aluminium Oxide	A

VI. Result and Discussion

As per Taguchi design on surface grinding machine all the experimentations are accomplishedeffectively. The best process quality and optimum condition has been reproduced in this investigational work. Surface roughness and Metal Removal Rate readings for all 16 objects are measured and response tables for them are given in table 4.

TABLE 4 EXPERIMENT RESULTS

No. of Exp.	No of passes (N)	Feed rate (f) mm/min	Depth of cut (d) mm	Material Removal Rate (MRR) grm/sec	Surface Roughness (Ra) (μm)
1.	1	30	0.02	0.00532	0.37666
2.	1	60	0.04	0.01527	0.25000
3.	1	90	0.06	0.02857	0.30666
4.	1	120	0.08	0.10169	0.35666
5.	2	30	0.04	0.00552	0.27333
6.	2	60	0.02	0.01327	0.39333
7.	2	90	0.08	0.01818	0.40333
8.	2	120	0.06	0.02655	0.55000
9.	3	30	0.06	0.00369	0.44666
10.	3	60	0.08	0.00554	0.53666
11.	3	90	0.02	0.00565	0.52666
12.	3	120	0.04	0.01266	0.46333
13.	4	30	0.08	0.00420	0.51666
14.	4	60	0.06	0.00621	0.43000
15.	4	90	0.04	0.00826	0.63333
16.	4	120	0.02	0.00600	0.69000

From the overhead attained experimental data it is state that maximum MRR is 0.10169 grm/sec obtained at no. of pass (1) of the object, 0.08 mm of depth of cut and 120 mm/min of feed rate. As the similar minimum Ra 0.25000 (μm) is obtained at no. of passes (1) of the object, 0.04 mm of depth of cut and 60 mm/min of feed rate.

The key effects plots of machining parameters v/s response are shown in fig. 2 and fig 3. Main effect plot shows that

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for MRR and Ra the Feed rate and no. of passes are the most effective parameters.

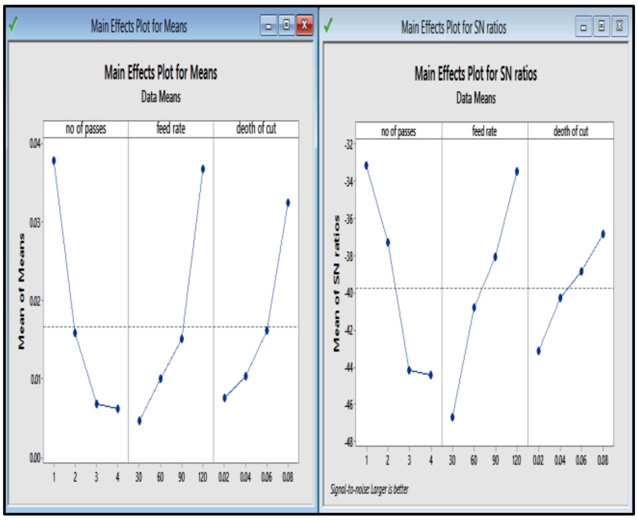

Fig. 2 MRR v/s Control parameters

Fig. 2 shows that when the no. of passes increases metal removal rate decreases and increases in depth of cut and feed rate MRR increases.

S/N data investigation has been accomplished, in this investigational work. From the investigation of S/N ratio it is originate that for MRR, feed rate extremely affects (with maximum delta of 13.27) then no. of passes (with delta of 11.31) then depth of cut (with nethermost delta of 6.27). From the overheadconversation we mark first rank to feed rate, second rank to no of passes and third rank to depth of cut according to their effects on MRR.

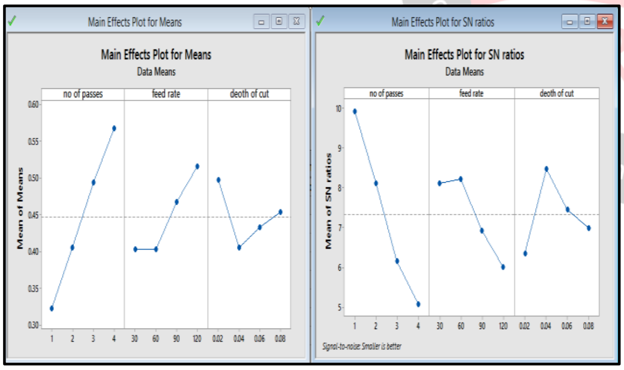

Fig. 3 Ra v/s Control parameters

Fig. 3 shows that when the no. of passes increases surface roughness increases, when feed rate and depth of cut increases surface roughness increases. As consequence we conclude that no of passes and feed rate are most controlling parameters that impacts surface roughness and depth of cut is minimum effective parameter.

Same as for Ra, no. of passes tremendously effects (with maximum delta of 4.872) then feed rate (with delta of 2.207) and Depth of cut (with delta of 2.145). From the overhead conversation we mark first rank to no. of passes, second rank to feed rate and third rank to depth of cut according to their effects on (Ra).

VII. Procedure to Develop ANN

For the approximation and prediction of surface grinding response parameters ANN is used in this present work. It is very familiar to calculate the surface roughness and material removal values with the use of ANN approach. Experimental data is used to train and test the model. Data obtained from experimentations is used to train the network. For the testing and testing of network the data of sixteen experiments are used. Constraints n, f, d is used as input set, while Ra and MRR is attention as intentions (output) set. Algorithms, transfer function, hidden layers, and neurons, network design were entitled on the basis of presentation of network.

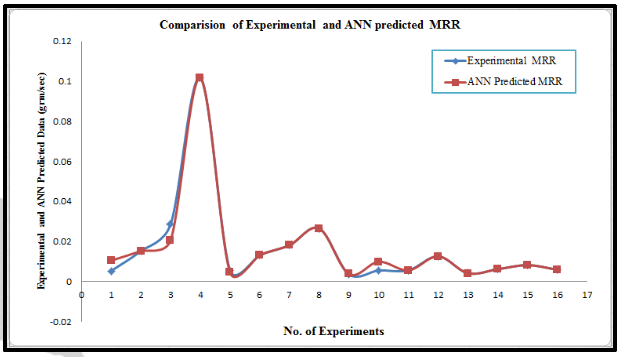

Fig. 4 Difference between experimental and predicted MRR

The difference between experimental data and ANN predicted data shown in fig.4 only three experimental values are conflicting from predicted values remaining thirteen values are same as predicted values. Experiment number 1, 3 and 10 have the dissimilar experimental and predicted ANN values.

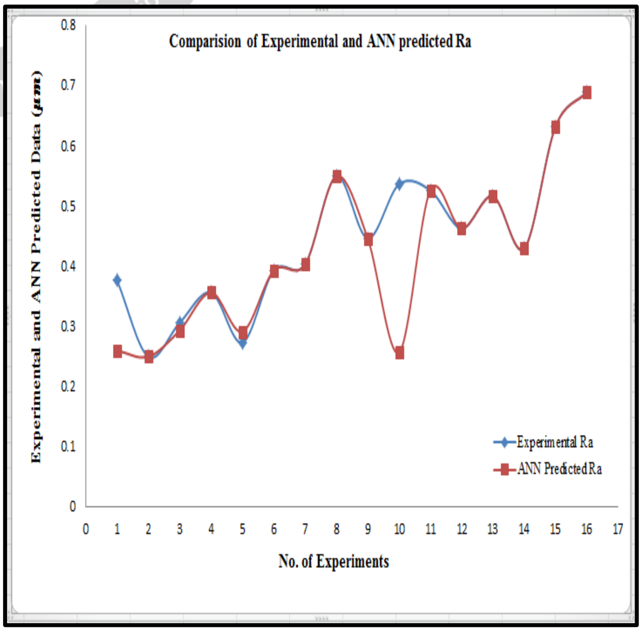

Fig. 5 Difference between experimental and predicted Ra

From the upstairs fig. 5 out of 16 investigational values only three investigational values are different from ANN

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predicted values. Experiment number 1, 5 and 10 have the dissimilar experimental and predicted ANN values.

VIII. RESULTS OF RA AND MRR

The experiments are accompanying on EN31 alloy steel in surface grinding process it is originate that:

- For generating preferred surface superiority, EN31 alloy steel has a capability to obtain desired result.
- The optimum data for surface roughness (Ra) is 0.25 (μm) attained.
- The optimum data for material removal rate (MRR) is 0.10169 (grm/sec) achieved.

IX. CONCLUSIONS

- Two software and computer built approaches such as Taguchi DOE in MINITAB, ANN in MATLAB is effectively practical for the prediction of Ra and MRR.
- No. of passes, feed rate are the most dominating parameters that effects surface roughness and depth of cut is less operative parameter for surface roughness.
- During machining process it is achieved that when the no. of passes and feed rate increases then surface roughness increases.
- Same as for MRR it is establish that when the no of passes increases metal removal rate decreases and increases in depth of cut and feed rate MRR increases.

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