IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

EXPERIMENTAL STUDY ON DRILL TOOL VIBRATIONS AND OTHER PARAMETERS ON EN'8 STEEL

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Abstract: Modern automotive industries are looking for high strength materials to increase their overall efficiencyy and performance. As in present scenario the stainless steel will secure and provide the requirements of such industries, because of their high strength, thermal resistant, and corrosion resistance properties. Machining of hardened materials like steel is a very commonly seen issue in industries with a low level or minimum number of process parameters and getting a optimised outputs so drilling experiments are conducted on the EN'8 steel according to TAGUCHI design of experiments using different coated HSS twist drill bits namely Normal HSS, Black Oxide coated, Cobalt mix coated for different parameter combinations of speed, feed, and different coolants like Soluble oil, Karenja oil, Neem oil. The data obtained from the present work is analyzed by using GREY REALTIONAL ANALYSIS optimisation in taguchi technique and optimum machining parameter levels are identified for minimization of responses mainly amplitude(vibrations) and other parameters like temperature, power and surface roughness.

Index Terms **- En8 steel, Coated drill bits,Coolants,Grey Relational Analysis.**

I.INTRODUCTION: The machining industry primarily focused on machinability, or the ease with which metal can be removed, which can be measured by a variety of factors like better surface quality,least damage to the machine tool,workpiece.very low level of tool wear , and lower cutting temperatures at the chip-tool interface, with less cutting force and power usage as well as being environmentally and economically viable.The difficulties of hardened work materials machining with the right cutting tool materials and process parameters levels is still a hot topic in the manufacturing business due to pressure of deadlines.The growth of tool wear has a negative impact on the requirement for surface quality. As a result, the optimised to address these difficult challenges, a process parameter is required. Additionally, the appropriate As a result, predictive algorithms are required to forecast wear and tear.

II.EXPERIMENT AND RESULTS

The Exeperimentation is done on the setup which is shown in the below figure according to the Design of Experiments which is done on the Minitab software and the setup uses the Data Aquisition system to obtain the required values from the experiment such as vibration ,temperature ,power and the surface roughness is measured by the talysurf tester ad the optimization is done by using the Grey Relational Analysis.

Fig 1 : Experimental setup

Fig 2 : experimented work piece

Exp no	Coolant	Material	Speed (Rpm)	Feed (mm/rev)	Vibration amplitude (mm)	Temperature (°C)	Power (Watts)	Surface roughness (μm)
1	K.O	Normal HSS	500	0.15	0.5952	58.5	1150	0.43
2	K.O	Black Oxide	550	0.20	0.0730	45.9	1500	0.34
3	K.O	Cobalt mix	600	0.30	0.2406	49.7	1600	0.60
4	N.O	Normal HSS	550	0.30	0.1137	43.8	1500	0.59
5	N.O	Black Oxide	600	0.15	0.1046	47.9	1600	0.52
6	N.O	Cobalt mix	500	0.20	0.1611	45.6	1550	0.34
7	S.O	Normal HSS	600	0.20	0.3024	46.7	1800	0.27
8	S.O	Black Oxide	500	0.30	0.2268	47.2	1600	0.33
9	S.O	Cobalt mix	550	0.15	0.0811	48.3	1650	0.26

Table 1 : Experimental values

III.OPTIMISATION USING GREY RELATIONAL ANALYSIS

In multi-responses data of problem, the influence and relationship between different parameters are bit confused and not clear. This is denoted as grey which signifies poor and uncertain way of information. This methodology (grey relational analysis) analyzes this complicated uncertainty among the multi-responses in a given system and optimize it with the help of grey relational grade(GRG). Therefore a multi-response optimization problem is converted to a single response optimization problem called single relational grade.

Step-1

To avoid using different units and getting confused, the data is to be first standardised. Because the variation of data differs from that of others, it is mostly required. To construct the array between 0 and 1, an appropriate value is obtained by the original value. Its the way of converting original data to equivalent data in general. If the answer is to be minimise, the below formula is used to normalised it into an appropriate range using smaller-is-better characteristics.

$$x^*_i(k) = \frac{\max\ x_i(k) - x_i(k)}{\max\ x_i(k) - \min\ x_i(k)} \qquad (1)$$

where, *i = 1,…, m; k = 1,…,n., m* is the number of experimental data and n is the number of responses. xi(k) gives the original sequence, *xi* (k)* denotes the sequence after the data preprocessing,
max xi(k) denotes the large value of xi(k), min xi(k) denotes the small value of xi(k), and x is the desired value.

Exp no	Vibration amplitude(mm)	Temperature (ºC)	Power (Watts)	Surface roughness (μm)
1	0.000	0.000	1.000	0.500
2	1.000	0.857	0.462	0.765
3	0.679	0.599	0.308	0.000
4	0.922	1.000	0.462	0.029
5	0.939	0.721	0.308	0.235
6	0.831	0.878	0.385	0.765
7	0.561	0.803	0.000	0.971
8	0.705	0.762	0.308	0.794
9	0.984	0.694	0.231	1.000

Table 2: Grey relation generational values

Step-2
Grey relational coefficient ξi(k) can be calculated by usage the usage of normalized values by the given formula as below

$$\Delta_{0i} = \|x_0(k) - x_i(k)\| \qquad (2)$$

where,
Δ0i is the deviation sequence of the reference and the comparability sequence
x0 (k) denotes the reference sequence, xi (k) implies comparability sequence.

Exp no	Evaluation of Δoi				Grey Relational Coefficient			
	Vibra-tion	Temper-ature	power	SR	vibration	Temper-ature	power	SR
1	1.000	1.000	0.000	0.500	0.333	0.333	1.000	0.500
2	0.000	0.143	0.538	0.235	1.000	0.778	0.481	0.680
3	0.321	0.401	0.692	1.000	0.609	0.555	0.419	0.333
4	0.078	0.000	0.538	0.971	0.865	1.000	0.481	0.340
5	0.061	0.279	0.692	0.765	0.892	0.642	0.419	0.395
6	0.169	0.122	0.615	0.235	0.748	0.803	0.448	0.680
7	0.439	0.197	1.000	0.029	0.532	0.717	0.333	0.944
8	0.295	0.238	0.692	0.206	0.629	0.677	0.419	0.708
9	0.016	0.306	0.769	0.000	0.970	0.620	0.394	1.000

Table 3. Grey Relational Coeffecient

Step-3

The grey relational grade (GRG) can be calculated as follows

$$\gamma_i = \frac{1}{n}\sum_{k=1}^{n} \xi_i(k) \qquad (3)$$

where, □ *i* is the required grey relational grade for I'th experiment and
n = number of response characteristics.
ζ is distinguishing or coeffiecient of identification and the range is 0 to 1. Usually, the value of ζ is taken as 0.5.
Thus the multi-response optimization problem is changed into single response optimization problem using grey relational analysis coupled with Taguchi way of approach.

Exp no	Grey Relational Grade	Rank
1	0.542	8
2	0.735	2
3	0.479	9
4	0.672	3
5	0.587	7
6	0.670	4
7	0.632	5
8	0.609	6
9	0.746	1

Table 4: Grey Relational Grade

Step-4

As higher grey relational grade means the appropriate level of process parameters is identified.it indicates greater product quality. To find the average grade values for each and every level of process parameter, which can then be displayed as a mean response table. High values of average grade are considered as the best and optimum parametric combination for multi-responses from the table of mean responses given below.

Level	Coolant	Material	Speed	Feed
1	0.5853	0.6153	0.6070	0.6250
2	0.6430	0.6437	0.7177	0.6790
3	0.6623	0.6317	0.5660	0.5867
Max-min	0.0770	0.0283	0.1517	0.0923
rank	3	4	1	2

Table 5: Main Effects on Mean Grey Relational Grade

Si no	Coolant	Material	Speed	Feed	GRG	Mean
1	1	1	500	0.15	0.542	0.542
2	1	2	550	0.20	0.735	0.735
3	1	3	600	0.30	0.479	0.479
4	2	1	550	0.30	0.672	0.672
5	2	2	600	0.15	0.587	0.587
6	2	3	500	0.20	0.670	0.670
7	3	1	600	0.20	0.632	0.632
8	3	2	500	0.30	0.609	0.609
9	3	3	550	0.15	0.746	0.746

Table 6 :Mean Values from Taguchi Analysis

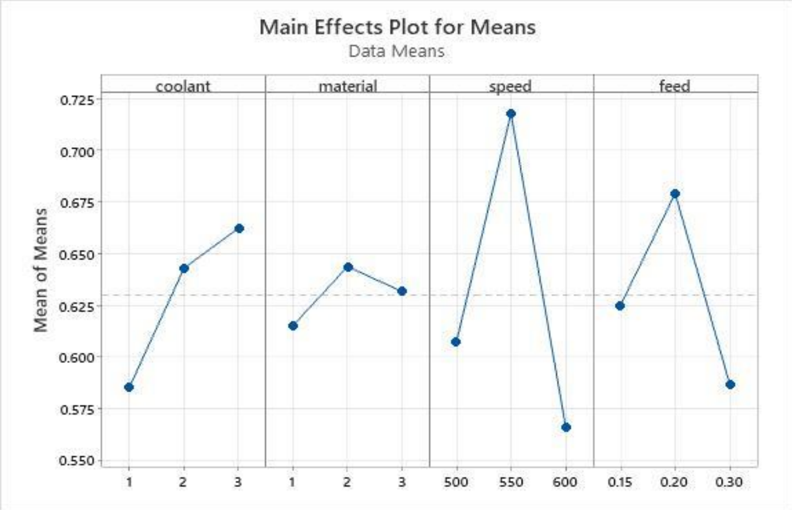

Fig 3 : Main Effect Plot For Means

Step-5

Next Analysis of Variance (ANOVA) is calculated by using the values of grey relational grade and to show the significance of the parameters as shown in the table 7 and the most significant parameter here Speed with 60.86% contribution than the other parameters.

Source	DF	Seq SS	contribution	Adj SS	Adj MS	F-value	P-value
Coolant	2	0.009628	15.87%	0.009628	0.004814	*	*
material	2	0.001214	2.00%	0.001214	0.000607	*	*
Speed	2	0.036931	60.86%	0.036931	0.018465	*	*
Feed	2	0.012911	21.28%	0.012911	0.006455	*	*
Error	0	*	*	*	*		
Total	8	0.060684	100.00%				

Table 7: Results of ANOVA on Grey Relational Grade

Step-6

Optimal combination of process parameters are to be found, next step is to vary improvement of grey relational grade by conducting confirmatory experiment. The predicted value of GRG for optimal level can be obtained as below.

		Optimal cutting factors	
	Intial parameters	**Predicted values**	**Experimental values**
Level	C3 – M3 – S2 – F1	C3-M2 - S2 -F2	C3-M2 - S2 -F2
Coolant	Soluble oil	Soluble oil	Soluble oil
Material	Cobalt mix coated HSS	Black oxide coated HSS	Black oxide coated HSS
Speed	550	550	550
Feed	0.15	0.2	0.2
Grey Relational Grade	0.746	0.812	0.6775

Table 8 : Confirmation experiment values

IV.RESULTS AND CONCLUSIONS

- The optimum combination of the parameters is found within the material **Black oxide coated HSS Drill bit ,** coolant **Soluble oil** at a speed of **550 rpm** with feed rate of **0.20 mm/rev** and their corresponding optimum responses are vibration amplitude of **0.1628 mm** with temperature **47 ºC ,**power consumption of **1700 watts** and surface roughness of **0.29 µm.**
- The most influential parameter is speed followed by feed ,coolant and the material.
- In the three different coated drill bits the **Black oxide coated HSS drill bit.**
- The response parameters temperature and power got minimum with the use of **Karenja and neem oil.**
- The parameters vibration amplitude and surface roughness got lowered by **Soluble oil.**

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