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AN EXPERIMENTAL INVESTIGATION OF PEELING OPERATION FOR AISI 202 STEEL WITH RESPONSE SURFACE METHOD

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ABSTRACT Bar peeling is a method which is used to remove oxide scale, mill scale, surface cracks etc. from hot rolled or forged blanks. During peeling operation, the bar is passed through a rotating peeling head, with a radial direction of cut. The influence of cutting parameters on surface roughness was analyzed for one insert and the influence of these parameters was obtained. There are many parameters that have an effect on surface roughness such as cutting speed, feed rate, and depth of cut are known to have a large impact on surface quality.

KEYWORDS : Peeling; bright bar; cutting parameters; surface roughness; insert.

I. INTRODUCTION

Bar peeling is a method, which is used to remove oxide scale, surface cracks, etc. from hot rolled and forged blanks. The size of blank can vary from 4 mm to over 400 mm in diameter. Compared with conventional turning bar peeling is a method of machining which provides high productivity and low production costs due to the shorter throughput times. He surface quality and dimensional tolerances are also high, which in turn leads to less machining at succeeding stages. During the peeling operation the bar is moved through a rotating peeling head, with a radial direction of cut. The peeling head in this case four cartridges, each with one to three insert which are all in contact with the bar. The inserts serve for roughing and finishing.

During the peeling operation the bars getting a helical pattern, "ringing", on their surface. So, more tolerance is to be provided on the peeled bars (around 0.1 – 0.5 mm). After peeling operation, the bars are taken on the center less grinding machines, at where the grinding is done on the bars to achieve the required size. This is done with the help of 3-4 grinding passes. So the operation cost is affected adversely.

II. WORKING PRINCIPLE OF PEELING PROCESS

In peeling process, first the black bar is fixed between jaws of input carriage manually and then it is fed to feed rolls. The feed rolls are driven through feed gear box, which is located on backside of the feed rolls. The feed roll gives linear feed to the bar. The bar then enters to the headstock where it passes through the rotating cutter head. The cutter head gets power and motion through gears and v-belt drive from cutter head gear box. Due to the rotating cutter head the bar is peeled off and gets the shape of bright bar. Then the bar moves further to output carriage. The bright bar is then once again fixed between the jaws of output carriage. The speed of the cutter head and feed of bar depends on the size and material of the black bar. The speed and feed are changed with hand lever manually. The machine is very simple in construction and quite similar to turning machine. It consists main 4 parts. Carriage, feed unit, head stock and power transmission system

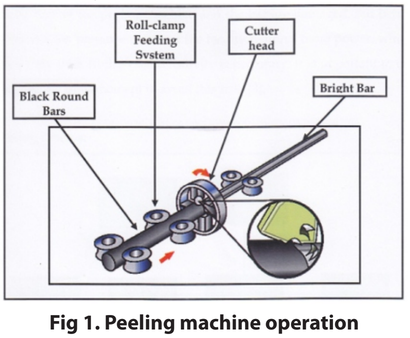


Fig 1. Peeling machine operation

Fig 2. Peeling machine

III. LITERATUREREVIEW

Hari Singh had optimized tool life of carbide inserts for turning parts using Taguchi's design of experiments approach, in which the results indicate that the selected process parameters significantly affect the mean and variance of the tool life of the carbide inserts. The contributions of parameters quantified in the S/N pooled ANOVA envisage that the relative power of feed (8.78%) in controlling variation and mean tool life is significantly smaller than that of the cutting speed (34.89%) and depth of cut (25.80%). The predicted optimum tool life is 20.19 min. The results have been validated by the confirmation experiments. **[1]**

A.Javant and V. Kumar had used the Taguchi optimization methodology, which is applied to optimize cutting parameters in turning when machining hardened steel AISI 4140 with carbide insert tool under semi-finishing and finishing conditions of high speed cutting on CNC lathe. The experiments carried out by' using L-27 (313) orthogonal array. The turning parameters evaluated are cutting speed, feed rate and depth of cut. An orthogonal array, signal-to-noise (S/N) ratio and Pareto analysis of variance (ANOVA) were employed to analyze The effect of these turning parameters on surface roughness.Main effects of process parameters on the quality characteristics have been analyzed and the results show that the optimum parameter setting for surface roughness obtained at a cutting speed of 200 m/min, feed rate 0.1 mm/rev and depth of cut 1.5 mm and the optimum parameter setting for force required was obtained at a cutting speed of 200 m/min, feed rate 0.1 mm/rev and depth of cut 1 mm Confirmation test with the optimal levels of cutting parameters were carried out in order to illustrate the effectiveness of Taguchi optimization method. Using Taguchi method for design of experiment (DOE), other significant effects, such as, the interaction among -turning parameters were also investigated. The selection criterion for parameters was based on out Puts of turning, namely, cutting force and surface roughness. And they concluded that optimum Parameter setting for better surface finish was obtained at a cutting speed o{ 200 m/min, feed rate 0.1 mm/rev and depth of cut i.5 mm. **[2]**

Krizbergs, J.; and Kromanis, A. has developed techniques to predict the surface roughness of a part to be machined. In their study all the surface parameters have been expressed in 3D parameters, like Sq, Ssk, Sa etc. 3D surface Parameters give more precise picture of the surface, therefore it is possible to evaluate more precise the surface parameters according to used machining technique' In the result of study, the mathematical models were developed, which may help technologists to understand more completely the process of forming surface roughness. This paper presents the surface roughness 3D parameters which can be used for more precise surface evaluation than 2D surface parameters, actually profile parameters **[3]**

Ty G. Dawson and Rhomas R. Kurfess have selected five different tool materials for full tool life tests at a range of reasonable cutting conditions. They tested a new tool geometry design which had a wiper on the nose radius of the tool that allowed improved surface finish. They derived one mathematical model to predict life of the selected tool. The model was tested against experimental data and they found that the model does an adequate job of capturing the effect of cutting speed and feed on tool life **[4]**

G. Akhyar, C.H.Che haron, J.A.Ghani have implement the taguchi optimization methodology to optimize cutting parameters in turning Ti-6%AL-4%V extra low interstitial with coated and uncoated cemented carbides tools under dry cutting condition and high cutting speed.the turning parameters evaluated are cutting speed of 55, 75, and 95 m/min, feed rate of 0.15, 0.25, and0.35 mm/rev, depth of cut of 0.10, 0.15 and 0.20 mm and tool grades of K313, KC9225 and KC5010, each at three levels. The analysis of results show that the optimal combination of parameters are at cutting speed of 75 m/min, feed rate of 0.15 mm/min, depth of cut of 0.10 mm and tool grade of KC9225. The cutting speed and tool grade have a significant effect on surface roughness are 0.000 and have a contribution are 47.146% and 38.881% respectively. At optimal condition contribution of each cutting parameter on surface roughness is reached at 20.47 from tool grade, 21.01 from feed rate, 11.54 from depth of cut and 11.17 from cutting speed**.[5]**

IV. OBJECTIVE

1. To establish the best or the optimum condition for a product or a process,
2. To estimate the contribution of individual factors.
3. To eliminate the number of grinding pass and reduce the process cost under the optimum condition

V. EXPERIMENTAL SET UP

In this work input parameters considered for peeling machine are machining parameters. Output parameter is surface roughness. Other parameters are considered as constant parameters. Input parameters are cutting speed(m/rev), cutting feed(mm/rev), depth of cut(mm). and constant parameters are Inser(RNGH 2509 MOS50-R50), work piece material(SS 202), work piece diameter(25mm), cutting condition, cutting length(4m) and output parameter are surface roughness and material removal rate. So here for my experimental work, we have 3 factors each with different levels.

The description of SS 202 is as follow Table 1:

Material	Composition	Mechanical Properties
SS-202	C-0.15%Max.	Tensile strength 515 Mpa
	Mn- 8-10%	
	Cr – 17-19%	Yield Strength 275 Mpa
	Ni- 4-6%	
	P-0.060%	Elongation 40%
	S-0.03%Max.	Elastic Modulus 190-210 Gpa
	Si-1% Max.	
	Cu-1.5%Max.	Density 7.8(*1000kg/m^3)

Table 1

VI. DESIGN OF EXPERIMENT

Full factorial method is used for DOE.A design in which every setting of every factor appears with every setting of every other factor is a full factorial design. Three-level full factorial design is used. The three-level design is written as a 3^k factorial design. It means that k factors are considered, each at 3 levels. This is a design that consists of three factors, each at three levels. It can be expressed as a 3 x 3 x 3 = 27.

Factors	Level 1	Level 2	Level 3
Cutting Speed (m/min)	24.976	60.633	66.916
Cutting Feed (mm/rev)	5.341	7.0986	8.6201
Depth of Cut(mm)	0.5	1.0	1.3

Table 2

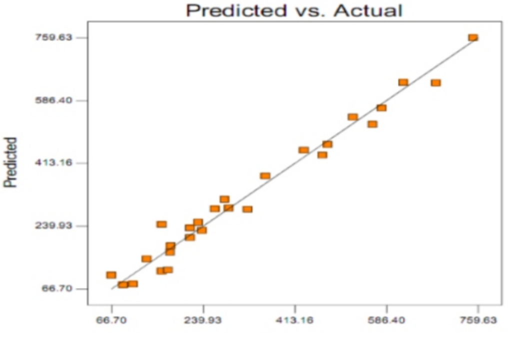
The experimental has been performed and reading are taken for the insert at different cutting sped,feed and depth of cut to find out the surface roughness and material removal rate in each case.Three value of cutting speed are utilized and for each of these three value,three different feed rate are employed. Again for each feed rate three different depth of cut are introduces.the value of surface roughness is measured for every time and the results show in table.

Table 3 shows the data obtained in the experiment.

Sr. No.	Cutting Speed (m/min)	Feed (mm/rev.)	Depth of Cut (mm)	Surface Roughness Ra(μm)	Material removal rate
1	24.976	5.341	0.5	4.10	66.698
2	24.976	5.341	1.	4.26	133.396
3	24.976	5.341	1.3	4.47	173.415
4	24.976	7.0986	0.5	5.77	88.647
5	24.976	7.0986	1	6.38	177.294
6	24.976	7.0986	1.3	6.45	230.483
7	24.976	8.6201	0.5	5.83	107.647
8	24.976	8.6201	1	6.71	215.295
9	24.976	8.6201	1.3	6.85	279.884
10	60.633	5.341	0.5	4.95	161.920
11	60.633	5.341	1	5.12	323.840
12	60.633	5.341	1.3	5.23	420.993
13	60.633	7.0986	0.5	3.74	215.204
14	60.633	7.0986	1	3.67	430.409
15	60.633	7.0986	1.3	4.47	559.532
16	60.633	8.6201	0.5	5.77	261.331
17	60.633	8.6201	1	5.93	522.662
18	60.633	8.6201	1.3	6.03	679.461
19	66.916	5.341	0.5	4.97	178.699
20	66.916	5.341	1	5.82	357.398
21	66.916	5.341	1.3	6.03	464.617
22	66.916	7.0986	0.5	4.12	237.504
23	66.916	7.0986	1	4.26	475.009
24	66.916	7.0986	1.3	3.77	617.512
25	66.916	8.6201	0.5	4.95	288.411
26	66.916	8.6201	1	5.62	576.822
27	66.916	8.6201	1.3	5.93	749.869

Table 3

VII. RESULTS AND DISCUSSION



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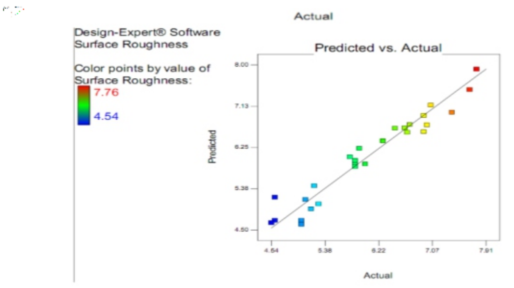

Fig 3. Predicated Vs. Actual Plot - SR

Fig. 3 show the indicates the validity of DOE method used for performing the experiment as the predicted values and the actual values are near to the average line.

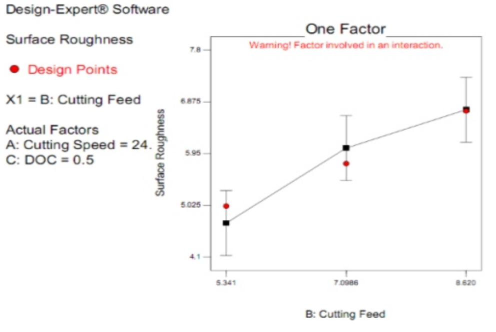

Fig 4. significant one factor - SR

The significant factor according the ANNOVA for surface roughness is cutting feed and as per fig.4 it shows that as the feed increases from 5.341 mm/rev , 7.0986 mm/rev and 8.820 mm/rev the surface roughness goes on increasing from 5.025 micron to 6.75 micron.

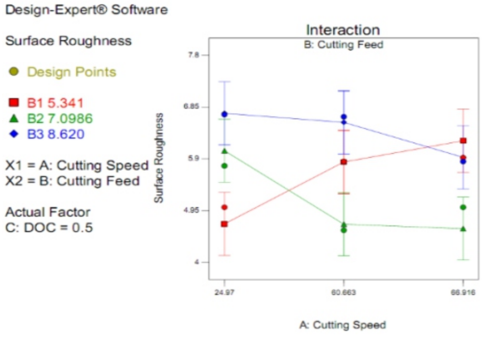

Fig 5. interaction factors - SR

figure 5. as cutting feed increases with increasing cutting speed at minimum depth of cut of 0.5 mm has reduces the surface roughness. Surface roughness has observed minimum at 4.788 micron with Cutting feed of 7.0986 mm/rev, maximum cutting speed of 66.916 m/min.

Fig 6. Predicted Vs Actual – MRR

Fig.6 indicates the validity of DOE method used for performing the experiment as the predicted values and the actual values are near to the average line.

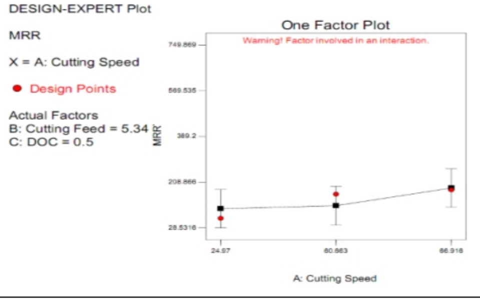

Fig7. (a) Significant One factor (cutting Speed)- MRR

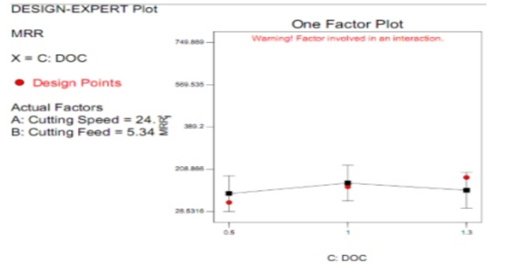

Fig 7. (b) Significant One factor (DOC) – MRR

The significant factor according the ANNOVA for MRR are cutting speed and depth of cut as per figure 7 (a,b) it shows that surface roughness is increases from 104 cm^3/ min to 186.8 cm^3/ min as the cutting speed is increases from 24.97 m/min to 66.196 m/min. while the variation in depth of cut is effect MRR in range band of 104 cm^3/ min to 149 cm^3/ min.

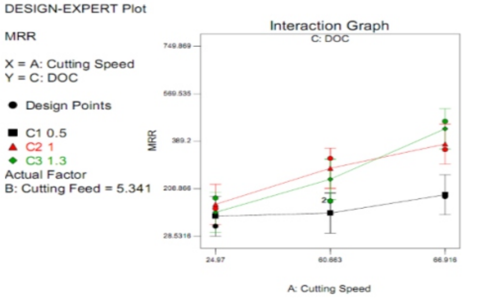

Fig 8. (a) interaction factor (@ 5.341 mm/rev) - MRR

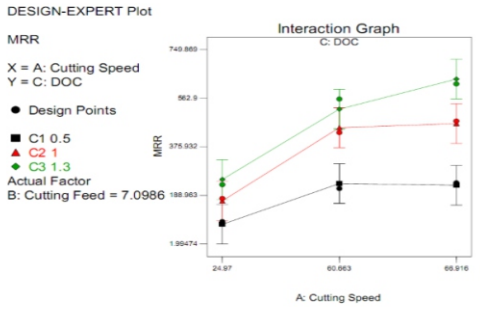

Fig 8. (b) interaction factor (@ 7.0986 mm/rev) - MRR

As per the results of ANNOVA the most significant interaction for MRR comes between two factors 'AC' & ' BC' as per the figure 8(a,b) shown above. MRR is significantly increases from 149 cm^3/min to 436 cm^3/min. but as cutting feed is increases from 5.3 mm/rev to 7.09 mm/rev, MRR has varies in range of 250 cm^3/min to 636 cm^3/min.

VIII. OPTIMIZATION

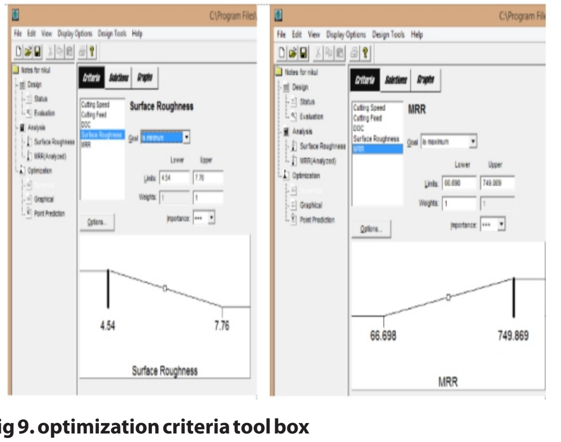

Fig 9. optimization criteria tool box

Constraints

Name	Goal	Lower Limit	Upper Limit	Lower Weight	Upper Weight	Importance
Cutting Speed	is in range	24.97	66.916	1	1	3
Cutting Feed	is in range	5.341	8.620	1	1	3
DOC	is in range	0.5	1.3	1	1	3
Surface Rougt	minimize	4.54	7.76	1	1	3
MRR	maximize	66.698	749.869	1	1	3

Solutions

Number	Cutting Speed	Cutting Feed	DOC	Surface Rougt	MRR	Desirability	
1	66.916	7.0986	1.3	5.19148	636.239	0.815	Selected

As shown in figure 9 surface finish has set to minimize and MRR to maximize along with that all other parameters have set within level range as mention in Table 2. entire optimization process revile 26 different solutions out of that based on maximum desirability of 85 % solution with cutting speed of 66.916 m/min, cutting feed of 7.0986 mm/rev and depth of cut of 1.3 mm. with this set of parameter on existing machine tool one can achieve optimize surface roughness of 5.19148 micron and MRR of 636.239 cm^3/min.

IX. CONCLUSION

1. In the dissertation work, there are three different inserts are utilized to get the different surface qualities of the bright bar. Out of there inserts, one RNGH 2509 MOS50-R50 is selected based on the experimental data, in which it provides better surface quality compared to existing insert and it saves the tooling cost up to 41.66% for the bright bar lot size of 700.

2. By selecting the new insert, one pass of grinding is eliminated entirely from peeling process. So it reduces the production time as well as the cost.

3. Parametric study shows the effect of different parameters i.e Speed, feed depth of cut etc. on the surface roughness.

4. Parametric analysis shows the percentage contribution of individual parameters on surface quality. The percentage contribution of cutting speed is 09.91%, feed of 31.22% and depth of cut is 04.98% for required surface finish.

5. By Full factorial regression analysis, the optimal machining parameters setting has been obtained for considering maximum metal removal rate (636.239 cm3/min) and minimum surface roughness(5.1914 µm) at speed =66.196 mm/min, feed=7.0986 & Depth of cut=1.3.at this speed ,feed and depth of cut one pass of grinding is eliminated entirely from peeling process. So it reduces the production time as well as the cost.

X. FUTURE SCOPE

Here, we have selected three inserts having different grades and of same shape. But possible to select different inserts of different shape by changing/designing the cutter head to check the surface quality of bright bar.Force analysis can be carried out for further parametric analysis and its effect on surface quality.Surface finish prediction model can be prepared by Artificial Neural Network and it can be helpful to select the proper parameter to get required surface finish of the bright bar.

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