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Application of Taguchi Method for Optimizing Milling Process by the Effects of Machining Parameters

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ABSTRACT

In order to improve the quality and productivity the present study highlights the optimization of CNC end milling process parameters to provide good surface finish. The surface finish has been identified as one of the main quality attribute and is directly related to the productivity of a machine. This paper reports on an optimization of milling process by the effects of machining parameters applying Taguchi methods to improve the quality of manufactured goods, and engineering development of designs for studying variation. Aluminium is used as the work piece material for carrying out the experimentation to optimize the Material Removal Rate. The plate used are of length 200mm width 75mm and thick 25mm.There are three machining parameters i.e. Spindle speed, Feed rate, Depth of cut. Different experiments are done by varying one parameter and keeping other two fixed so maximum value of each parameter was obtained. Operating range is found by experimenting with top spindle speed and taking the lower levels of other parameters. Taguchi orthogonal array is designed with three levels of milling parameters with the help of software Minitab 15. In the first run nine experiments are performed and material removal rate (MRR) is calculated. When experiments are repeated in second run again MRR is calculated. Taguchi method stresses the importance of studying the response variation using the signal–to–noise (S/N) ratio, resulting in minimization of quality characteristic variation due to uncontrollable parameter. The metal removal rate was considered as the quality characteristic with the concept of "the larger-the-better". The S/N ratio values are calculated by taking into consideration with the help of software Minitab 17. The MRR values measured from the experiments and their optimum value for maximum material removal rate. Every day scientists are developing new materials and for each new material, we need economical and efficient machining. It is also predicted that Taguchi method is a good method for optimization of various machining parameters as it reduces the number of experiments.

Keywords:-Taguchi Method, Machining Parameters, Milling Process, Aluminium, Software Minitab17

1. TAGUCHI METHOD

Taguchi's philosophy was developed by Dr. Genichi Taguchi and is an efficient too for the design of high quality manufacturing system. Taguchi's Orthogonal Array (OA) provides a set of experiments with less number of experimental runs, and Taguchi's signal-to noise ratios (S/N), which are logarithmic functions of desired output; serve as objective functions in the optimization process. Taguchi method uses a statistical measure of performance called signal-to-noise ratio.The S/N ratio takes both the mean and the variability into account. The S/N ratio is the ratio of the mean (Signal) to The standard deviation (Noise) The ratio depends on the quality characteristics of the product/process to be optimized. The standard S/N ratios generally used are as follows: - Nominal-is Best (NB), lower-the-better (LB) and Higher-the-Better (HB). The optimal settings the parameter combination, which has the highest S/N ratio Because, irrespective of the quality criteria may be (NB, LB, HB) S/N ratio should always be maximized. Once experimental data (quality attribute value) is normalized using NB/LB/HB criteria; normalized value lies in between zero to one. Zeroes presents worst quality to be rejected and one represents most satisfactory quality. Since S/N ratio is expressed as mean (signal) to the noise (deviation from the target); maximizing S/N ratio ensure minimum deviation and hence it is (S/N ratio) to be maximized

2. WORK PIECE MATERIAL USED

The present study was carried out Aluminum. The chemical composition and mechanical properties of the work piece materials. It is available in material hand book. All the specimens were in the form of 200mm × 75mm × 25mm blocks.

3. TAGUCHI ORTHOGONAL ARRAY

If there is an experiment having 3 factors which have three values, then total number of experiment is 27. Then results of all experiment will give 100 accurate results. In comparison to above method the Taguchi orthogonal array make list of

nine experiments in a particular order which cover all factors. Those nine experiments will give 99.96% accurate result. By using this method number of experiments reduced to 9instead of 27 with almost same accuracy.

MRR = (Initial Wt. - Final Wt.)/Time Taken MRR is calculated for both set of experiment. Considering one set correct S/N ratio is calculated from MINITAB 17 software.

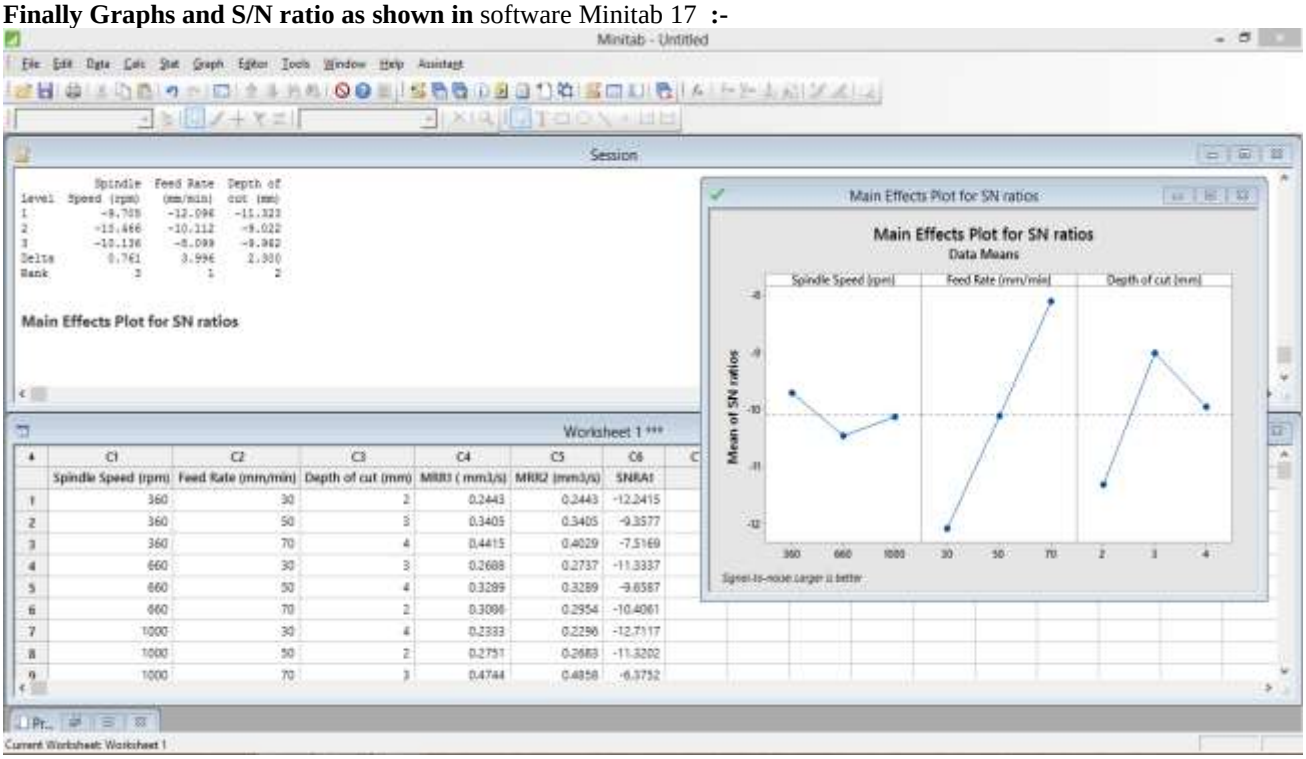
JOB NO.	Spindle Speed (rpm)	Feed Rate (mm/rev)	Depth of cut (mm)
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2

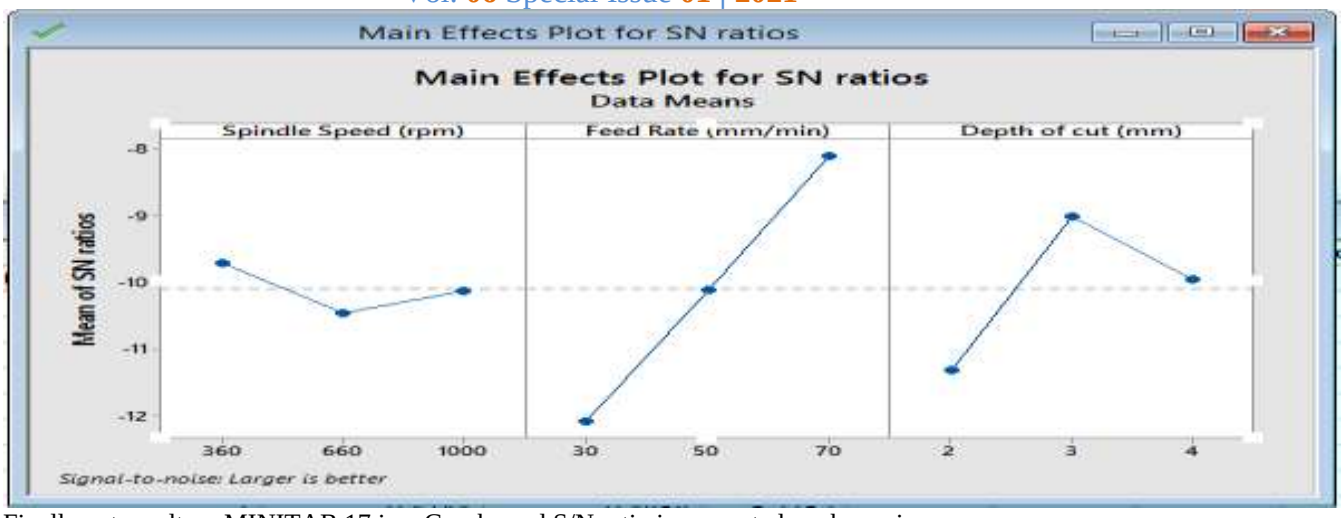
Table1: Taguchi Orthogonal Array

4. EXPERIMENTAL RESULT AND CORRESPONDING S/N RATIO

Sr. no.	Spindle speed *N* (rpm)	Feed Rate *f* (mm/rev)	Depth of cut *d* (mm)	MRR-1 (mm3/s)	MRR-2 (mm3/s)	S/N Ratio
1	**360**	**30**	**2**	**0.244**	**0.244**	**-12.24**
2	**360**	**50**	**3**	**0.340**	**0.341**	**-9.357**
3	**360**	**70**	**4**	**0.411**	**0.403**	**-7.804**
4	**660**	**30**	**3**	**0.268**	**0.274**	**-11.33**
5	**660**	**50**	**4**	**0.329**	**0.33**	**-9.658**
6	**660**	**70**	**2**	**0.308**	**0.295**	**-10.39**
7	**1000**	**30**	**4**	**0.233**	**0.229**	**-12.71**
8	**1000**	**50**	**2**	**0.275**	**0.268**	**-11.32**
9	**1000**	**70**	**3**	**0.474**	**0.485**	**-6.373**

Finally Graphs and S/N ratio as shown in software Minitab 17 **:-**





Finally get result on MINITAB 17 i.e Graphs and S/N ratio is generated as shown in :-

5. CONCLUSION

1.Regardless of the category of the performance characteristics, a greater S/N value corresponds to a better performance. Therefore, the optimal level of the machining parameters is the level with the greatest value.
2. Spindle Speed: The effect of parameters spindle speed on the metal removal rate values is shown above figure for S/N ratio. Its effect is increasing with increase in spindle speed up to 1000 RPM beyond that it is decreasing. So the optimum spindle speed is level 3 i.e. 1000 RPM.
3. Feed Rate: The effect of parameters feed rate on the metal removal rate values is shown above figure S/N ratio. Its effect is increasing with increase in feed rate. So the optimum feed rate is level 3 i.e. 70 mm/min.
4. Depth of Cut: The effect of parameters depth of cut on the metal removal rate values is shown above figure for S/N ratio. Its effect is increasing within crease in depth of cut. So the optimum depth of cut is level 2 i.e. 3 mm

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