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Tuning of Process Parameters of Indexable Carbide Cutters (Milling) by using Taguchi Methodology

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Abstract

Objective: Increase in production by maintaining quality of products with economical machining processes is main need of industry. A product can be made economical by reducing expenses of machining or by optimum use of tools. So if we use carbide, HSS tools as according to process, we can overcome these obstacles. In this paper we use two types of index able cutters and optimize their results. Both cutters have similar functions such as milling, gangue milling and side and face milling. **Methods:** Index able cutters are mostly used for bulk production in automotive industries, agriculture industries to produce hubs, brackets, structural parts etc. Mostly two types of cutters TPKN cutter (three edges) and SPKN (four edges) are used. There are used for machining of high strength material like aluminum. Many of the factors affect machining quality as well as the tool life. In this paper we have used to study how different parameters of both the tools affects machining of SG iron with index able cutters to achieve better results with changes in different parameters are analyzed and optimized by L18 orthogonal array with Taguchi methodology. By which we can decide which one of tool is more convenient to use as compare to another one. **Findings:** In this research we have concluded how different parameters affect SPKN and TPKN tools. Comparison of both the cutters has been done for same conditions of variable parameters. **Applications:** Machining in gang milling, face milling, side and face milling.

Keywords: Index Able Cutters, MRR, SPKN, Surface Roughness, TPKN

1. Introduction

Milling process is the second most common method (after turning) for metal cutting and especially for finishing of machine parts. Heavy jobs and parts of automobile, tractor parts are finished by this operation. [1]In recent years industry approach to develop high performance machine tools increases for materials which are difficult to machine[2,3]. SG Iron is widely used in automotive industry due to its strength. The parts manufactured by this material are heavy and machining processes are also costly. The machining of this material is also difficult due to its strength. So the SPKN, TPKN P-20 GradE carbide inserts are used almost everywhere for machining. Both inserts have same material but cost varies. TPKN is triangular insert and SPKN is square. So by its shape it is clear that TPKN is used and applied in corners of work piece where required but peoples used this inserts for gang milling facing, milling[3] side and facing where we can use 90 degree inserts for machining like SPKN inserts. By proper management and awareness we can reduce cost. After survey of some industry where these parts are manufactured and these tools are used. We also try this and obtain the desired results. Both inserts are useful but according to applications.

2. Taguchi Method and Designs of Experiment

The most efficient method of experimental planning is Design of Experiment (DOE) using Taguchi approach. In Taguchi methodology the trails become limited and results obtained are correct. This method also reduces the experimental cost[4]. Taguchi method of design provides a

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simple, efficient and systematic approach for optimization of experimental designs for performance quality and cost. In this, firstly the input factors are selected which are used in experiments and these factors values are entered in Taguchi design and are stated in Table 1. The experimental values are obtained by design of experiment technique as shown in Figure 1.

Table 1. Factors and their levels of interest

Factors	Factors designation	Level1	Level2	Level3
Steam jet pressure (lb/in^2)	A	10	15	
Speed (rpm)	B	540	900	1500
Feed rate (mm/min)	C	50	80	150
Depth of cut (mm)	D	0.5	0.75	1

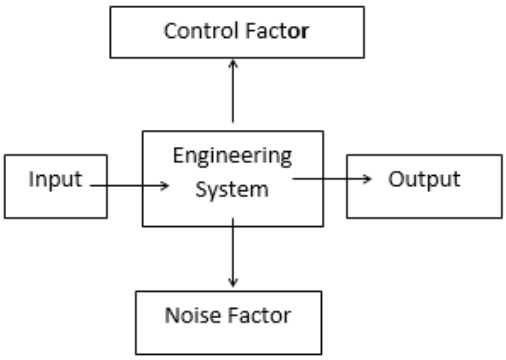

Figure 1. Factors and their levels of interest.

3. Purpose of using Taguchi Methodology

- It conducts balanced experiment combinations.
- The main advantage of Taguchi is its efficiency, in that multiple factors consider at once.
- Optimal parameters can be identified with fewer experimental resources than traditional approach. Taguchi allows looking into variation caused by control factor and noise factor, while noise factor ignored in traditional approach.

4. Taguchi Procedure

- System design - This is at conceptual level involving creativity and innovation.
- Parameter design – In many circumstances this allows the parameters to be chosen so as to minimize the effects on performance arising from variations[5].

4.1 Analysis of Results

- Controllable means design of factor.
- Uncontrollable means results with noise factor.
- The optimum condition is identified by studying the main effects of each of the factors. The process involves minor arithmetic manipulation of numerical results and usually can be done by using simple calculator. The main effects indicate the general trend of influence of factors.
- Signal-to-noise ratio or the SN number is calculated for each variable to determine the effect on the output. In the equations, y_i is the mean value and s_i is the variance. y_i is the value of the performance characteristic for a given experiment.

4.2 Result of MRR

The effects of input factors are evaluated by using ANOVA and factorial design analysis. 18 trails are made for evaluation and studying the effects of input parameters on output parameters are stated in Table 2. Taguchi methodology helps to find the individual input parameter effect during process. Higher the fisher value more is the effect of input parameter on output parameter. It is clearly observed that the feed rate effects the output parameter, it means by increasing feed rate we can obtained high material removal during machining. Depth of cut and speed also affects the output parameters, but not as much as compared to feed rate. Feed rate contribution 51.1% with fisher value (F) 27.66, Depth of cut contribution of 18.17% with fisher value (F) 18.17, Speed contribution 8.17 with F value 4.17. Interaction between Pressure x Speed remains insignificant.

4.3 Surface Roughness

The effect of parameter was evaluated using ANOVA and factorial design analysis made for evaluation and studying the effects of input parameters on output parameters. Taguchi methodology helps to find the individual input parameter effect during process. Higher the fisher value more is the effect of input parameter on output parameter. It is clearly observed from Table 3 that the feed rate affects the output parameter, it means by increasing or decreasing feed rate we can obtain the required surface finish of job during machining. Pressure and speed also affects the

Table 2. Results for MRR

Experiment No:	Pressure (lb/in²)	Speed (rpm)	Feed Rate(mm/min)	DOC(mm)	MRR (mm³/min)	MRR (mm³/min)
					SPKN	TPKN
1	10	540	50	0.5	123	123
2	10	540	80	0.75	226	226
3	10	540	150	1	430	430
4	10	900	50	0.5	119	119
5	10	900	80	0.75	276.6	276.6
6	10	900	150	1	607.3	607.3
7	10	1500	50	0.75	130.9	130.9
8	10	1500	80	1	396.5	396.5
9	10	1500	150	0.5	433.5	433.5
10	15	540	50	1	186.1	186.1
11	15	540	80	0.5	167.4	167.4
12	15	540	150	0.75	321.3	321.3
13	15	900	50	0.75	140.9	140.9
14	15	900	80	1	223.4	223.4
15	15	900	150	0.5	223.7	223.7
16	15	1500	50	1	198.6	198.6
17	15	1500	80	0.5	211.7	211.7
18	15	1500	150	0.75	299.7	300

Table 3. Results for surface roughness (Ra)

Trail No.	Pressure (lb/in2)	Speed (rpm)	Feed Rate(mm/min)	DOC(mm)	Surface Roughness(μm)	Surface Roughness(μm)
					SPKN	TPKN
1	10	540	50	0.5	0.28	0.38
2	10	540	80	0.75	0.49	0.59
3	10	540	150	1	0.71	0.81
4	10	900	50	0.5	0.29	0.39
5	10	900	80	0.75	0.55	0.65
6	10	900	150	1	1.23	1.33
7	10	1500	50	0.75	0.49	0.59
8	10	1500	80	1	0.81	0.91
9	10	1500	150	0.5	1.14	1.24
10	15	540	50	1	0.37	0.47
11	15	540	80	0.5	1.05	1.25
12	15	540	150	0.75	1.08	1.18
13	15	900	50	0.75	0.81	0.91
14	15	900	80	1	1.14	1.24
15	15	900	150	0.5	1.41	1.51
16	15	1500	50	1	0.99	1.06
17	15	1500	80	0.5	1.17	1.28
18	15	1500	150	0.75	1.01	1.32

output parameters. Feed rate contribution 39.75% with fisher value (F) 33.45, Pressure contribution of 17.93% with fisher value (F) 18.32, Speed contribution 23.93% with F value 8.9. Interaction between Pressure × Speed remains insignificant.

5. Results and Conclusion, Future Scope

- By readings and results this is clearly observed that both sizes of cutters with inserts perform almost same as in case of MRR. This provides the reason to use tooling according to applications.
- In case of surface roughness SPKN perform better as compare to TPKN, this is due to their geometry of inserts.
- As compared to the market rates of both inserts we should found that by using tooling according to application we can reduce costs of machining process without troubling the production and machines.
- After using both inserts, we can sell these inserts in market at scrap rates. Which also affect the high tooling cost.

6. References

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