Experimental Investigation of milling operation during machining process of Monel alloy

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Abstract: End milling is one of generally imperative and normal metal cutting tasks utilized for machining parts due to its ability to evacuate materials at quicker rate with sensibly great surface quality. Monel is a gathering of nickel compounds, fundamentally made out of nickel and copper, with modest quantities of iron, manganese, carbon and silicon. Monel is utilized for marine designing, compound and hydrocarbon preparing gear, valves, siphons, shafts, fittings, clasp, and warmth exchangers. Right now, utilization, instrument wear and device life was estimated without bargaining surface quality with various shaft speed during end processing procedures of Monel composite. The different device wear, for example, flank wear, cavity wear and web wear is discovered utilizing Tools producers magnifying instrument. The instrument life is broke down by Taylor's condition with various axle speeds. Force utilization is investigated during end processing process utilizing cutting speed and cutting forces. The result showed that Monel alloy has good machinability property and produce better surface finish during end milling process using cBN coated tool. Higher level of spindle speed produces higher tool life with large power consumption. Medium level spindle speed produce more wear rate and built up edges and abrasion wear in BN coated tool.

Keywords: End milling, Monel alloy, Tool wear, Tool life, Analysis

I-Introduction:

In competitive manufacturing industries, the makes extreme objectives is to deliver excellent items with less expense and time requirements. Processing has been one of the most broadly utilized metal evacuation forms in industry and processed parts are generally utilized in mating parts. Processing is a procedure of machining level surfaces, bended and unpredictable surfaces by taking care of the work piece against a turning shaper containing various forefronts. The determination of effective machining parameters is one of the incredible worries in assembling ventures where economy of machining activity assumes a key job in serious market. The fundamental point of this paper is to accomplish bigger material evacuation rate with low cutting powers and apparatus wear for hard to machine hard materials of higher creation rate. Machinabilty of hard materials is a significant factor for profitability. The ceaseless improvement of new materials and interest for specialists to create confused shapes with high level of precision is essential. Campose et al [1] applied Taguchi technique to anticipate surface

quality and material expulsion rate by upgrading cutting parameters, for example, shaft speed, feed rate and profundity of cut in CNC processing. Gauri et al [2] advanced the cutting pace, feed and profundity of cut of CNC end processing process utilizing symmetrical exhibit and sign to commotion proportion. Khorasamy et al. [3] revealed the material expulsion rate and surface unpleasantness with relating reaction parameter, for example, axle speed, feed and profundity of cut of processing process by utilizing ANOVA. Lajis et al [4] anticipated the impact of procedure parameters on surface harshness and material evacuation pace of processing process by utilizing structure of examination and ANOVA idea. Aladullah et al [5] utilized Analysis of difference to anticipate the material expulsion rate reaction utilizing processing process parameter improvement method. Majerik et al [6] led end processing process on hard steel and detailed that the profundity of cut is the most affecting parameter for accomplishing bigger material evacuation rate in processing process. Toll [7] directed examinations dependent on L18 symmetrical exhibit of Design of investigation idea and discovered Feed rate is the most ruling procedure parameter in face processing activity to create great surface quality and bigger material evacuation rate. Dimple Rani and Dinesh Kumar [8] announced least surface unpleasantness and most extreme material expulsion rate in end processing activity. They found that bigger material evacuation rate is gotten in medium level profundity of cut. Ashok Raj et al [9] examined the variable parameter of shaft speed, feed and Depth of cut of processing process. They finished up, the most affecting variable of processing procedure to accomplish bigger material expulsion rate is profundity of cut. Kannan et al [10] directed tests on Monel K-400 in face processing process. They reasoned that lower surface unpleasantness was gotten in high shaft speed and higher material expulsion rate was acquired in high profundity of cut. Anyway as far as I could possibly know past writing report recommends that next to no work has been completed on monel K-400 material. In the current work, power utilization, apparatus wear and device life was estimated for various axle speed. Apparatus wear, for example, flank wear, pit wear and web wear was discovered utilizing Tools producers magnifying instrument. The instrument life was likewise broke down by Taylor's condition with various axle speed. Force utilization was broke down utilizing cutting speed and cutting forces

II- Experimental Details

Milling operations are carried out in dry environment on Vertical milling machine as shown in Fig.1.The details of chemical composition and mechanical properties of Monel-400 alloy are given in Table l and Table 2. A carbide coated cBN end milling cutter is used as cutting tool for machining Monel alloy. The experiment was conducted by 3 levels of spindle speed, feed and depth of cut. The input parameters of end milling process are spindle speed, feed and Depth of cut and responses are Tool wear, Power consumption and tool life of Monel K-400 during End milling process.

Fig 1 Experimental set up for end milling operation

Table 1 Chemical composition of Monel K-400

Ni	Cu	Al	Ti	C	Mn	Fe	Si
70	24	2.0	0.8	0.25	1.04	2.05	0.50

Table 2 Mechanical properties of Monel K-400

Tensile strength (Ksi)	Elongation (%)	Hardness (HRc)
180	30	35

Table 3 Process parameters and their levels

Parameter	**Unit**	**Level 1**	**Level 2**	**Level 3**	**Level 4**
spindle speed (s)	Rpm	1400	2100	2800	3500
Feed (f)	mm/tooth	0.03	0.06	0.09	0.12
Depth of cut (d)	Mm	0.75	1.00	1.25	1.50

III –Result and Discussion

3.1 Power consumption

Power consumption is a major parameter in optimum machining of milling process with hardened steels. Mechanism of energy consumption process with machining system is a dominating parameter for economic production method [1]. Generally power consumption is calculated as the product of cutting force and cutting velocity of machining process parameters. The corresponding power consumption values in end milling process are given below.

Table 4 Power consumption of End milling process of Monel alloy

Spindle speed (rpm)	Cutting force (N)	Cutting Velocity (m/sec)	Power consumption (Watts)
1400	900	43.96	39.56
2100	1200	65.94	79.12
2800	1240	87.92	109.02
3500	1280	109.9	140.67

Table 4 shows that power consumption of end milling process for 10 minutes. It shows higher power consumption rate is developed for higher spindle speed and produce medium level of surface finish. Fig. 2 clearly shows that spindle increases power consumption of machine also increases. The medium level of spindle speed may consume moderate level of power consumption

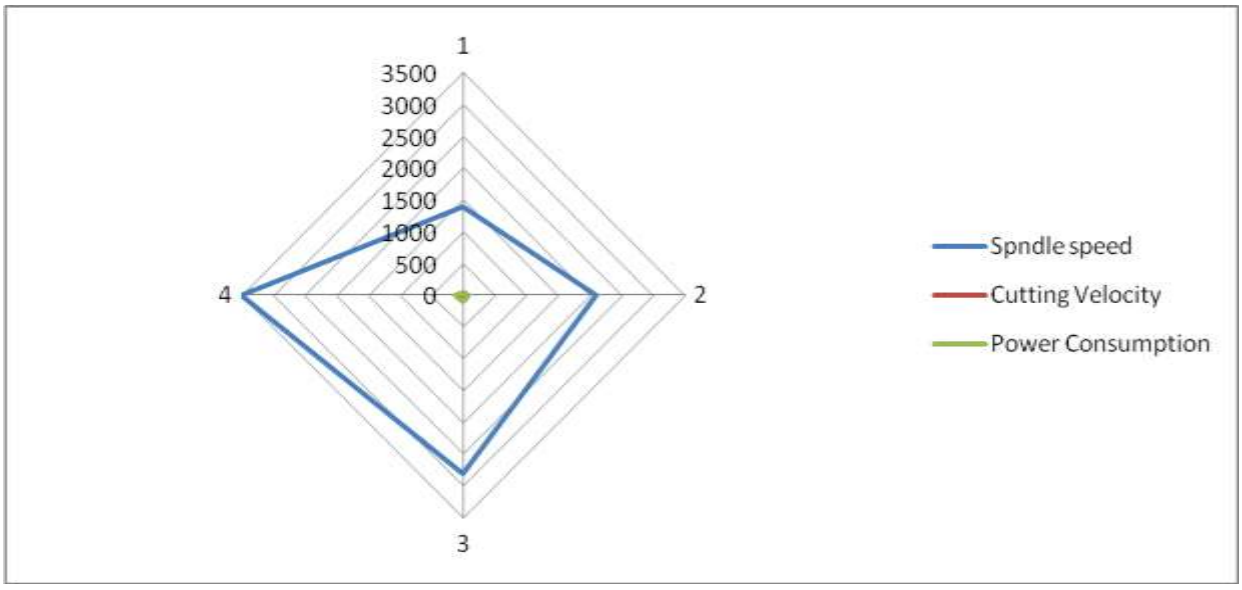

Fig 2 Radar diagram for Power consumption of Monel machining process

3.2 Tool Wear

Demonstrating of fast cutting procedure of processing process having potential for improving cutting instrument structure and choosing ideal conditions, particularly ahead of time applications, for example, rapid processing process. Metal cutting tasks are a metal evacuation process as well as a misshapening procedure where disfigurement is exceptionally gathered in a little zone. The stream attributes at high temperature strain rate and stress experienced during cutting activity are significant for foreseeing chip stream, cutting powers, temperature and stresses. Flank wear and cavity wear is created during medium level cutting pace and profundity of cut for machining of solidified steels. Developed edges are likewise evolved in edges of machining high super combination with higher axle speed rate [7]

Table 5 Tool wear of End milling process of Monel alloy

Spindle speed (rpm)	Face Wear (mm)	Flank wear (mm)	Web wear (mm)
1400	0.2	0.1	0.1
2100	0.4	0.2	0.3
2800	0.3	0.2	0.1
3500	0.2	0.3	0.3

Table 5 shows that tool wear such as face wear, flank wear and web wear of cBN coated tool during milling of Monel. It focused on principal dependence between tool wear and spindle speed. The larger face wear occur at 2100 rpm of spindle speed during machining of Monel alloy. Corresponding flank wear and web wear of cBN coated tool occur at 3500 rpm of spindle speed for 10 minutes in dry machining environment.

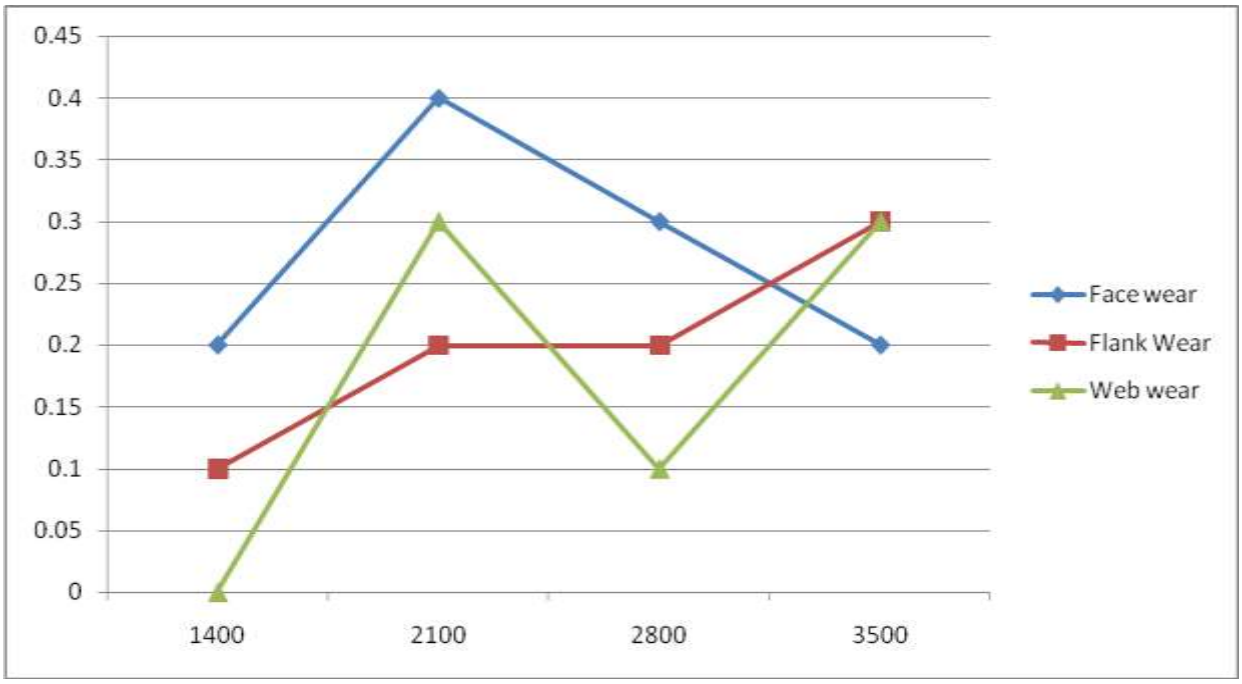

Fig. 3 Relation between Tool wear and spindle speed of End milling process of Monel alloy

Fig. 3 denotes the various tool wear developed during milling process using cBN coated tool. It represents second level of spindle speed (2100 rpm) produce more wear rate and also affect cutting edges in small zone. Small deformation occurs and abrasion wear also takes place. The tool wear is measured by Tools maker microscope and analyzed by merchant circle.

3.3 Tool life

Instrument life is a significant pointer of processing activity in assembling process. Machining reactions of end processing process regarding cutting parameters can be communicated as

R =CVk f l dm. As announced somewhere else, more elevated level of profundity of cut and medium degree of feed rate impact higher apparatus life of solidified steel machining process [3]. Kannan et al [10] detailed cBN apparatus embeds as the most appropriate materials for machining solidified steel on account of their high hardness, wear obstruction and compound inactivity. He additionally researched about warmth segment, instrument life and advancement of Merchant circle.

Table 6 Tool life of End milling process of Monel alloy

Spindle speed (rpm)	Cutting Velocity (m/sec)	Tool Constant	Tool life (Min)
1400	43.96	0.243	439600
2100	65.94	0.243	659400
2800	87.92	0.243	879200
3500	109.9	0.243	1099000

Table 6 represents the analysis of tool life of End milling process for Monel with different spindle speed. Higher level of spindle speed and cutting velocity produce higher level of tool life cBN coated tool life.The spindle speed of milling parameter influence the tool life. It is found that 3500 rpm of spindle speed increase the tool life during the machining of Monel alloy.

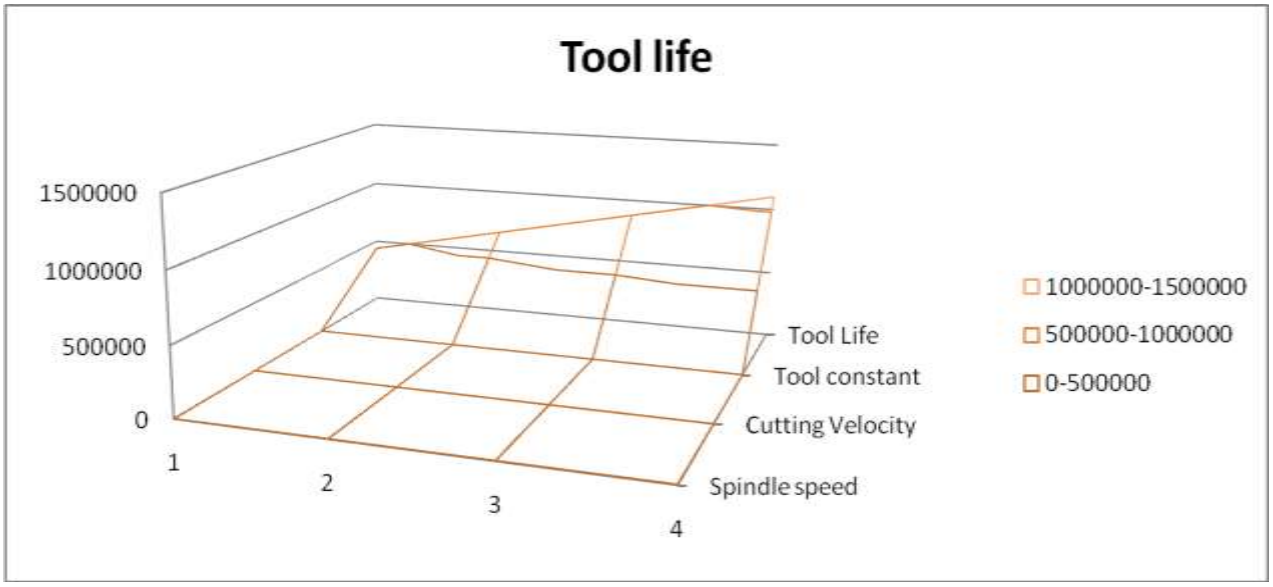

Fig 4 Relation between cutting velocity and tool life for Monel alloy

Fig 4 denotes the relation between cutting velocities and tool life for end milling operation of Monel alloy using cBN coated tool.The higher level of cutting velocity indicate larger the tool life. Cutting velocity of 109.9 m/s produce high surfce finish and also increases the tool life without any tool failure.The significant value of cutting velocity (109.9 m/s) leads to 1099000 minutes of tool life economically.

IV – Conclusion

This experimental study focuses on the principal analyses of power consumption, tool wear and tool life of End milling process of Monel alloy. The following conclusions are drawn from this study are

- Monel alloy has good machinability property and produce better surface finish during end milling process using cBN coated tool
- Higher level of spindle speed produces higher tool life using cBN coated tool
- Medium level spindle speed produce more wear rate. It also produce built up edges and abrasion wear in BN coated tool
- Larger power is consumed in higher level of spindle speed.
- Monel alloy provides higher surface finish and suitable for manufacturing valves, pump and heat exchanger

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