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SELECTION FOR BETTER AND INCREASED TOOL LIFE BY THE USE OF HSS CUTTING TOOL WITH VARIOUS WORKPIECES

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Abstract - *These days one of the most important machining process in industries is turning. Turning is one of the most important machining operation in industries. Turning is affected by many factors such as the cutting velocity, feed rate, depth of cut and geometry of cutting tool etc., which are input parameters in this project work.. The finished product with desired attributes of size, shape, and surface roughness and cutting forces developed are functions of these input parameters. The objective of this paper is to evaluate the optimal setting of cutting parameters such as cutting velocity (N) , depth of cut(d) , feed(f) to have a maximum cutting tool life under dry machining environment. In this project HSS cutting tool material and workpiece materials (mild steel and aluminium) are examined. The experiments are conducted under three different spindle speeds (190, 325, 520 rev/min) and feed rates (0.5, 0.75, 1.0 mm/rev). The values of depths of cut are recorded by the research work.. The relationship between cutting parameters and tool life is obtained.*

Key words: *Depth of cut; Feed rate; HSS Cutting Tool; Tool Life*

1. INTRODUCTION

This paper provides a general review about turning processes and their parameters as well as tool materials and cutting fluids. In addition, machinability of difficult to cut materials and tool wear are discussed. Manufacturing process can be defined as the process of converting raw materials into products, including the product design, selection of raw materials and the sequence of the manufacturing procedure. In today's highly competitive market, the quality of manufactured products must be assured in all manufacturing stages. This has increased the demand for efficient manufacturing processes with optimum manufacturing cost, high quality and environmental sustainability considerations. Turning is the removal of metal from the outer diameter of a rotating cylindrical work piece. Turning is used to reduce the diameter of the work piece, usually to a specified dimension, and to produce a smooth finish on the metal. Often the work piece will be turned so that adjacent sections have different diameters. Turning is the machining operation that produces cylindrical parts. An ability to predict the tool life during machining is necessary for the design of cutting tools and the determination of cutting conditions and tool change strategies. The extensive research in this area during the past century or so has contributed greatly to our understanding of the problem. However, there is as yet no machining theory to provide adequate relationships between tool life and cutting conditions, tool geometrical parameters and, work and tool material properties. Some of the major difficulties are: (i) the complexity of the machining process which involves extreme conditions of very high strains, strain-rates and temperatures, and (ii) lack of suitable data. Moreover, tool life depends on a number of variables which include the machine tool, tool material and geometry, work material and cutting conditions. For a practical machining situation, since no machining theory is available to predict the tool life, one is compelled to rely on empirical relations such as those proposed by F.W. Taylor early in the last century. However, in order to predict tool life in a fundamental way, an in-depth understanding of tool wear mechanisms is required. The present work uses cutting parameters and Taylor tool life exponent results available in the literature to investigate the tool life with various workpieces and appropriate selection of cutting tool and workpiece material.

2. LITERATURE SURVEY

El Baradie has developed tool life expression in terms of cutting speed and feed rate under dry cutting conditions. Ezugwu and Wang have developed cutting tool materials which have significantly improved the machinability of a large number of metallic materials, including cast irons, steel and some high temperature alloys (such as nickel-based developments for cutting titanium alloys (Ti-6AI 4V). Choudhury and El-Baradie have investigated machining operations using both coated and uncoated carbide tools and Ghani and Choudhary and Husni have presented a study of tool life while machining nodular cast iron using a ceramic tool. S.R.Das, R.P. Nayak and D. dhupal indicate in their paper that Depth of cut and cutting speed are the most important parameter influencing the Tool wear while dry turning of AISI D2 steel etc.

3. EXPERIMENTAL PROCEDURE

Machining test was performed on a Turning centre in dry cutting condition at various cutting Speeds, feed rates and depth of cut. Turning tests have been carried out on the samples with 250 mm length and 40 mm diameter Samples have been machined at three various cutting speeds of 29.845, 51.05 and 81.68 m/min and three different feed rates of 0.5, 0.75 and 1.0 mm/rev. The values of depth of cut were measured experimentally. A Lathe machine with a spindle speed range from 190 to 520 rpm was used for the machining trial. For preparing the samples, the mild steel and aluminium bar of diameter 50 mm and length 250 mm has been cut from a long one. After preparing the sample, the mild steel and aluminium bar were clamped separately on the lathe machine using 3-jaw chuck and the tail stock centre. The machining centre was driven by 2kW electric motor. The experiment was done under dry machining environment. Tool life was determined by dividing the Taylor's constant by the product of feed rate, depth of cut and cutting speed of machining. The same machine was used for all experimental work. The tool life data were collected for each of the cutting conditions.

The tool life is estimated from

T = C/(V1/n f n1/n dn2/n)

Where,

C= Taylor's constant

V=Cutting speed in m/min

f= Feed rate in mm/rev

d= Depth of cut in mm.

n, n1, n2 = Taylor's exponents

*value of n1, n2 varies with tool and workpiece material

4. RESULT & DISCUSSION

There are two different combination of design of experiment which are as follows:

	Tool Material	Work piece Material
Case-I	HSS	Mild Steel
Case-II	HSS	Aluminium

Case-I Here in this case, we have taken Mild steel as work piece material and HSS as tool material. Spindle Speed, Cutting Speed and Feed are taken as input parameters. Depth of cut and tool life are taken as output parameters. The relation between 3 input parameters and 2 Output parameters are shown in below table where we can see the result of Depth of cut and Tool Life against each case. The design of this experiment is as represented by the table given below.

S.No.	Spindle Speed (rpm)	Cutting Speed (m/min)	Feed per revolution	Depth of cut (mm)	Tool life (min)
1.	190	29.845	0.5	1.05	221.9
2.	190	29.845	0.75	1.31	106.07
3.	190	29.845	1.0	1.51	64.55
4.	325	51.05	0.5	0.93	81.69
5.	325	51.05	0.75	1.11	42.35
6.	325	51.05	1.0	1.40	21.86
7.	520	81.68	0.5	0.57	67.96
8.	520	81.68	0.75	0.94	19.49
9.	520	81.68	1.0	1.29	8.63

Case-II Here in this case, we have taken Aluminium as work piece material and HSS as tool material. Spindle Speed, Cutting Speed and Feed are taken as input parameters. Depth of cut and tool life are taken as output parameters. The relation between 3 input parameters and 2 Output parameters are shown in below table where we can see the result of Depth of cut and Tool Life against each case. The design of this experiment is as represented by the table given below.

S.No.	Spindle Speed (rpm)	Cutting Speed (m/min)	Feed per revolution	Depth of cut (mm)	Tool life (min)
1.	190	29.845	0.5	1.1	193.9
2.	190	29.845	0.75	1.5	82.79
3.	190	29.845	1.0	1.58	59.41
4.	325	51.05	0.5	1.1	59.8
5.	325	51.05	0.75	1.56	22.6
6.	325	51.05	1.0	1.65	16.1
7.	520	81.68	0.5	1.3	15.04
8.	520	81.68	0.75	1.6	7.37
9.	520	81.68	1.0	1.8	4.69

5. CONCLUSIONS

The following conclusions can be drawn from this study:

Among the parameters which affect the process quality, spindle speed has an inverse influence on tool life and it was more dominant than the effect of feed rate. The effect of feed rate at (1.0 mm/rev) was evident on tool life giving shorter tool life in all cases. Using experimental data, a graphical representation was developed and proves to be effective in optimizing the cutting condition in turning operations. The machining of aluminium alloys is relatively not good because there is built up edge or material adhesion problem.

HSS tool has the longest tool life with Mild steel as a work piece material which leads to the conclusion that for improved tool life, lower cutting speeds and appropriate work piece should generally be selected in combination with suitable feed rates.

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