MACHINABILITY AND CORRELATION OF MACHINING VARIABLES OF PLASTICS DURING DRILLING

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Abstract

The quest for applying the machining processes beyond metals has paved the way to look at the machining characteristics of non metals like plastics, ceramics, composites etc, Toeing this trend, the study on machining of plastics was taken up to assess the machining characteristics of two different plastics, namely HDPE and Nylon

The plastics were machined by drilling process. The cutting speed and drill bit size were varied in drilling. The effect of these variations on the different machining parameters was studied.

An attempt was made to rank the under consideration in the order of machinability by adopting simple statistical means.

The following were the parameters chosen for the assessment of machinability in drilling.

- Drilling torque
- Drilling thrust
- Power consumption

Similarly the ranking of plastics was observed in drilling operation. Finally the plastics were ranked in the order of machinability as 1.HDPE 2.Nylon.

Key words: ***HDPE, High density polymers. Drill bit size.***

1. Introduction

Machining is a term that covers a large collection of manufacturing processes designed to remove unwanted material in the form of chips, from a work piece. The machining operation may be easy or tough depending on the materials used, tool, coolant and many other factors.

Machinability cannot be attributed to one single factor and also lacks proper definition or formulae. However efforts have been made by many researchers and manufacturers to assess the machinability of materials by considering factors such as torque, thrust & power consumption etc keeping all such factors and limitations in view, Machinability can be referred as "ability of being machined" or more reasonably as "ease of machining".

Machining of plastics in comparison to machining of metals is complex, as many factors like the thermal co efficient of expansion, melting points, low dimensional stability, etc contribute to the complexity. Many studies have been conducted to assess the machinability of plastics by considering different factors such as torque, thrust & power consumption etc

An effort has been made in this work to understand the machinability of some of the commercial plastics such as Nylon and HDPE, A comparative study of the machinability of these materials is been done by subjecting them to two machining operations namely Turning and Drilling. In this work the above mentioned materials has been subjected to drilling operation only. The Drilling operation carried out for the two plastic materials involved the comparison on the basis of the following parameters. 1) Drilling torque 2) Drilling thrust 3) Power consumed.

The Drilling operation was done on a radial drilling machine. A Drill tool dynamometer was used for measurement of thrust and torque. Ammeter and voltmeter were used for measurement of power consumption. This experiment is carried in various combinations. Once the experiment is done by varying the drill bit size, keeping the speed constant and later, the experiment is carried out by varying the speed keeping the drill bit size constant. The parameters were tabulated in both the experiments.

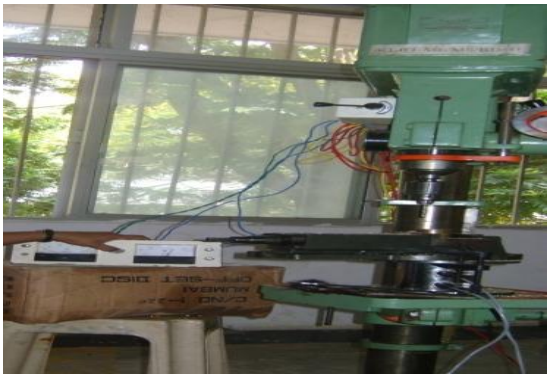

Fig1: Setup of drill tool dynamo meter

Experimental work:

Material properties

The following are the properties of materials considered for the experiments [3]

Table 1

PROPERTIES	NYLON	HDPE
Density in g/cm^3	1.14	0.96
Young's Modulus in MPa	3300	1100
Poisson's ratio	0.4	0.43
Specific heat in J/Kg ^oK	1700	2200
Co efficient of thermal expansion in /^oK	$7*10^{-5}$	$12*10^{-5}$
Thermal conductivity in w/m ^oK	0.25	0.49

Drilling operation details:

The operation was carried on a table mounted Drilling machine with the following settings

Table 2

Speeds in rpm	Drill bit size in mm
315	3
520	4
625	6
1060	8
1060	11

Depth of the drilled hole: 250 mm. Cutting tool used: HSS Drill bits of the sizes mentioned in the table (2). The experiments were conducted on two different materials, for drilling operations. The machinability of the Nylon and HDPE is assessed by the drilling torque drilling thrust power consumed measurement in drilling operation.

Experimental procedure for drilling operation:

This operation was performed on the table mounted drilling machine with one HP motor. Four dill bit sizes were chosen and for each drill bit four trials were done with different speed for each trial as shown in table 2The diameter of the specimen was 50 mm and the thickness of the discs was 60 mm. The specimen was fixed to a vice which is placed above the drill tool dynamometer supported on the table. The required speed is adjusted on the machine and machine is switched on. The initial voltage and current are noted from the voltmeter and the ammeter as V_1 and I_1. The feed is given manually for a standard depth of 25mm when the drilling process begins, the stop watch is activated. As the drilling is in progress, the torque and thrust values are observed on the display of the dynamometer and the maximum values are recorded. During the drilling process the voltage and current values are monitored continuously and the highest values are recorded as V_2 and I_2. The power consumed during machining is calculated as follows. P = (V_2 I_2 -

V_1 I_1) in watts. When the required depth is attained the stop watch is stopped and the machining time is recorded. Since the thermocouples cannot be directly connected to the drill bit during machining, the probe of the thermocouple is brought in contact with the drill bit and the temperature is recorded. The chips are collected by making suitable arrangements on the table and they are weighed on a digital weighing scale and the values are recorded. The same procedure is repeated for both the materials for all the drill sizes and four trials are done at different speeds.

Results and discussions:

The experiments are conducted on two different materials, the machinability of the Nylon, HDPE is assessed by the Cutting forces, cutting temperature, Surface finish & Power consumption during turning operations.The following graphs illustrate the effect of varying speeds on different parameters for a drill bit size of 11mm in drilling different plastics.

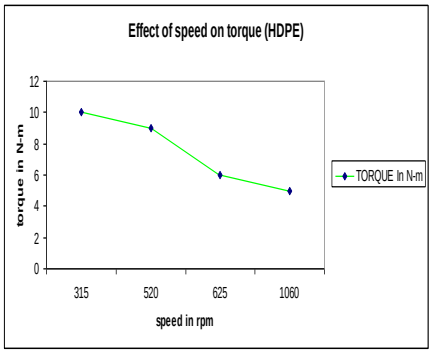

Fig 1: Effect of speed on torque produced during drilling HDPE

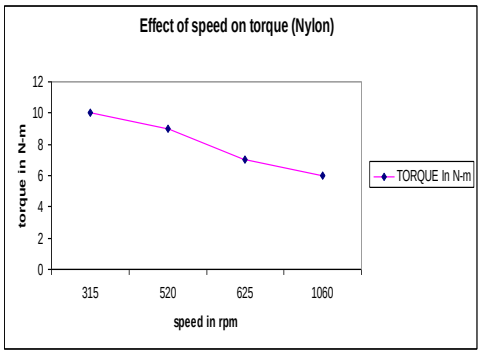

Fig 2:Effect of speed on torque produced during drilling Nylon.

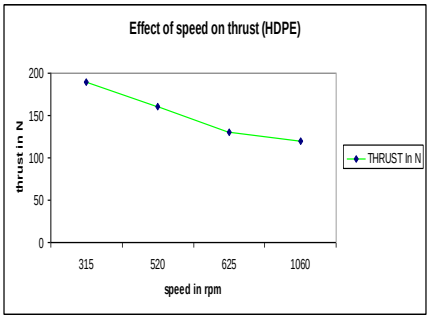

Fig (3) Effect of speed on thrust produced during drilling HDPE.

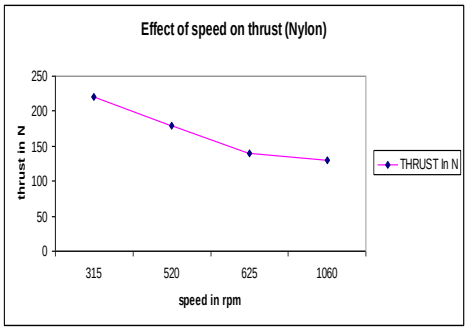

Fig (4) Effect of speed on thrust produced during drilling Nylon.

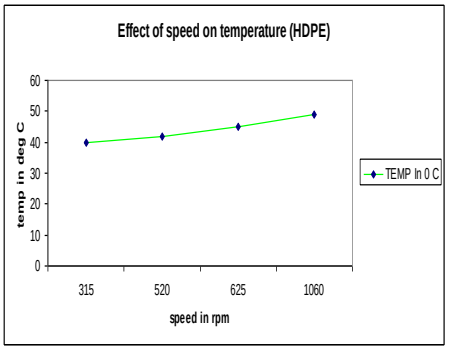

Fig (5) Effect of speed on temperature during drilling HDPE

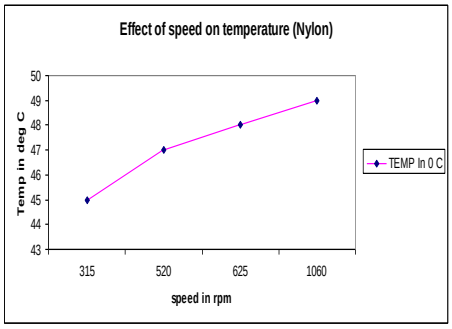

Fig (6) Effect of speed on temperature during drilling Nylon

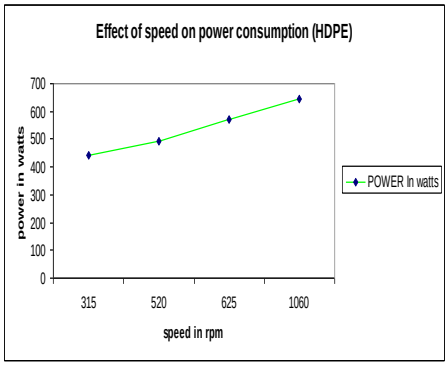

Fig (7) Effect of speed on power consumption during drilling HDPE

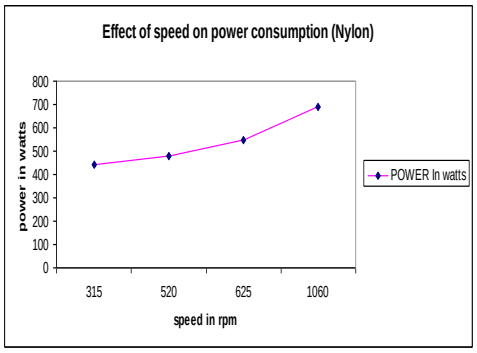

Fig (8) Effect of speed on power consumption during drilling Nylon.

Influence of drilling speeds on different machinability parameters.

The results of drilling experiments which were conducted at different speeds of drill bits were tabulated and the graphs were generated for different materials. The drill bit size of 11 mm was considered for comparison as the values generated for all other sizes of drill bits showed similar variations.

(a) The effect of drilling speed on the torque developed.

The following observations were made from the figs (2) & (3) it is seen that for both the materials, there is not much difference in the torque produced at different speeds. The graphs indicate a decrease in the torque as the speeds are increased for both the materials.

(b) The effect of drilling speed on the thrust developed.

The thrust values also decreased with the increase in speed as it is evident from the figs (4) & (5) Similar to torque values.

(c) The effect of drilling speed on the temperature.

An increase in the temperature of tool was observed with increasing speeds as shown in figs (6) & (7) The temperature increased in the same proportions for different speeds for both the plastics as seen from the figs. (8) & (9). When the drill bit sizes were reduced, the variation in temperature followed the same pattern as that of higher drill bit sizes and the values of temperature were relatively less in comparison with the temperature values recorded at bigger drill bit sizes. Gumming was

observed in case of Nylon while drilling at high speeds.

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