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Experimental Investigation for Surface Roughness in Turning of Reinforced Polymer Composite Material using Different Coolants

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Abstract— Due to superior strength-to-weight ratio and good tribological properties, polymer matrix composite has seen its development in leaps and bounds settings its foot in almost all manufacturing industries. Polyamide 6 GF-15 is a very common thermoplastic polymer composite with a number of applications such as gears, bearings, which can be due to their impact resistance, fatigue resistance, thermal resistance, wear resistance , high strength and low cost of manufacturing also Vegetable oils have traditionally been applied in food uses but recent trend suggests that it has economic usefulness as an industrial fluids. Increasing crude oil prices and emphasis on the development of renewable, environment friendly fluids have brought vegetable oils to a place of prominence. As environment pollution and health problem are becoming more and more concerned, the use of environment friendly lubricants is strongly supported by manufacturer. The objective of this work is to investigate machining characterstics of Polyamide 6 GF-15 also the influence of lubricant on surface roughness by using CNC LATHE Machine. The Regression Analysis has performed by using Least square principle approximation and Roughness value (Ra) predicted by using Speed, Feed and Depth of cut as a function. The experimentation is proposed to identify the influence of Powercut oil and Cottonseed oil as a coolant in Turning of Polyamide 6 GF-15. The above experimentation will help practitioners to compare and increase Surface finish and possible use of environment friendly cutting oils in future.

Keywords— Nylon-6,Nylon66, Turning process, MRR, Vegetable oils as lubricant, Surface roughness.

I. INTRODUCTION

Cutting fluids which are also known as coolants or lubricants play an important role in material removal process and machining operation such as drilling, turning and milling. Over the past decades the landscape of the lubrication has significantly changed because of a combination of environmental, health, economics, and performance challenges. To address these challenges it is essential to develop and use lubricants that come from natural resources. Environment friendly or "Green 'lubricants are renewable and usually made from vegetable oils e.g. rapeseed, canola, corn, soybean oil [1].

Also PA6 is a very common thermoplastic semi-crystalline with a number of tribological applications such as gears, bearings, which can be due to their impact resistance, fatigue resistance, thermal resistance, wear resistance, high strength and low cost of manufacturing[2]. Sunday Albert Lawal [1] has studied on recent research work on the application of vegetable oil-based cutting fluids in machining non-ferrous metals, The results obtained established vegetable oil-based cutting fluids

as a good metalworking fluid. Sudhir Kumar et al [2] In this experimental work, pin-on-disc set up were used to study the tribological behavior of Glass Filled (GF) Nylon 6 composite on polymer/polymer and polymer/ AISI D2 steel disc (SD) contacts under dry conditions. Load (N) and sliding speed (m/s) are the factors considered for the test and the output studied was Coefficient-of-Friction (COF), Specific-Wear-Rate (SWR) and heat generated at the contact zone The COF and SWR have a close relationship with generation of heat and mechanisms of wear. Dilip S. Choudhari and V.J. Kakhandki [3] studied and analysed mechanical properties of chopped carbon fibre reinforced nylon 66 composite materials, It was observed from manufacturing methods that improved processability, high time efficiency, good compatibility and interface of the composite materials. Strength is calculated by rule of mixture method for chopped carbon fibre reinforced nylon 66 composites compared to carbon steel By rule of mixture method 30% chopped carbon fibre reinforced nylon 66 composites optimum tensile and flexural strength compared to carbon steel are observed. Similarly, 60% chopped carbon fibre reinforced nylon 66 composites optimum compression strength are observed.Its observed from literature review that very less work is available in investigating the effect of coolant in turning of Polyamide 6 GF15 also known as Nylon6 GF15.

II. EXPERIMENT DETAILS

The objective of this work to experimentally determine the surface roughness in turning Polyamaide6 15GF under wet (flooded) environment by using two cutting fluid i.e. Industrial power cut oil and cotton seed oil . Regression methodology was used for optimization and analysis of experiment. The work piece material used is Polyamaide6 15GF of 30mm long and 60mm diameter in the form of bar .The material is known Nylon6 15%Glass filled by weight natural in the industry. The shore D hardness is 72.

A Korloy make carbide insert with grade as TNMG 160408-HA Insert (0.8mm corner radius) Triangular shape was used for 27 trials under wet environment . For every experimental runs a new cutting edge was used.

The experiment have been conducted using ACE DESIGNERS CUB LM lathe. The machine unit with three jaw independent chuck, a computer numerically controlled tool slide which move accordingly to two axis horizontal and vertical-X and Z axis

2.1 Design of Experiment

The Following Three level DOE is used for experimentation -1 to 0 to +1.

Table-1: Levels for Design of Experiments

Process Parameter	**Level**		
	Low (-1)	**Medium (0)**	**High (+1)**
Speed (rpm)	2000	2200	2400
Feed (mm/rev)	0.05	0.1	0.15
Depth of cut (mm)	0.4	0.5	0.6

III.MATHEMATICAL MODEL DEVELOPMENT FOR SURFACE ROUGHNESS

After conducting experiments to develop mathematical model and to find significant factor for surface roughness, Regression and anova is done by MATLAB, Surface Roughness (Ra) versus Speed, Feed and Depth of cut is analyzed.

Surface Roughness for power cut oil

Ra = -0.4305 + 0.000127 Speed + 26.257 Feed - 0.3033 DOC

Surface Roughness for Cottonseed oil

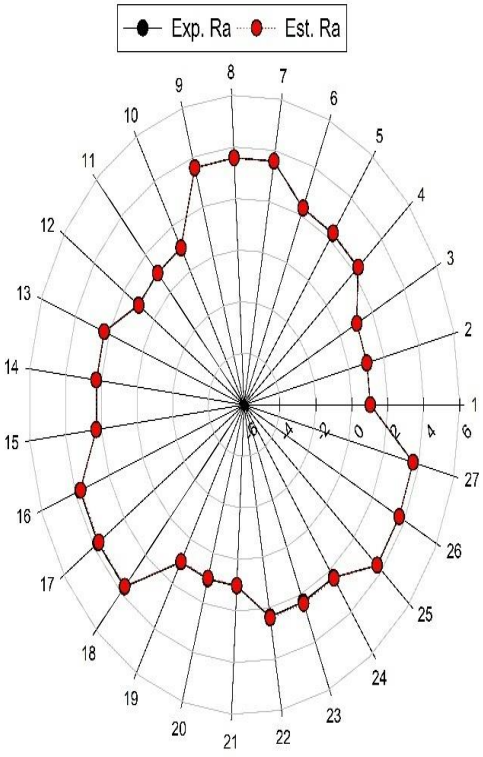
Ra = -0.304 + 0.000087 Speed + 26.241 Feed - 0.379 DOC

The Regression Analysis has performed by using Least square principle approximation and Roughness value (Ra) predicted by using Speed, feed and DOC as a function.

Model Summary table Shows R-sq Value 99.93% for predicted Ra from speed, feed and DOC for Powercut oil Model Summary table Shows R-sq Value 99.74% for predicted Ra from speed, feed and DOC for cotton seed oil.

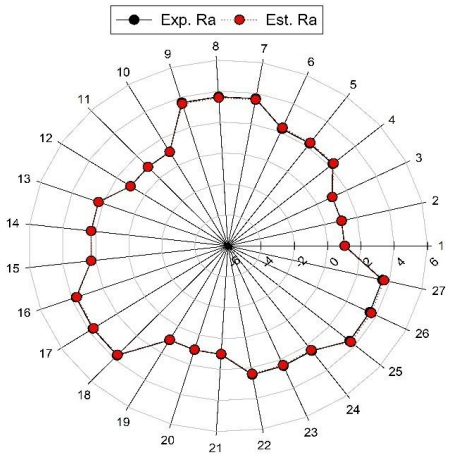
IV. RESULTS AND DISCUSSION

Following are the Radar plots showing Experimental surface roughness (Ra) value and Estimated surface roughness (Ra) value.



Graph -1: Comparison of Exp. Ra and Est. Ra based on speed, feed, and depth of cut for power cut oil

Graph 1 Provide the Radar Plot for Exp. Ra and Est.Ra based on Speed, Feed and Depth of cut for Powercut oil, RunNumber1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27 Shows Highest Accuracy of the Developed Correlation in Exp. Ra and Est.Ra.



Graph -2: Comparison of Exp. Ra and Est. Ra based on speed, feed, and depth of cut for Cottonseed oil

Graph 2 Provide the Radar Plot for Exp. Ra and Est.Ra based on Speed, Feed and Depth of cut for Cottonseed oil, RunNumber1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27 Shows Highest Accuracy of the Developed Correlation in Exp. Ra and Est.Ra.

V. CONCLUSION

- The Actual Experimentation Performed by using Speed, Feed and Depth of Cut ranges from 2000 to 2400, 0.05 to 0.15, 0.4 to 0.6 respectively.
- The modelling or Numerical Investigation has performed by using Least square principle approximation to predict Roughness value by considering Speed, Feed and Depth of cut as individual and combined
- The Ra value predicted by using regression analysis showed highest accuracy of 99.93%, By using Speed, Feed and Depth of cut as a function.
- As the Number of function Increases in equation ultimately the Accuracy of the correlation of Ra and MRR Increases and vice versa.

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