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Optimization of Machining Parameters for Turning of Al6061 using Robust Design Principle to minimize the surface roughness

Deepak D[a]*Rajendra B[b]

[a,b]*Department of Mechanical and Manufacturing Engineering, Manipal Institute of Technology, Manipal University, Manipal -576104,karnataka, India*

Abstract

The present work aims at optimization of the process parameter such as cutting speed, depth of cut and feed rate on surface roughness produced on the machined component. Analysis is carried out using Taguchi robust design principles. From the analysis, feed rate is found to be the most influential process parameters which influence the surface roughness followed by cutting speed and depth of cut. Increase in feed rate and depth of cut is found to increase the surface roughness.

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Keywords: Al6061; Surface Roughness; Turning Process; SN ratio; ANOVA

1. Introduction

Aluminium alloys are among the most commonly used lightweight metallic materials which possess attractive mechanical and thermal properties. Machinability of this material possesses relative easiness compared to other metals. Machinability quantifies the machining performancewhich can be defined by various criteria such as tool life, surface finish, material removal rate and power consumption (V. Songmene et. al, 2011), etc. Pure aluminium possess relatively low mechanical properties, which are improved by alloying the metal with other metals such as copper, manganese, silicon, magnesium, silicon, zinc, etc. Aluminium with magnesium and silicon as alloys are

* Corresponding author. Tel.: 91-7204308289.
E-mail address: Email:deepak.d@manipal.edu

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commercial designated as Al 6xxx series alloys. Among aluminium alloys Al 6061 exhibits excellent mechanical properties, corrosion resistance (Xuewu Lia,2015) and weldability (Omega Research,2002) which finds the applications in aircraft, missiles and space, ground and marine transportation, machine parts and architectural applications.

Nomenclature

A	Cutting Speed (m/min)
B	Feed (mm/rev)
C	Depth of Cut (mm)
Ra	Surface roughness µm
SN	Signal to Noise ratio
n	Total number of trial runs at i^{th} setting
y_i	Value of the response at i^{th} setting
k	Total number of replications.
DF	Degrees of freedom
SS	Sum of squares
MS	Mean sum of squares
F	Fisher's Number
d	Confidence interval
η_{eff}	Effective sample size

Toh et. al. (2004) studied the surface integrity effects on turned 6061 and 6061-T6 aluminium alloys. Investigations on machining of 6061 aluminium alloy with minimum quantity of lubricant, dry and flooded lubricant conditions were made by Sreejith (2008). Mukesh Kumar et. al. (2009) studied the effect of coated carbide tool on 6061-t4 aluminium. The effects of cutting parameters such as speed, depth of cut and cutting feed rate on the surface roughness were investigated by the authors and regression model are developed. Further, optimization of cutting parameters was carried by Carmita (2013) to minimize the energy consumption in turning of Al 6061-T6. Influence of cutting parameters on cutting force and surface finish was investigated by Rao et. al. (2013). It was found that feed rate is the significant factor that influence the cutting force as well as surface roughness. Also, depth of cut was found to have significant influence on the cutting force. Authors also have determined the optimum combination of feed rate and depth of cut to reduce power consumption as well as to achieve the better surface finish. Vinod Mishra et. al. (2014) studied the effects of tool overhang on selection of machining parameters and surface finish. It was found that too large and very small tool overhangs results in poor surface finish. Further, optimum range of tool overhang with minimum tool vibrations was established. Deepak et. al. (2015) studied the effect of coolant in turning of Al6061. It was found that use of coolant in machining improves the surface quality. In continuation of this, the present work attempts to optimize the process parameters and to study the interaction effect of the process parameters.

2. Methodology