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EXPERIMENTAL STUDY OF EFFECT OF CUTTING PARAMETERS ON CHIP MORPHOLOGY IN TURNING OF AISI 904L

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ABSTRACT

Austenitic stainless steel is one of the most important engineering materials with wide variety of applications. Superior resistance to corrosion and compatibility in high temperature and high vacuum has particularly made it an attractive choice. However, the machinability of austenitic stainless steel is not very promising owing to lower thermal conductivity, higher degree of ductility and work harden ability. Chromium, Nickel, Copper and Molybdenum gives 904L better corrosion resistance properties in sulphuric and phosphoric acid environment. It has excellent forming and welding characteristics.
The present work is concentrated on dry turning of 904L. In this study the effect of cutting parameters on chip morphology is studied by experimentation. A plan of experiments is done by Taguchi design of experiments to acquire data.

KEYWORDS: Cutting Parameters, Tool Wear, Taguchi method, S/N ratio, turning

INTRODUCTION

Austenitic stainless steel is one of the highly consumed steel worldwide and it is commonly used to fabricate chemical and food processing equipment, as well as machinery parts requiring high corrosion resistance. It is also amongst the “difficult to cut” material and the difficulties such as poor surface finish and high tool wear are common. The work hardening and low thermal conductivity is recognized to be responsible for the poor machinability of AISI304, AISI 904L austenitic stainless steels. In addition, they bond very strongly to cutting tool during cutting and when chip is broken away, it may bring with it a fragment of cutting tool.

PROBLEM DEFINITION & PROPOSED METHODOLOGY

PROBLEM DEFINITION

As we know the stainless steel material AISI 904L is very difficult to machining due to reasons such as having low thermal conductivity, high built up edge tendency and high corrosive resistance. So study the effect of cutting parameters of AISI 904L on chip morphology.

PROPOSED METHODOLOGY

Considering the problem occurring while selecting parameters for machining of AISI 904L, here firstly we selected the tool insert for machining of AISI 904L, tool holder PCLNR 2525M12. After the selection of tool insert, and tool holder we selected the Taguchi technique for performance of dry turning of AISI 904L in Taguchi method. Firstly we select the orthogonal array and cutting parameters like cutting velocity, feed and depth of cut and the reading are to be taken as per the orthogonal array selected.

EXPERIMENTATION

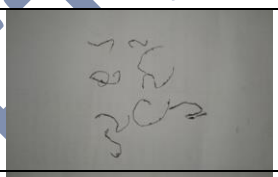
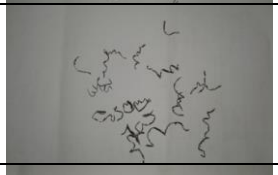
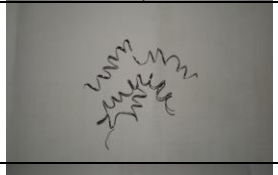
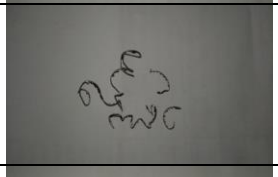
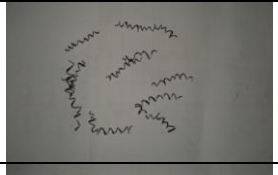
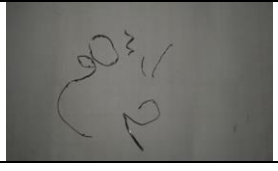
In this study, AISI 904L with Brinnel hardness of 187 (HBW is used as the work piece material. Dimensions of the work piece are diameter Ø40 mm × length 200 mm. Lathe (Maxcut PRH175) of maximum power 2 HP is used for experiments. The maximum RPM of the lathe machine is 1535 rpm, photograph of the machine is shown in Fig 1. Machining operations are performed in dry environment with Coated carbide, CNMG 120408-5, TN4000 grade. Tool Holder PCLNR 25*25-M12 (Korlay Make) is used for holding the insert.

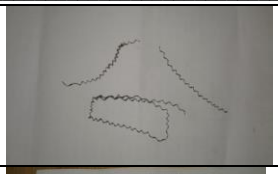
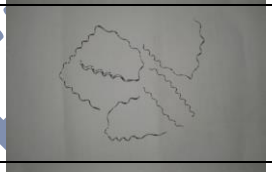
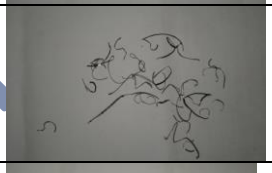
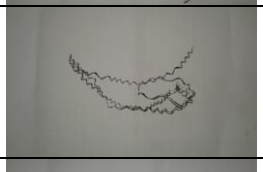
Figure 1: Lathe Maxcut PRH175

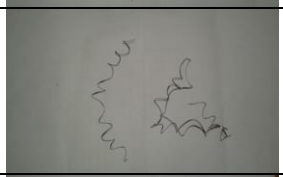
TURNING CONDITIONS AND EXPERIMENTAL DESIGN

Type of cutting velocity, feed rate and depth of cut are considered as turning parameters. The ranges of turning parameters are selected as recommended from the tool manufacturer. Experimental plan is organized according to the Taguchi method for the three factors and three level designs (L27 orthogonal array).

Table 1: Macro morphology of chip obtained at different cutting speed

Sr No.	SPEED (rpm)	DOC (mm)	FEED (mm/rev)	Photograph of Chip
1	202	0.133	0.15	
2	202	0.133	0.2	
3	202	0.133	0.25	
4	202	0.167	0.15	
5	202	0.167	0.2	
6	202	0.167	0.25	
7	202	0.267	0.15	

8	202	0.267	0.2	
9	202	0.267	0.25	
10	303	0.133	0.15	
11	303	0.133	0.2	
12	303	0.133	0.25	
13	303	0.167	0.15	
14	303	0.167	0.2	
15	303	0.167	0.25	
16	303	0.267	0.15	
17	303	0.267	0.2	
18	303	0.267	0.25	

19	455	0.133	0.15	
20	455	0.133	0.2	
21	455	0.133	0.25	
22	455	0.167	0.15	
23	455	0.167	0.2	
24	455	0.167	0.25	
25	455	0.267	0.15	
26	455	0.267	0.2	
27	455	0.267	0.25	

CONCLUSIONS

From above table, at various spindle speeds (i.e. at 202, 303, 455 rpm), Feed (0.133, 0.167, 0.267 mm/rev) & Depth of Cut (0.15, 0.20, 0.25 mm) it is observed that the chip flow rate is continuous for maximum observations & surface finish is better for all these observations. But, the observation no.1, 2, 3, 10, 14, 19, and 22 shows the discontinuous chip formation. The cutting speed & depth of cut are low but feed rate is high, due to that the tool moves in faster therefore chip produced is discontinuous. Cutting speed has important effect on various chip characteristics.

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