STUDY OF BRASS WIRE AND CRYOGENIC TREATED BRASS WIRE ON TITANIUM ALLOY USING CNC WEDM

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Abstract

In this paper we attempt the cryogenic treated brass wire to machined titanium alloy,Cryogenic treated hard brass wire is used in production of high performance dies, punches, etc. Cryogenic treatment is a process of keeping the wire in cold environment to increase its wear resistance and relieving its residual stresses. Experimental observations are based on Taguchi Method to find the optimum process parameter. Titanium alloys Grade-2 are often employed in Aerospace industry components due to their outstanding mechanical properties. This project work will steer towards attaining higher machining efficiency by acquiring a higher Cutting Speed (CS), Material Removal Rate (MRR) and low Surface Roughness (SR) with low wire consumption and frequency of wire breakage and making comparative study of brass wire and cryogenic treated brass wire on titanium alloy (Grade 2) using CNC WEDM with cryogenic setup.

Keywords: *Wire Electric Discharge Machine (WEDM), Cryogenic Setup, Titanium alloy.*

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1. INTRODUCTION

In the present economic scenario, the technology of wire electrical discharge machining is improved significantly to satisfy the requirements in various manufacturing fields. WEDM has been found to be an extremely potential electro-thermal process in the field of conductive material machining.

A thin single-strand metal wire, usually brass, is fed through the work piece, submerged in a tank of dielectric fluid, typically deionized water is used to machine the work piece. Wire-cut EDM is typically used to cut plates as thick as 300mm and to make punches, tools, and dies from hard metals that are difficult to machine with other methods. Wire-cutting EDM is commonly used when low residual stresses are desired, because it does not require high cutting forces for removal of material. WEDM is also known as Wire-Cut EDM and Wire Cutting. The most important performance factors in study of WEDM are material removal rate and surface finish.

Working Principle

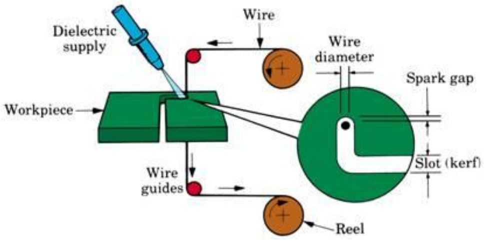

Fig 1.1 wire electrical discharge machining

They depend on machining parameters such as discharge current, pulse on time, pulse off time, feed and Wire tension ,this project is to make the comparative study between untreated and cryogenic treated brass wire, three process parameter such as pulse on time, pulse off time, wire feed have been considered.

The process performance is measured in terms of material removal rate (MRR) and surface finish for untreated and cryogenic treated brass wire

2. EXPERIMENTAL AND SELECTION OF PROCESS PARAMETERS FOR CNC WIRE CUT EDM

Input Factors:-

Pulse on Time	T_{on}	µs
Pulse off Time	T_{off}	µs
Wire Feed	WF	m/min
Wire Tension	WT	k

Table 2.1 Factors and the levels of the process parameters

Factors	Levels		
	1	2	3
A, Pulse On Time	1	2	3
B, Pulse Off Time	6	7	8
C, Wire Feed	3	4	5

2.2. Taguchi Method

The Taguchi method is very effective, because it is simple to carry on the experimental design and its approach is very systematic to provide good quality and low cost in manufacturing.

According to the L9 orthogonal array, three experiments for each set of process parameters have been carry out on taguchi L9 orthogonal array design matrix is selected from array table

Table 2.2 Experimental layout of L9 Orthogonal array

S.I No	Factor 1	Factor 2	Factor 3
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2

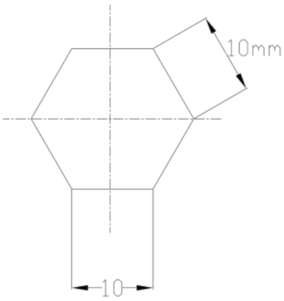

Fig. 2.1 Part Diagram

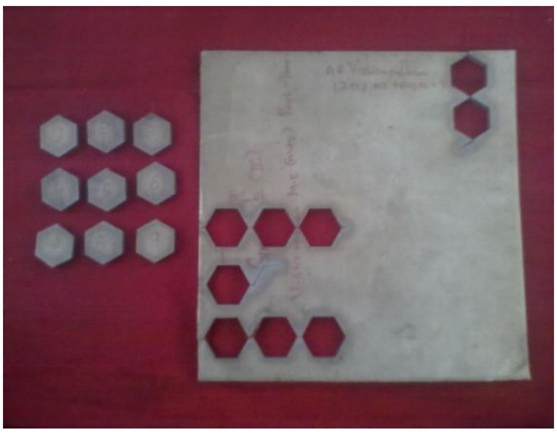

Fig 2.2 machined workpiece on ti alloy (grade2) using normal brass wire

Table 2.3 Machining time for titanium alloy Grade-2 using normal brass wire.

S.No	Pulse On Time T_{on} (µs)	Pulse On Time T_{off} (µs)	Wire Feed (m/mim	Machining Speed (mm/min)	MRR (mm3/min)	Ra (µm)
1	1	6	3	4.2	4.5528	2.509
2	1	7	4	4.3	4.6612	2.614
3	1	8	5	4.0	4.336	2.387
4	2	6	4	3.4	3.6856	3.065
5	2	7	5	3.6	3.9024	1.957
6	2	8	3	3.9	4.2276	2.807
7	3	6	5	3.8	4.1192	1.606
8	3	7	3	3.9	4.2276	2.297
9	3	8	4	4.0	4.336	2.456

Table 2.4 Material Removal Rate & Surface roughness for titanium alloy Grade-2 using normal brass wire.

S. No	Pulse On Time T_{on} (µs)	Pulse On Time T_{off} (µs)	Wire Feed (m/mim)	Wire Tension (G)	Spark Gap Set Voltage (V)	Peak Current Amps	Machining Time (Mt) min
1	1	6	3	400	68	1.5	15
2	1	7	4	400	66	1.5	16.15
3	1	8	5	400	68	1.5	15.45
4	2	6	4	400	68	1.5	17.10
5	2	7	5	400	68	1.5	17
6	2	8	3	400	66	1.5	17.35
7	3	6	5	400	70	1.5	16.15
8	3	7	3	400	70	1.5	16.72
9	3	8	4	400	70	1.5	16.20

3. EFFECT OF CRYGENIC TREATMENT

Cryogenic processing (cry processing) is the process of cooling a material at very low temperature around 77k (-196˚C) . Cryoprocessing is a supplementary process to conventional heat treatment process is the process of deep-freezing materials at cryogenics temperature to enhance the mechanical and physical properties of the material. The execution of cryoprocessing on cutting tool materials increase wear resistance, hardness, and dimensional stability and reduces tool consumption.

Cryogenic processing is capable of treating a wide variety of materials such as metals , alloys, polymers, carbides, ceramics and composites . Deep cryogenics is the ultra low temperature processing of materials to enhance there desired metallurgical and structural properties .

The Cryogenics treatment will affect the micro structure of the material these changes in micro structure enhance the properties of the material such as hardness and wear strength of the material . Generally there are two reasons for improvement in the properties of material because of cryogenic treatment. They are

(1) The transformation of retained austenite into martensite

(2) Formation and distribution fine carbides.

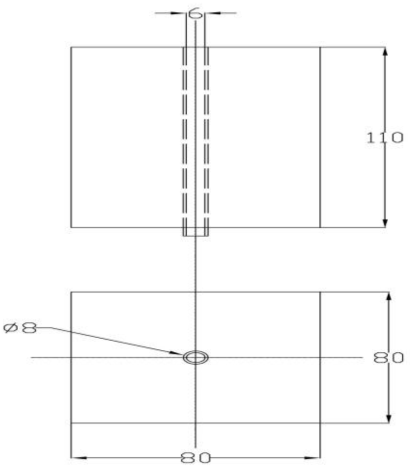

Fig.3.1 Part diagram of cryogenic setup

Fig.3.2 Fabrication of cryogenic setup

Fig.3.3 Mounting of cryogenic setup on cnc WEDM

Fig.3.4 Machined specimen of titanium alloy Grade-2 using cryogenic setup

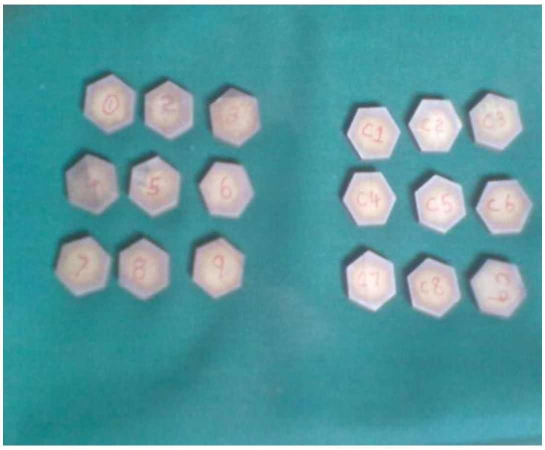

Fig 3.5 machined specimen of titanium alloy

Fig 3.6 Machined specimen of titanium alloy grade -2 using cryogenic treated brass wire (C1) and normal brass wire (1).

Table 3.1 Machining time for titanium alloy Grade-2 using cryogenic treated brass wire.

	Pulse On Time T_{on} (µs)	Pulse On Time T_{off} (µs)	Wire Feed (M/Mim	Wire Tension (G)	Spark Gap Set Voltage (V)	Machining Speed (Mm/Min) Cbw	Peak Current Amps	Machining Time (Mt) Min Cbw
1	1	6	3	400	68	4.8	1.5	12.47
2	1	7	4	400	66	5.2	1.5	9.25
3	1	8	5	400	68	5.0	1.5	12.02
4	2	6	4	400	68	5.1	1.5	11.59
5	2	7	5	400	68	4.4	1.5	13.54
6	2	8	3	400	66	4.2	1.5	13.56
7	3	6	5	400	70	5.4	1.5	8.25
8	3	7	3	400	70	5.6	1.5	10.50
9	3	8	4	400	70	5.5	1.5	11.06

4. RESULT AND DISCUSSION

From the tables 3.1&2.3 it is found that the Machining Time Of Titanium Alloy (Grade2)Using Cryogenic Treated Brass Wire is More Effective than normal brass wire

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