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Optimization of Wire Cut Electro Discharge Machining Process Parameters for HCHCr-D2 Steel

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Abstract: The process parameters for wire cut electro discharge are optimised in this paper. The analysis takes into account the process parameters pulse on time, pulse off time, and current. High Carbon High Chromium (HCHCr-D2) steel is a high tensile strength alloy that is typically utilised in cold dies and tooling applications that demand a high level of and dimensional accuracy. For the machining procedure, a rectangular-shaped plate of the alloy steel HCHCr-D2 was used. By examining the material removal rate (MMR) and surface roughness, wire cut electro discharge machine (WEDM) performance using a molybdenum wire has been evaluated (SR).
Keywords: Optimization, Material Removal Rate, Surface Roughness.

I. INTRODUCTION

A high level of resistance, high wear and tear, hardness, strength, and toughness are now required by the industries that produce tools, dies, moulds, and metalworking. The development of novel materials such as titanium, inconel, ceramics, zirconium, stainless steel, carbides, and many other high strength temperature resistant alloys has led to their widespread application in the automotive, aerospace, medical, defence, and tool and die production industries. Such materials make ordinary machining challenging and occasionally impossible. For exceptionally hard and brittle materials, non-traditional procedures are used in place of traditional ones.

Wire cut electrical discharge machining is one such unconventional method (WEDM). An example of contemporary manufacturing is the production process. In order to erode the work material by creating sparks between the work and tool, the WEDM uses a wire that transforms into a tool when current flows through it. To remove the material by erosive action and prevent overheating, the tool and work piece are partially or fully submerged in a dielectric fluid. Computer numerical control (CNC) systems typically maintain a space between the work piece and the wire that ranges from 0.015 to 0.05 mm. The manufacturing of moulds and dies, as well as the aerospace and automobile industries, mostly utilise this method. Most industries are driven by the desire for higher productivity at the lowest possible cost. WEDM must be carried out more effectively due to the rising demand for high-quality products as well as for increased productivity. The modelling and optimization of process parameters to produce a high-quality product while lowering production costs is thus one of the most intriguing and research-intensive fields.

II. SELECTION OF MATERIAL

In this study, the workpiece is made of HCHCr-D2 steel. Size is offered in square, flat, and round shapes. This substance is primarily applied in the manufacturing of moulds and dies, and time, pulse off time, and WEDM current affect the rate of material removal (MMR), as well as the surface roughness (SR). The item code for material HCHCr steel is D2. Table 1 displays the chemical composition of HCHCr-D2 Steel.

Composition	C	Si	Mn	Cr
Percentage	1.40 - 1.60 %	0.25 - 0.40 %	0.20 - 0.40 %	11 - 12 %

Table.1. Chemical Composition of HCHCr-D2 Steel

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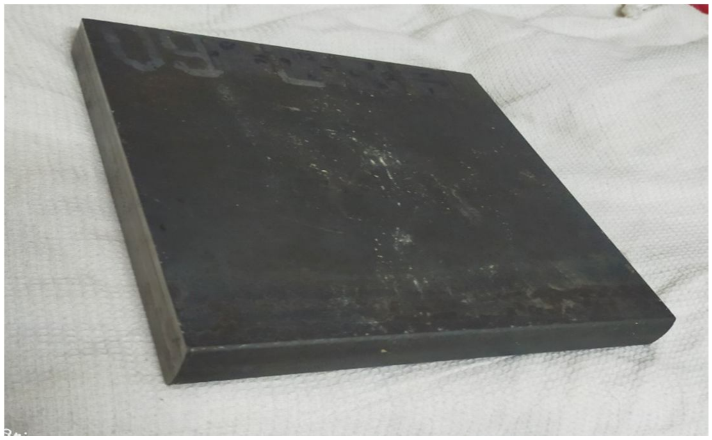

Fig.1.HCHCR D2 steel

III. LEVELS OF INPUT PARAMETERS

Each parameter has three levels that have been chosen for optimization. It would have taken more experiments to choose more than three tiers. When examining the effects of factors for the first time, choosing fewer than three levels is not justified. Three levels of input parameters for the optimization research are shown in the table.

S NO	PULSE ON TIME (µs)	PULSE OFF TIME (µs)	CURRENT (A)
1	30	6	3
2	40	8	3
3	30	6	3
4	40	8	3
5	30	6	4
6	40	8	4
7	30	6	4
8	40	8	4
9	30	6	5
10	40	8	5
11	30	6	5
12	40	8	5
13	30	6	6
14	40	8	6
15	30	6	6
16	40	8	6

Table.2. Levels of Input Parameters

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IV. WORKING OF EDM

In EDM, the tool electrode and workpiece electrode are both completely submerged in a dielectric fluid such as Kerosene oil, EDM grade oil, transformer oil, distilled water, etc. Typically, the tool is made negative by being connected to the cathode (which is called the negative polarity) and made positive by being connected to the anode (which is called the positive polarity). Intermittent electric discharge is used to machine unwanted material because dielectric strength breaks down at high enough voltages.

Electric discharge machining is done in this way because of the intermittent discharge between the gaps of 10.5 and 125.7 m, which happens after each pulse on duration, produces a very high temperature in a fraction of a second that melts the metal at such a high temperature in the range of 8000oC to 12000oc

that evaporates the metal. There is no current flowing in the circuit for the duration of the pulse off. At this point, dielectric fluid enters the scene and, in addition to cooling the area, serves as a flushing agent, clearing away any debris in the fluid and cleaning the area by washing out microchips.

Fig.2. Wire EDM Machine

V. EXPERIMENTAL WORK

Electric Discharge Machine (Die Sinking) Semi-Automatic Machine (EMS 5030), produced by Massive Engineering Pvt. Ltd. in Pune. For the purpose of conducting the studies, the workpiece HCHCr was given negative polarity and the copper tool electrode was given positive polarity. In this experiment, EDM oil with a specific gravity of 0.765 and a flash point of 94 °C was employed as the dielectric medium for external flushing. The flushing pressure was set at 0.4 kgf/cm2.

As will be covered in more detail later, three distinct values of the spark producing current (Ip), two different values of the thickness of the copper flat (t), and three different values of the pulse on duration (Ton) were selected in this case. According to the diagram, the semiautomatic die-sinking machine has a dielectric rotational system with a filter, a pump, and a container for dielectric fluid. System for servo control and power development unit. Device for fixing electro-magnetic jobs that has a tank for a fully submerged workpiece in dielectric fluid while cleansing the outside

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Fig.3. EDM spark

As will be covered in more detail later, three distinct values of the spark producing current (Ip), two different values of the thickness of the copper flat (t), and three different values of the pulse on duration (Ton) were selected in this case. According to the diagram, the semiautomatic die-sinking machine has a dielectric rotational system with a filter, a pump, and a container for dielectric fluid. System for servo control and power development unit. Device for fixing electro-magnetic jobs that has a tank for a fully submerged workpiece in dielectric fluid while cleansing the outside.

VI. EXPERIMENTAL RESULT

Experiments	Inputs Factors			Output Responses	
Trial No.	Pulse on time (µs)	Pulseoff time (µs)	Current (A)	MaterialRemoval Rate (In Min)	Surface roughness Ra In Micron
1	30	6	3	12.22	2.435
2	40	6	3	10.51	2.821
3	30	8	3	15.30	3.221
4	40	8	3	15.31	2.222
5	30	6	4	10.24	3.344
6	40	6	4	09.27	3.527
7	30	8	4	10.52	3.725
8	40	8	4	13.47	3.302
9	30	6	5	09.16	3.520
10	40	6	5	07.53	4.175
11	30	8	5	10.32	3.109
12	40	8	5	11.11	3.455
13	30	6	6	08.30	3.331
14	40	6	6	07.04	3.797
15	30	8	6	09.25	3.379
16	40	8	6	10.15	3.271

Table.3. Experimental Result

VII. CONCLUSION

The current study examines the machining of HCHCr (D2) by Die Sinking EDM and looks for the suitable application of output process parameter values while varying the input response variables and gathering various data in accordance with strategies for parameter variation. Following an analysis of the impact of machining responses on MRR, TWR, and SR, final results are reached.

The conclusions are as follows: Inferences regarding MRR 10.9051 mm3/min is found to be the MRR's ideal value. This is discovered at Run-18 when the ideal confluence of the input parameters is copper tool electrode thickness (t) = 8 mm, pulse on duration Ton = 32 s, and Discharge Current Ip = 4A. Also, it is determined that the thickness of the electrode has the least impact on the parameter and that the value of the discharge current (Ip) is the most dominant parameter, followed by the pulse on duration (Ton), which is the most significant factor.

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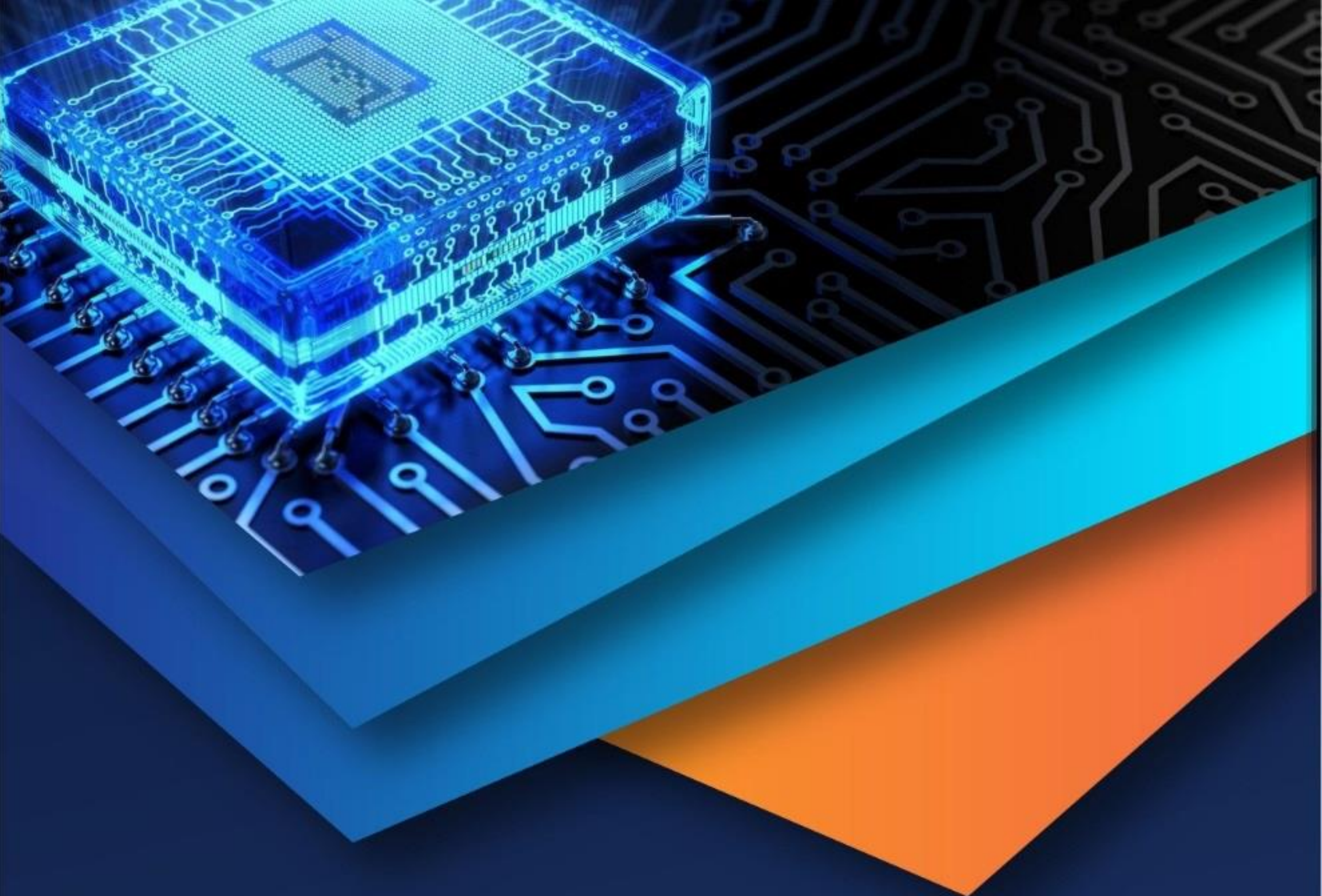

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