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OPTIMIZATION OF TIME TAKEN IN BURR REMOVAL OF CP TITANIUM (TI) GRADE 2 USING ELECTRICAL DISCHARGE MACHINE (EDM)

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ABSTRACT

Time plays an important role in production industry which helps industry for making best quality product's available in market in minimum time and gaining profit through it. This will help in the analyses of the business needs and to help in building up the plant management information system of Manufacturing time and Manufacturing time Management. Managing the time of production in digital factory for manufacturers, which uses standardized processes and tools for the world-wide production, is of great interest. The firm's objective is to maximize the benefits by selecting an optimal time taking process into account that (i) reduce machining time while deburring operation of CP Titanium (Ti) Grade 2, and (ii) the specimen must be able to satisfy a pre-specified quality level. CP Titanium (Ti) Grade 2 has been widely used in marine and chemical applications such as condensers, evaporators, reaction vessels for chemical processing, tubing and tube headers in desalinization plants, and cryogenic vessels. Other uses have included items such as jigs, baskets, cathodes and starter-sheet blanks for the electroplating industry, and a variety of medical applications. Burr removable can also be performed by using non-conventional process like Electrical Discharge Machine (EDM). Electrodes like Copper, Graphite and Brass are used for the deburring method. In this present research work Burr Removal was done with Copper electrode and the varying input control variables and their effects on Time Taken for the performance were investigated. Minitab 17 software was used to perform the statistical analysis and to obtain combination of the optimum levels of parameters for minimum Time Taken.

KEYWORDS: Time Taken, CP Titanium (Ti) Grade 2, Burr, EDM and Stop-Watch.

It is rightly said that "Time and Tide wait for none". Industry should understand the value of time for their success in all aspects of production. Industries which don't give importance to time or delay time in production are the ones who fail to create an identity of their own in the market. Time Management refers to managing time effectively so that the right time is allocated to the right activity. Effective time management allows individuals to assign specific time slots to activities as per their importance. Time Management refers to making the best use of time as time is always limited. Engineer must know which activity is more important and how much time should be allocated to the same. Know which work should be done earlier and which can be done a little later. Time Management plays a very important role not only in organizations.

Time Management Includes

I. Effective Planning
II. Setting goals and objectives
III. Setting deadlines
IV. Delegation of responsibilities
V. Prioritizing activities as per their importance
VI. Spending the right time on the right activity

Electrical discharge machining (EDM) is a metal-removal process that is used to remove metal by means of electric spark erosion in controlled way. Electric spark is used as the cutting tool to cut (erode) the work piece to produce the finished part to the desired shape in this method of machining process. Electrical charge of high-frequency current is used for metal-removal process which is performed by applying a pulsating (ON/OFF) through the electrode to the work piece. As the electrode approaches the work piece, dielectric breakdown occurs in the fluid, forming a plasma channel and a small spark jumps. This removes (erodes) very tiny pieces of metal from the work piece at a controlled rate (Steve Krar). Copper is a chemical element with symbol Cu (from Latin: cuprum) and atomic number 29. Copper is one of the few metals that occur in nature in directly usable metallic form as opposed to needing extraction from an ore. Copper does not react with water, but it does slowly react with oxygen present in the atmospheric to form a layer of brown-black (copper oxide) which, unlike the rust that forms on iron in moist air, protects the inner lying metal from further corrosion. In old copper structures a green layer of verdigris (copper carbonate) can often be seen, such as the roofing of many older buildings (Grieken, Rene van; Janssens, Koen 2005). They have one s-orbital electron on top of a filled d-electron shell and are characterized by high ductility and electrical and thermal conductivity (Pleger, Thomas C. "A Brief Introduction to the Old Copper Complex of the Western Great Lakes: 4000–1000 BC).

METHODOLOGY

For the present research work the experiment work was designed strategically using the DOE (Design of Experiment) statistical tool.

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The design of experiments (DOE or experimental design) is the design of any task that aims to describe or explain the variation of information under conditions that are hypothesized to reflect the variation. As the systematic procedure carried out under controlled conditions in order to discover an unknown effect, to test or establish a hypothesis, or to illustrate a known effect. In which process inputs have a significant impact on the process output, and what the target level of those inputs should be to achieve a desired result (output) while analyzing a process experiments which are often used to evaluate process. Designing of experiment can be done in many different ways to collect this information. In its simplest form, an experiment aims at predicting the outcome by introducing a change of the preconditions, which is reflected in a variable called the predictor. The change in the predictor is generally hypothesized to result in a change in the second variable, hence called the outcome variable. Experimental design can be used at the point of greatest leverage to reduce design costs by speeding up the design process, reducing late engineering design changes, and reducing product material and labor complexity. Designed Experiments are also powerful tools to achieve manufacturing cost savings by minimizing process variation and reducing rework, scrap, and the need for inspection. Taguchi Orthogonal Array Deigns (OA) design is a type of general fractional factorial design. It is a highly fractional orthogonal design that is based on a design matrix proposed by (Dr. Genichi Taguchi) and allows you to consider a selected subset of combinations of multiple factors at multiple levels. To ensure the balance that all levels of all factors are considered equally, for ensuring this Taguchi Orthogonal arrays is used. For this reason, the factors can be evaluated independently of each other despite the fractionality of the design. In the Taguchi OA design, only the main effects and two-factor interactions are considered, and higher-order interactions are assumed to be nonexistent. The permutations of factor levels comprising a single treatment are so chosen that their responses are uncorrelated and therefore each treatment gives a unique piece of information. The net effects of organizing the experiment in such treatments are that the same piece of information is gathered in the minimum number of experiments. For this reason L18 array was selected and the following control input variable with different level has been used (Table 1):-

Table 1: EDM Process Parameters and their Levels

Parameters	Tw	TON (Pulse on)	TAU (Pulse Off)	IP	IB	TDI	SV	SF
Level 1	10	150	16	18	2	60	75	30
Level 2	20	400	20	25	3	70	80	50
Level 3	--	750	24	32	4	80	85	70

For this present research work CP Titanium (Ti) grade2 was selected as specimen material and stop watch was used for monitoring time.

Titanium is a chemical element with symbol Titanium (Ti) and atomic number 22. It is a lustrous transition metal with a silver colour, low density and high strength. The two most useful properties of the metal are corrosion resistance and strength-to-density ratio, the highest of any metallic element (Donachie, Matthew J., Jr. 1988). In its unalloyed condition, titanium is as strong as some steels, but less dense (Barksdale 1968). Titanium can be alloyed with iron, aluminium, vanadium, and molybdenum with other elements to produce strong, lightweight alloys (Table 2, 3 & 4).

Application of Titanium and CP Titanium Grade-2

I. In aerospace (jet engines, missiles, and spacecraft)
II. Military and Industrial process (chemicals and petro-chemicals, desalination plants, pulp, and paper)
III. Automotive
IV. Agri-food, medical prostheses
V. Orthopedic implants, dental and endodontic instruments and files, dental implants,
VI. Jewelry, mobile phones, and other applications.
VII. Titanium is used in steel as an alloying element (ferro-titanium) to reduce grain size and as a deoxidizer, and in stainless steel to reduce carbon content.

Table 2: L18 Orthogonal Array with Experimentally Obtained Response Data

Sr. No.	Tw	TON (Pulse on)	TAU (Pulse Off)	IP	IB	TDI	SV	SF	Time Taken (min)	SNRA1
1	10	150	16	18	2	60	75	30	90	-39.0849
2	10	150	20	25	3	70	80	50	70	-36.9020
3	10	150	24	32	4	80	85	70	49	-33.8039
4	10	400	16	18	3	70	85	70	57	-35.1175
5	10	400	20	25	4	80	75	30	75	-37.5012
6	10	400	24	32	2	60	80	50	107	-40.5877
7	10	750	16	25	2	80	80	70	30	-29.5424
8	10	750	20	32	3	60	85	30	45	-33.0643
9	10	750	24	18	4	70	75	50	2	-6.0206
10	20	150	16	37	4	70	80	30	110	-40.8279
11	20	150	20	18	2	80	85	50	2	-6.0206
12	20	150	24	25	3	60	75	70	60	-35.5630
13	20	400	16	25	4	60	85	50	65	-36.2583
14	20	400	20	32	2	70	75	70	43	-32.6694
15	20	400	24	18	3	80	85	30	85	-38.5884
16	20	750	16	32	3	80	75	50	57	-35.1175
17	20	750	20	18	4	60	80	70	49	-33.8039
18	20	750	24	25	2	70	85	30	60	-35.5630

Table 3: Chemical composition of CP Titanium Grade 2

Component	C	Fe	H	N	O	Ti
Wt.%	Max 0.1	Max 0.3	Max 0.015	Max 0.03	Max 0.25	99.2

Table 4: Various properties of CP Titanium grade2 (Ti)

Physical property	Metric
Density (g/cc)	4.51
Mechanical Property	
Hardness Rockwell B	80
Tensile Strength, Ultimate (Mpa)	344
Tensile strength, Yield (Mpa)	275 - 410

Chemical Properties

Titanium readily reacts with oxygen at 1,200 °C (2,190 °F) in air, and at 610 °C (1,130 °F) in pure oxygen, forming titanium dioxide. It is however; slow to react with water and air at ambient temperatures because it forms a passive oxide coating that protects the bulk metal from further oxidation. When it first forms, this protective layer a thickness of 25 nm in four years. Application of Titanium are Pigments, additives, coatings, Aerospace and marine, Industrial, Consumer and architectural, Jewellery, Medical and Nuclear waste storage.

Dimensions of specimen were: 40 X 40 X 5 mm

No. of specimens used were 18 pieces

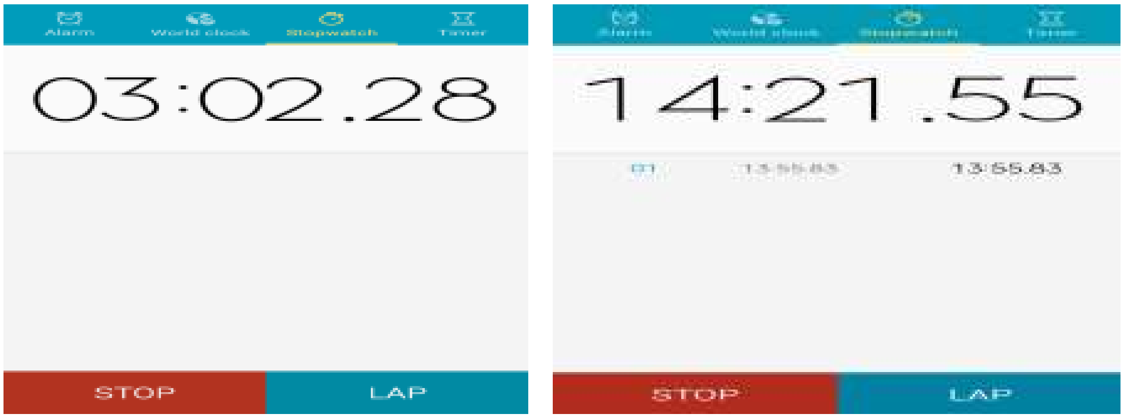

Figure 1: Observation of Time Taken with Stop Watch

Therefore the experiment were perform on the CP Titanium (Ti) Grade2 specimen with varying level of the controlled variables levels and Burrs got formed followed by deburring with the significant Material Removal Rate, which was measured later on. The output parameter of interest measured in this research was Time Taken which was monitored with the help of stop watch for the each deburring operation involved in this experiment (Figure 1, 2.1 & 2.2).

RESULTS & DISCUSSION

Table 5: Response Table for Signal to Noise Ratios - "Smaller-is-better" for Time Taken

Level	Tw	TON (Pulse on)	TAU (Pulse Off)	IP	IB	TDI	SV	SF
1	-32.40	-32.03	-35.99	-26.44	-30.58	-36.39	-30.99	-37.44
2	-32.71	-36.79	-29.99	-35.22	-35.73	-31.18	-36.33	-26.82
3		-28.85	-31.69	-35.05	-31.37	-30.10	-31.20	-33.42
4				-40.83				
Delta	0.31	7.94	6.00	14.39	5.15	6.30	5.34	10.62
Rank	8	3	5	1	7	4	6	2

Table 6: Response Table for Mean of Time Taken

Level	Tw	TON (Pulse on)	TAU (Pulse Off)	IP	IB	TDI	SV	SF
1	58.33	63.50	68.17	47.50	55.33	69.33	54.50	77.50
2	59.00	72.00	47.33	60.00	62.33	57.00	73.20	50.50
3		40.50	60.50	60.20	58.33	49.67	51.86	48.00
4				110.00				
Delta	0.67	31.50	20.83	62.50	7.00	19.67	21.34	29.50
Rank	8	2	5	1	7	6	4	3

Table 7: Analysis of Variance for Time Taken

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Tw	1	787.0	787.0	1.47	0.439
TON (Pulse on)	2	5077.4	2538.7	4.74	0.309
TAU (Pulse Off)	2	2532.8	1266.4	2.36	0.418
IP	3	1585.0	528.3	0.99	0.612
IB	2	941.2	470.6	0.88	0.602
TDI	2	518.2	259.1	0.48	0.713
SV	2	3563.8	1781.9	3.33	0.361
SF	2	4259.2	2129.6	3.98	0.334
Error	1	535.5	535.5		
Total	17	14954.0			

Table 8: Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
23.1412	96.42%	39.12%	*

Main effect Plots and Contour Plots for Time Taken

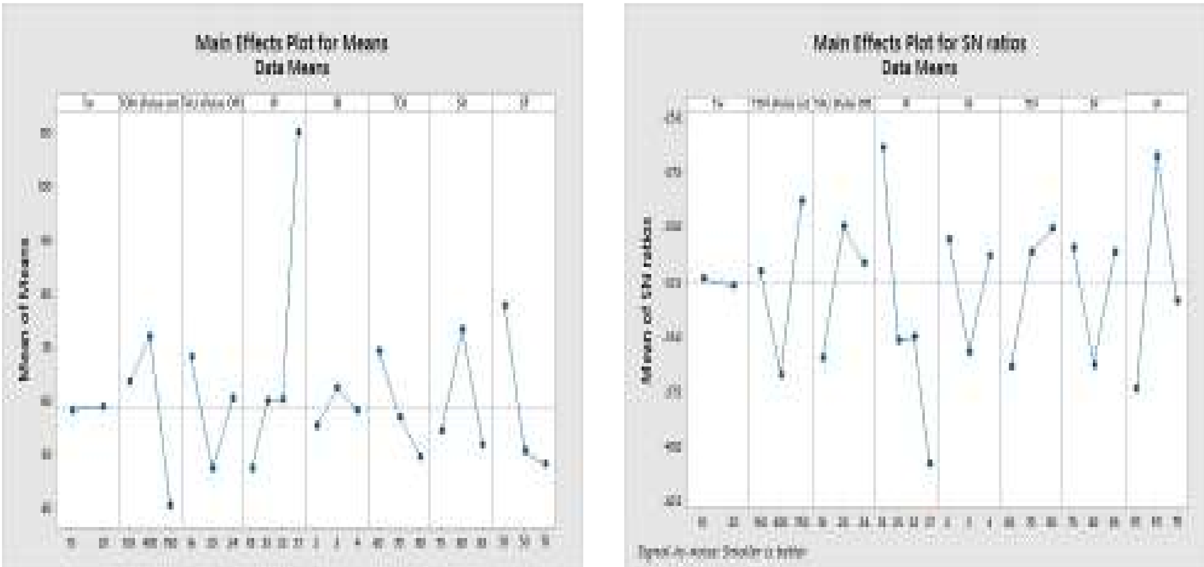

Figure 2.1:Main effects for Mean and SN Ratio for Time Taken (min)

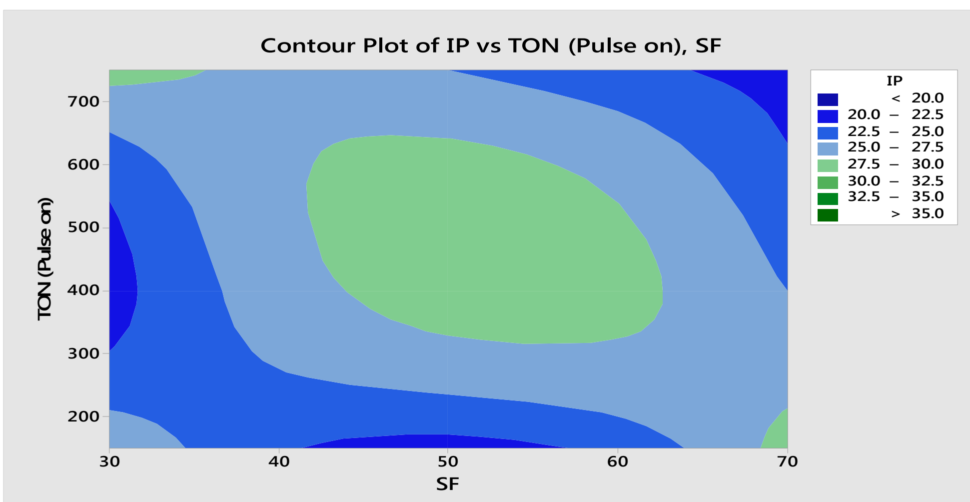

Figure 2.2: Graph for Time Taken with Copper Electrode on CP Titanium grade 2

Table 9: Optimal Levels of the Parameters for Time Taken

Parameters	Tw	TON (Pulse on)	TAU (Pulse Off)	IP	IB	TDI	SV	SF
Levels	2	2	1	2	2	1	2	1
Values	20	400	16	25	3	60	80	30

According table no. 9 during deburring machining through EDM the response table for Time Taken for Signal to Noise Ratios- "Smaller-is-better" were highly affected by IP followed by SF, TON, TDI, TAU, SV, IB and Tw.

CONCLUSION

- The present research work was performed at Tool Room Training Centre, Patna, Bihar, India.
- Deburring Operation was performed using Copper electrode at various level of parameters and the Material Removal Rate was measured as the response data.
- Table no.9 during deburring machining through EDM the response table for Time Taken for Signal to Noise Ratios- “Smaller-is-better” were highly affected by IP followed by SF, TON, TDI, TAU, SV, IB and Tw.

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