TEST EXAMINATION AND IMPROVEMENT OF NUMERICAL AND STATISTICAL CORRELATIONSHIPS OF CUTTING BOUNDARIES FOR MACHINING TITANIUM CNC WEDM

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ABSTRACT : Wire cut EDM measure materials Titanium various boundaries of machining current, cutting pace, flash hole and material evacuation rate will be examined and most appropriate qualities for steady and controlled machining with least wire breakage. In the current work focused on exploratory examination to deciding ideal benefits of machining of titanium material of various thicknesses utilizing wire cut electric release machine. It likewise focused on advancement of numerical connections to decide the impact of machining boundaries on current, cutting pace, sparkle hole and material evacuation rate researched and most appropriate qualities for steady and controlled machining with least wire breakage. The examinations are directed on the titanium material by cutting L and U shapes by differing machining current from a lower an incentive to a higher incentive in 5 stages. The chopping speed is noted down from machine show and surfaces completions is estimated on utilizing count surf. The sparkle hole, surface unpleasantness and MRR are utilizing the cause 8.0, software. The numerical connection is for best fit bend and genuinely examination is performed to discovered wellness of the bend. the most extreme mistake acquired from determined qualities and exploratory qualities are discovered to be under 4 % from these we reason that relapse measurable examination given better expectation esteems with least error% .catchphrases WEDM, cutting velocity, MRR, sparkle hole, surface harshness, numerical connection, relapse investigation .

Keywords: viscoelastic damping, vibrations, arrangement of dampers and rail.

Introduction:

Wire electrical release machining (Wire EDM), is a machining cycle in which a wire conveying electrical charge is utilized to cut the hard materials, the two significant the parts needed for wire EDM machine the wire anode and the level of accuracy and the measure of material that can be eliminated . To cut muddled or perplexing plans with more noteworthy accuracy and 3D profiles, wire EDM machines requires the customary X and Y pivot as well as the U and V hub for a standard 4-hub tooling yet can likewise have fifth hub

In the wire EDM the material being machined is normally embedded in an installation and siphoned with die electric liquid, regularly a deionized water of appraised conductivity electrical flows going through metals increments inner temperatures and metals tooled in higher warmth condition turns out to be less inflexible and have a deficiency of rigidity tooling in water is to eliminate the chips and diminishing the measure of scoring of the completed items, to diminish the general the existence of wire anode. Wire EDM framework include different machining parts and sub –segments which incite the different phases of activity of the framework initiating from the underlying phase of sparkle hole age, through the different parametric settings prompting the last phase of completing the items . in this ways , the framework mirrors the innovation of cycle controls to be to some degree complex and fundamentally complicated . Subsequently, a thorough investigation of the operational innovation of the interaction is profoundly required for a superior comprehensive of the diverse machining boundaries and related control wordings which assume essential part in the row reconciliation of framework segments.

The WEDM framework includes a primary work table called X-Y table on which the work piece is clipped, an assistant table called U-V table and the wire feed drive subsystem. The fundamental table moves along the X and Y tomahawks, in strides of generally 1 ^m by method for beat engine set along U and V tomahawks. Which are corresponding to X and Y tomahawks separately. To accomplish high dimensional precision of item WEDM utilizes a low contact slides drive . the slides for developments of X and Y tomahawks are mounted on accuracy needle-confines in pre tensioned solidified guide ways .the guide ways are reasonably shielded from dust by utilizing roars and the slide drive is gotten by either a shut circle dc engine drive or a dc stepper engine drive . the dc stepper engine of low dormancy and high goal driven by a uniquely and controlled interpreter gives the progression size of 1 ^m precisely . the dc servo engine drives, utilizing SCR control or heartbeat width balance control with the high goal encoder inputs, give exact situating repeatability of typically 2 ^m.

Fig:1 Wire-cut EDM machine table

2. Survey of past exploration:

Liao and Yu [1] performed tests to decide the particular release energy (SDE) for the example the energy needed to eliminate a unit volume of material . it is accounted for that SDE is consistent for a particular material . a quantitative connection between machining qualities MRR, productivity of MRR and machining boundaries is deciding the setting of machining boundaries is inferred the outcomes can be boundaries is inferred the outcome can be applied for deciding the setting of machining boundaries of various materials .

Han et al . [2] dissected the impact of release current on machined surface morphology . the surface morphology is concentrated under different heartbeat lengths, brought about by beat energy produced through release current . the short heartbeat and long the heartbeats having 0.67 and 0.60 mj of heartbeat caused comparable size cavities offering ascend to comparative surface . the creators presumed that the surface . the surface morphology relies upon beat energy in turn release as it were Sanchez et al . [3] examined while machining AISI D2 steel of 50 mm and 0.25 mm measurement metal wire. The creators investigated the explanations behind blunders in corner cutting as the erosion between wire guide , dielectric flushing, wire misshapeninga and work piece thickness . the better exactness and recommended numerous trim cuts.

Han et al [4] intended to reenact the relative movement between the wire anode way and NC way of the harsh cutting in the WEDM . the tests results and recreation results are contrasted and found with have consistency . the creators proposed finding the corner esteem forecast by recreation and as needs be way program can be created symmetrical cluster dependent on taguchi strategy to assess the primary impacting factors that influence the cutting velocity , surface harshness and mathematical exactness because of wire slack . the creators machined solidified and strengthened M2 type pass on steel of 28mm thickness with 0.25 mm wire on supercut 734 model machine instrument vibration

Mu- Tian yan , pin –Hsum Huang (6) built up a shut circle wire strain control framework for a wire-EDM machine is introduced to improve the machining precision . dynamic models of wire feed controls mechanical assembly and wire strain control contraption are determined to dissect and plan the control framework .PI regulator and one-stride ahead versatile regulator are utilized to explore the powerful exhibition of the shut circle wire pressure control framework. To diminish the vibration of wire pressure during wire taking care of , dynamic safeguards are added to the inactive rollers of wire transportation component . exploratory outcomes not just show that the created control framework with dynamic safeguard can acquire quick transient reaction and little consistent state mistake than an additionally demonstrate that the mathematical shape blunder of corner cutting is decreased with around half and the vertical straightness of a work piece can be improved altogether.

Kanlayasiri and boonmung [7] upgraded the boundaries affecting surface completion , for machining DC53 device steel of 27mm thick with sodick A280 model machine utilizing 0.25m width wire by planning the analyses with taguchi technique. The creators created numerical model for improvement to anticipate surface unpleasantness esteems and mistake investigation is applied . the created model is demonstrating a most extreme blunder of 30%

Toll and maggi [8] analyzed the machinability of ten distinctive steel grades with WEDM, considering the warmth influenced zone and miniature hardness . it was seen that the steel producing strategy had incredible impact on conclusive precision than synthetic creation . the creators prescribed the trim slice strategy to dodge heat influenced zone . shajan kuriakose and shunmugam [9] planned the examination utilizing taguchi L18 cluster and directed on ti6a14v material with 0.25 mm . measurement metal covered wire under preset conditions , 80 v , 8-12 A machining current , 4-8 ^ s beat time. The creators noticed the arrangement of oxides because of high temperature age, full scale and miniature level anxieties incited during the cycle . the creators uncovered that when the time between two heartbeat is bigger , non uniform cooling and warming happens. The creators recommended covered wire as cathode according to metallurgical perspective.

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Fig :2 Ultra CNC machine

3 EXPERMENTATION

3.1 METHODOLGY :

Study the electrical properties like discharge current gap , voltage and power required and their effects on cutting criterion . analysis based on various .thicknesses of titanium material . it is hoped that the results will be useful in setting the machine for quality cutting.

Fig 3.1 Ultra cut CNC cut wire EDM machine

4 . Measurements: **surface roughness values of work piece or job was measured by tall surface instrument**

Fig 4.1 Tally surface roughness measuring instrument

Results and discussion:

Experiment are conducted on the work piece of every thickness by cutting L shapes and U shape by varying the machining current. MRR is calculated as, MRR = T x Cw x Cs is the cutting speed, mm/min and T is work piece thickness. As the current increase to 6.864 mm/3min to 94.29 mm3/min for experimental data regression analysis is R-sq-99.0% error is 1 %. The maximum error obtained from calculated values and experimental values are found to be less than 4%. The validation of discharge current on job thickness, on the machine criteria such as cutting speed and surface roughness is done using Talysuf. The best fit curve is selected using the software and an analysis is performed to find the fitness of curve . the current increases 1.5amp to 2.20amp and cutting speed increases maximum to 4.12amp

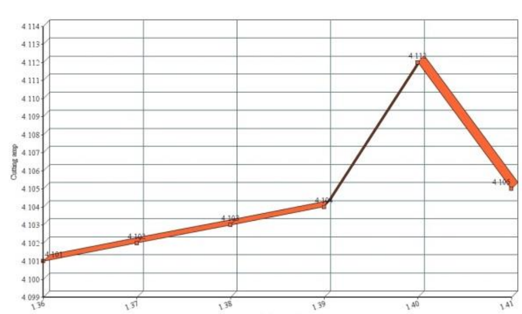
5. Parametric analysis based on experimental data:

5.1. Effect of machining current on cutting speed for 5 mm thickness:

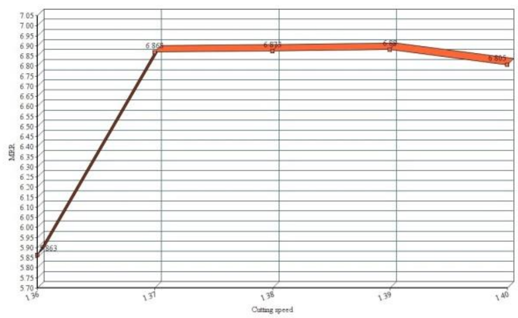
Table 5.1 Parameters obtained for 5mm thickness

S.No	Current Amp	Cutting speed,mm/min	Spark gap µm	Ra, µm	MRR,mm³/min
1	1.36	4.101	32.00	0.49	5.863
2	1.37	4.102	32.00	0.49	6.868
3	1.38	4.103	32.04	0.48	6.873
4	1.39	4.104	32.09	0.46	6.874
5	1.40	4.112	32.14	0.45	6.88
6	1.41	4.105	32.00	0.49	6.805

The experiment is performed for **5mm** thickness current varies **1.36 Amp to 1.40Amp** and **cutting speed varies 4.101 mm/min to 4.105mm/min** Graph 5.1 gives the effect of machining current on cutting speed for machining 5mm thick titanium work piece. As the current increases, energy input increases, causing raise in cutting speed. Beyond 1.5 amp current, the machining is observed to erratic and wire getting ruptured. The maximum cutting speed of 4.112mm/min is obtained with minimum wire rupture. The current at this cutting speed is considered as optimum value.

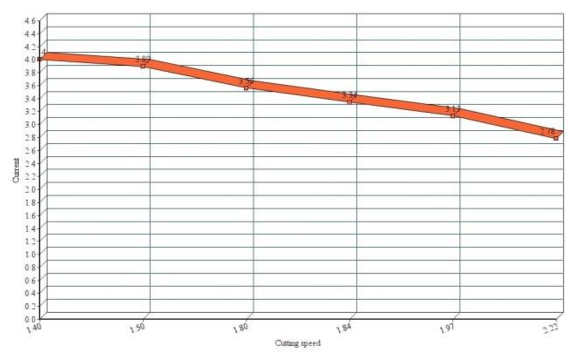


Graph: 5.1 Effect of machining current on cutting speed for 5 mm thickness



Graph: 5.2 Effect of Current on MRR for 5 mm thickness

Graph 5.5 gives the variation of machining current on cutting speed: Machining current has been varied from 1.6amp to 1.77amp in 0.02amp steps .the cutting speed for 30 mm thick job is lower than that of 5mm thick at 1.77amp current the machining is getting interrupted with large toll wear and wire brake edge . this may be due to avalanche of high energy sparks striking back the wire, breaking it. So 1.75amp is considered to be the optimum current value. Highest cutting speed is achieved for machining 30mm thin work piece.



Graph: 5.3 Effect of machining current on Spark gap for 30 mm thickness

6. Mathematical Modeling:

The mathematical model was developed in the regression analysis using MINITAB statistical. The statistic toolbox provides us four model in regression analysis. The response variable Y is modeled as a combination of constant, linear, interaction and quadratic terms formed from two predictor variables x1 & x2. Given data on x1, x2 and y, regression estimates the model parameters. The model is based on the data set provided by the MINIT AB statistical toolbox. The result of the study were published in the open source software mathematical .

Linear: $Y = \beta 0 + \beta 1x1 + \beta 2x2$ (5)

Interactions: $Y = \beta 0 + \beta 1x1 + \beta 2x2 + \beta 3x1x2$ (6)

Pure quadratic: $Y = \beta 0 + \beta 1x1 + \beta 2x2 + \beta 3x1^2 + \beta 4x2^2$ (7)

Full quadratic: $Y = \beta 0 + \beta 1x1 + \beta 2x2 + \beta 3x1x2 + \beta 4x1^2 + \beta 5x2^2$ (8)

Here a response variable Y is modeled as a combination of constant, linear, interaction and quadratic terms formed from two predictor variables x1& x2.

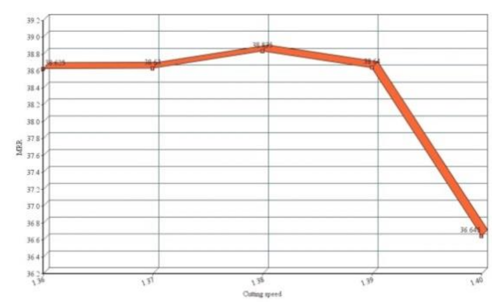
Given data on x1, x2 and Y, regression estimates the model parameters.

6.1Regression analysis results for 5, 15, 30, 45, 60, 90mm thickness:

Table 6.1: Experimental data for 5mm, 15mm, 30mm, 45mm, 60mm, 90mm Machining Titanium

S.No	Thickenss, mm	Current, amp	Cutting speed, mm/min	Surface roughness, Ra	Spark gap mm/1000	MRR, mm3/min
1	5	1.40	4.00	0.60	40.00	6.890
2	15	1.50	3.89	0.65	42.40	20.48
3	30	1.80	3.56	0.64	50.66	38.10
4	45	1.83	3.34	0.69	53.10	55.84
5	60	1.97	3.13	0.70	56.55	68.59
6	90	2.22	2.78	0.74	60.00	95.25

6.1.1 Effect of current on cutting speed 5,15,30,45,60,90mm thickness:



6.1 Effect of current on cutting speed

The regression equation is
cutting speed = 7.030 - 1.931 current
S = 0.0254488 R-Sq = 99.8% R-Sq(adj) = 99.7%

Analysis of Variance ANOVA:

Source	DF	SS	MS	F	P
Regression	1	1.1245	1.205649	1867.10	0.000
Error	4	0.00367	0.00064		
Total	5	1.22348			

In 6.1 cutting speed values are required the experimental data is compared with statistical analysis. As the current increases, energy input increases causing raise in cutting speed. According to regression analysis the above. Graph is drawn between current cutting speed for data R-sq-99.8%. the regression values always equal to 1 then the curve becomes best fit curve.

6.2 Equation formed from regression analysis:

Statistical analysis on effect of WEDM parameters on machining criteria and development of Regression analysis.

6.2 Optimized parameters for 5 to 90 mm thickness

S.No	Thickness, mm	Currentamp	Cuttingspeed, mm/min	Surface roughness, Ra µm	Spark gap mm/1000	MRR mm^3/min
1	5	1.52	4.13	0.52	42.00	6.864
2	7.5	1.55	4.06	0.54	42.80	10.182
3	10	1.59	4.04	0.56	43.50	13.924
4	15	1.63	3.98	0.56	44.20	20.152
5	20	1.67	3.95	0.60	45.59	23.44
6	30	1.76	3.78	0.62	48.68	39.13
7	40	1.84	3.55	0.65	51.21	49.80
8	45	1.87	3.44	0.66	51.12	54.834
9	55	1.91	3.27	0.68	53.78	64.476
10	60	1.96	3.22	0.69	54.50	69.58
11	70	2.00	3.16	0.70	56.00	79.63
12	75	2.02	3.04	0.69	57.05	83.26
13	80	2.12	2.98	0.72	58.06	86.97
14	85	2.16	2.88	0.75	58.99	90.38
15	90	2.22	2.91	0.78	60.00	94.30

6.2.1 Effect of Discharge Current on Thickness:

The variation in the discharge current with the increase in work piece thickness is obtained. graph.6.5. shows that

With increase, for 5mmm thickness, current 1.50amp the required machining current also increase for 90mm thickness. This is attributed to the high amount of energy required for a high thickness job in high amount of energy required for a high thickness job in which machining is possible only by increasing the current. The plot is useful to extract suitable minim discharge current . the plot is useful to extract suitable minimum discharge current required for machining of any thickness titanium work piece with in the machine working range. The regression equation is cutting speed = 4.183-0.01443 thickness -0.000846 total 2.95217

Analysis of Variance

Source DF SS MS F P

Regression 3 2.9423 0.980965 1159.88 0.000

Error 11 0.00931 0.000854

Total 14 2.95219

6.3 Effect of surface roughness on Thickness

Polynomial Regression Analysis:
The regression equation is
Surface roughness = 0.4786 + 0.007962Thick ness - 0.000123 Thick ness**2
+ 0.000001 Thick ness**3
S = 0.004840424 R-Sq = 99.7% R-Sq(adj) = 99.6%
Analysis of Variance
Source DF SS MS F P
Regression 3 0.08571 568 0.0285719 1219.54 0.000
Error 11 0.0002687 0.0000256
Total 14 0.0859833

6.4 Validation using Regression analysis:

The experimental results are compared with the regression analysis for the validation and the error percentage is calculated.

Table 6.3: Validation of Regression Results with the Experimental Results

Thickness (t)	Current		Cutting speed		Surface roughness		Spark gap		Metal Removal Rate	
	Regression	Experiment value	Regression	Experiment	Regression	Experiment	Regression	Experiment	Regression	Experiment
12.5	1.584249803	1.8	3.996140654	3.99	0.546765645	0.56	44.00445321	46	16.48134377	16.817
17.5	1.632249175	1.65	3.919296896	3.96	0.571181879	0.58	45.3422093845	46.9	22.72303225	23.43
25	1.689997645	1.9	3.804152	3.86	0.601526	0.8	47.215665	47	31.87255	33.15
35	1.740393493	1.10	3.654665	3.68	0.634199	0.72	49.500278	50.6	43.60426	44.803
50	1.758982	1.13	3.4514	3.38	0.6786	0.66	52.60	52	59.969	59.64
65	1.709158267	1.99	3.291523	3.18	0.735806	0.69	55.405029	55.1	74.56274	74.32

The average error percentage for all the predicted values in the regression model is in the is 0.68%, according to the study

7.1Conclusions:

Influence of parameters, like discharge current, job thickness, on the machining criteria such as cutting speed, spark gap, surface finish , material removal rate are determined . the average error percentage for all the predicted valves in the regression model is 0.68%. the regression models provide better prediction capabilities because they generally offer the ability to model more complex non –linarites, the study found. The study concluded that the best suited values for stable and controlled machining with least wire breakage were found.

- A regression model is also developed by using the experimental data. The experimental
results are compared to the regression models.
- As it has been anticipated, the regression models provided better prediction capabilities
. because they generally offer the ability to model more complex non-linearities
- Comparison of predicted current, cutting speed, spark gap, surface roughness and MRR with experimental results in all testing cases indicate that the error is less than 4% for regression model.
- The average error percentage for all the predicted values in the regression model is 0.68%.

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