EXPERIMENTAL STUDY ON MULTIPLE RADII PROFILE CUTTING FOR ROUNDNESS ERROR IN WIRE EDM

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Abstract:
One of the most important fundamental forms for engineering components is the circular cross-section. Circular forms arise in many applications, particularly in bearing surfaces such as rotating shafts and ball bearing applications. The measurement of out-of-roundness (usually referred to simply as roundness) is an extremely important assessment. The way of Wire EDM has its significance in decreasing the errors in roundness, but the elastic nature of the materials will vary from male profiles to closed profiles. Multiple corner radiuses are also an important option to check the variable parametric components machining. Cutting speed deviates from single radius profiles to multiple radius profiles which may affect the roundness in profiles. Present experiments deal with the multiple radii corner profile machining of two Ferro alloys which are well known in the production of dies SS316 and EN24. Parameters taken as 6mm, 10mm thickness constant and 2 cuts in profile has been observed for roundness error, ZESIS CMM used to measure with 1mm probe for final results.

Key words: multiple roundness, roundness error, Ferro metals

Introduction:

It is to be enhanced that the materials with high demand in space technology can be economically cut using conventional cutting tools. Special, super-hard materials, normally quite expensive, are required. Synthetic diamonds or diamond compounds that are almost impossible to grind are very expensive, but are cut effectively by WEDM.

Machine main unit is also known as machine tool where the actual work takes place. Work piece machining is carried out in this unit. Second unit is numerical control unit which is mainly responsible for all the movement of the work table and other motions of the machining unit. Power supply unit provides the power in the controlled manner for the servo motors, sparking unit and other units. Dielectric fluid unit mainly consists of two side by side tanks where one consists of the impure water and other tank to collect the water after the purification, from this tank the dielectric is supplied to the work table tank.

The mechanical behavior of the wire in WEDM is extremely complicated in nature. This is because the magnitude and directions of various forces acting upon the wire are not always constant as the occurrence of sparks is highly stochastic in nature. Specimens of SS316, EN24

material are machined and extensive machining was carried out for set machining conditions to study the behavior & performance of wire electrode under varied conditions of machining.

Problem statement

The effects of the process parameters on different responses such as roundness, attempts have been made to carry out experiments considering the WEDM process parameters. They used the orthogonal array with grey relational analysis to optimize the WEDM process with the multiple performance characteristics.

Scope of the wok:

Investigations were carried out to study the effect of main controlling process parameters and to find out optimization condition of machining and its impact on the process parameters like roundness produced while machining difficult to machine materials and application materials like EN24 and SS316. Extensive machining on ferrous specimens such as EN24 and SS316 was carried out for set machining conditions. EN24 and SS316 specimens are machined for different machining conditions, to study their effect on the roundness produced. Based on the experimental values obtained, error in radius compared for different materials at different nozzle heights.

Objectives:

- To Improve the accuracy of roundness in wire EDM
- Study the roundness variation for different radii profiles at different nozzle heights on the materials EN24 and SS316.
- To find out radius error by using CMM with 1mm probe touch at segments of radius for different profiles.

Methodology:

Machining has been done on WEDM Machine. This is a versatile computer numerically controlled machine provided with latest SODIK CNC controller capable of coordinating work table movements.

A) Setting the parameters for the machining B) Wire EDM processing of the material for roundness

The machining conditions were:

- wire speed: 10 m/min
- flushing rate: 10 L/min
- open circuit voltage: 85 V
- servo voltage: 44 V
- wire electrode wire of diameter: 0.25 mm
- wire tension: 600gf
- pulse on time: 2μs

	PARAMETERS										
LEVELS	2	3	4	5	6	7	8	9	10	11	12
2	L4	L4	L8	L8	L8	L8	L12	L12	L12	L12	L16
3	L9	L9	L9	L18	L18	L18	L18	L27	L27	L27	L27
4	L16	L16	L16	L16	L32	L32	L32	L32	L32		
5	L25	L25	L25	L25	L25	L50	L50	L50	L50	L50	L50

Above table shows the orthogonal array of experiments creation using TAGUCHI method and the below table shows the variable parameters and levels consider for the preparation of experiments.

Nozzle height from work piece top surface	Level 1-9mm	Level 2-29mm
Thickness variance- work piece	6mm, 10mm	6mm, 10mm
Number of cuts	1 cut, 2 cuts	1 cut, 2 cuts

Expt No	Levels (L)	Thickness (A)	No of cuts(C)
1	L1	A1	C1
2	L1	A1	C2
3	L1	A2	C1
4	L 1	A2	C2
5	L2	A1	C1
6	L2	A1	C2
7	L2	A2	C1
8	L2	A2	C2

Empirical expressions have been developed to evaluate the relationship between input and output parameters. The experimental values of Roundness have been used to construct the empirical expressions. A practical approach is done on basis of different cutting speeds and roundness error is carried out at all the cutting speeds.

Figure shows the wire cut machining output objects with multiple radius with inside and outside machining as single cut and two cuts.

Results:

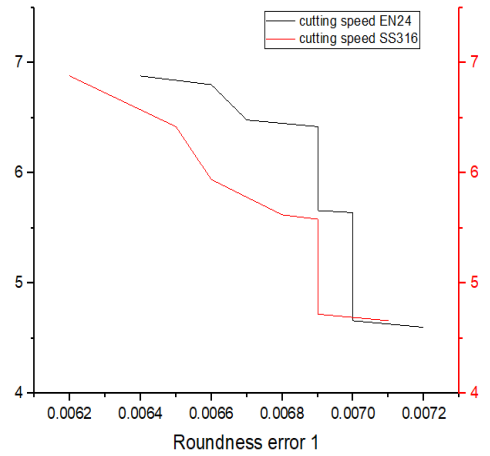
By taking the machining profiles to CMM machine named as ZESSIS and the probe diameter of 1mm the following results are obtained.

Inside profile results for multiple radii of EN-24

Expt no	Cutting speed	Roundness error-1	Roundness error-2
1	5.66	0.0072	0.0071
2	6.80	0.0069	0.0070
3	5.64	0.0067	0.0066
4	6.88	0.0070	0.0068
5	4.66	0.0066	0.0067
6	6.48	0.0069	0.0070
7	4.60	0.0064	0.0063
8	6.42	0.0070	0.0069

Inside profile results for multiple radii of SS316

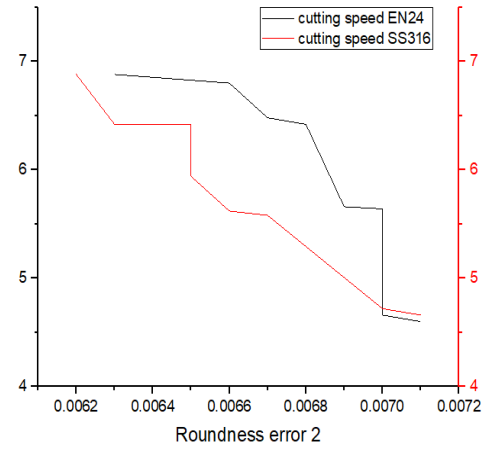
Expt no	Cutting speed	Roundness error-1	Roundness error-2
1	5.62	0.0071	0.0070
2	5.94	0.0066	0.0065
3	5.58	0.0065	0.0063
4	6.88	0.0069	0.0065
5	4.72	0.0065	0.0066
6	6.42	0.0068	0.0071
7	4.66	0.0062	0.0062
8	6.42	0.0069	0.0067



Inside profile results for roundness error1 for materials EN24 and SS316

Outside profile results for multiple radii of EN-24

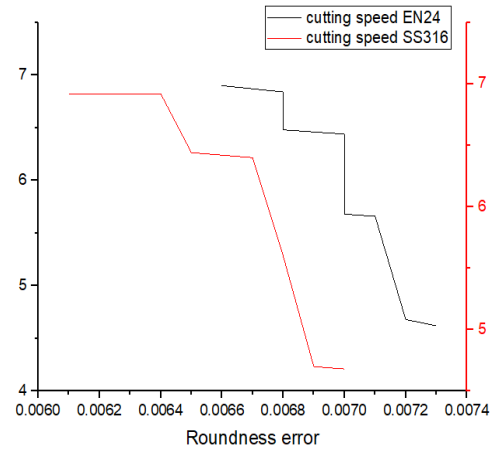
Expt no	Cutting speed	Roundness error-1	Roundness error-2
1	5.68	0.0073	0.0072
2	6.90	0.0070	0.0069
3	5.66	0.0068	0.0067
4	6.84	0.0072	0.0069
5	4.68	0.0068	0.0066
6	6.44	0.0070	0.0069
7	4.62	0.0066	0.0065
8	6.48	0.0071	0.0069



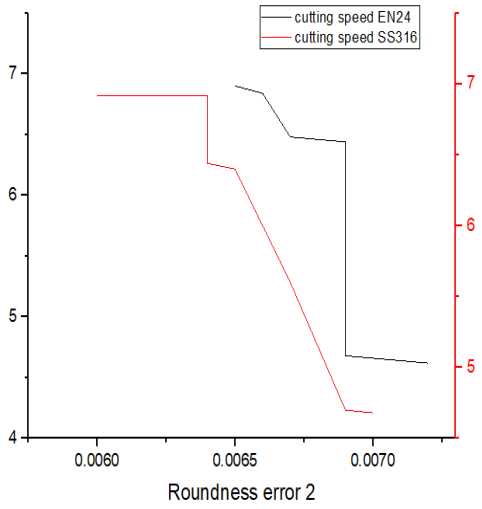
Inside profile results for roundness error 2 for materials EN24 and SS316

Outside profile results for multiple radii of SS316

Expt no	Cutting speed	Roundness error-1	Roundness error-2
1	5.60	0.0070	0.0069
2	6.92	0.0065	0.0064
3	5.60	0.0064	0.0064
4	6.92	0.0069	0.0067
5	4.70	0.0068	0.0067
6	6.44	0.0067	0.0070
7	4.68	0.0061	0.0060
8	6.40	0.0068	0.0065



Outside profile results for roundness error 1 for materials EN24 and SS316



Outside profile results for roundness error 2 for materials EN24 and SS316

Discussions:

As the experiment is conducted for different radii for 2 materials SS316 and EN24 it is observed for the roundness 1 and roundness 2. In the case of inner & outer profile for the material SS316 cutting speed is varied and decreased as the roundness error decreases.

In case of roundness error 1 for inner profile the SS316 is found maximum cutting speed of 6.9mm/min which is greater that EN24 5.86 mm/min with an average roundness error of 0.007.

In case of roundness error 2 for inner profile the SS316 is found maximum cutting speed of 7.0 mm/min which is greater that EN24 6.89 mm/min with an average roundness error of 0.0068.

In case of roundness error 1 for outer profile the SS316 is found maximum cutting speed of 6.89 mm/min which is greater that EN24 6.56 mm/min with an average roundness error of 0.0072.

In case of roundness error 2 for outer profile the SS316 is found maximum cutting speed of 7.1 mm/min which is greater that EN24 6.34 mm/min with an average roundness error of 0.007

Conclusions:

The experiments were conducted to optimize the different machining parameters like roundness and tool material characteristic in Wire cut EDM. In Ferro alloy materials, a better roundness characteristic can be achieved during machining; the roundness error values for SS316 material machining impulse indicate that the values are comparatively less as compared to EN24. Roundness error is decreasing due to increase in cutting speed. During machining it is observed that increase in rate of machining impulse will result in large time span for the spark contained during any cycle.

Scope of work:

The practical approach done in this approach can be compared to PSO analytical approach for further validation.

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