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The Effect of Wire Straightness Electric Current Variation on Size Diversion and Roughness of The Cutting Current Profile of Medium Carbon Steel Dental from Wire (EDM)

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Abstract

Wire Electric Discharge Machine (EDM) is a non-conventional metal cutting machine. This machine is commonly used to form machine components that have complex shapes and require high precision. Not many conventional and non-conventional machines are capable to produce small module gears. The cutting groove occurs from the erosion of the electric spark by the electrode wire moving from the coil of wire and forming or cutting the workpiece. One of the machining parameters that determines the quality of the product on an EDM wire is Current. Therefore, this study aims to determine the deviation of the gear profile cutting groove and the roughness that occurs in the straight gear profile cutting groove from the results of the Wire EDM process. In this thesis research, the varied parameters are electric current. The current used is 6 A, 7 A, 8 A, 9 A 10 A. The results of this research show that the current 6 A has an average deviation value of 0.0228 mm. At current 7 A has an average deviation value of 0.0255 mm. At current 8 A has an average deviation value of 0.0275 mm. At current 9 A has an average deviation value of 0.0313 mm. And at a current of 10 A has an average deviation value of 0.0362 mm. At current 6 A has an average roughness value. At current 7 A has an average roughness value. At current 8 A has an average roughness value. At current 9 A has an average roughness value. And at current 10 A has an average roughness value. This is due to the greater use of an electric current at the electric voltage, which will cause the sparking to get bigger too, this causes the movement of the electron flow to hit the surface of the workpiece faster, resulting in an increase in temperature which results in erosion of the workpiece surface. This will change the result of the cut which affects the size precision and roughness of the wire EDM.

***Keywords**: current variations; profile gear; wire EDM; wire straightness*

1. INTRODUCTION

The development of science and technology as a result of the increasing demands of society provides a response for engineering experts to create or improve existing working methods and equipment to produce better products. To meet these needs, a machine called EDM (Electrical Discharge Machining) was created. Today's EDM technology is increasingly being used in the manufacturing industry to manufacture molds and to process very strong and hard materials [1,2,3,4] such as tool steel by producing products that have high precision, complex shapes, and good surface quality.

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EDM (Electrical Discharge Machining)

The origin of EDM (Electrical Discharge Machining) is in 1770, when the British scientist Joseph Priestly discovered the erosive effect of electric current sparks. In 1943, Russian scientists B. Lazarenko and N. Lazarenko had the idea of exploiting the damaging effects of electric currents to create a controlled process for electrically machining conductive materials. With this idea, the EDM process was born. The Lazarenko brothers perfected the process by placing a non-conductive liquid where an electric spark occurs between two conductors, a liquid called a dielectric [5,6,7].

At this time many EDM units were used that were more advanced than Lazarenko's. At this time there are two types of EDM machines, namely: conventional EDM (usually called Sinker EDM or Ram EDM) and Wire EDM [8,9]. In the early EDM process, the electrode containing the electric voltage is brought closer to the workpiece (positive electrode approaches the workpiece / falls). Between the workpiece and the electrode there is an insulating liquid (which does not conduct electric current), which in EDM is called a dielectric liquid. Although dielectric fluid is a good insulator, a large enough difference in electric potential causes the liquid to form charged particles, which causes an electric voltage to pass from the electrodes to the workpiece [10].

The presence of graphite and metal particles mixed into the liquid can help transfer the electric voltage in two ways. The particles (conductors) aid in the ionization of the dielectric fluid and carry the electric voltage directly, and the particles can accelerate the generation of electric voltage from the liquid. The area that has the strongest electric voltage is at the point where the distance between the electrode and the workpiece is closest [11,12].

EDM / RAM EDM sync

EDM sinking is sometimes also referred to as the cavity or volume type. Sinking EDM consists of electrodes and workpieces immersed in an insulating fluid such as oil or other dielectric fluids. When the electrode approaches the workpiece, sparks occur in large numbers at random locations between the electrode and the workpiece. This reaction causes part of the base metal to be eroded, and the electrode gap then increases, the electrode moves up and down automatically so that the process can continue until the job is done.

2. METHODS

This section contains methods only, does not contain charts or flowcharts. This research was conducted using experimental methods. The variables used are the electric current 6 amperes 7, amperes, 8 amperes, 9 amperes, 10 amperes independent variables. While the dependent variable is a deviation in the form of a straight gear profile cutting groove.

2.1 Steps of the Gear Manufacturing Process

There are steps to do to process the gear manufacturing.

1. Preparation of Research Tools and Materials
    a. Mitsubishi Wire EDM type BA8 machine with dielectric liquid type aqua distilation or distilled water from Air Condition.
    b. The electrode wire used is AC Brass 900N, with a wire diameter of 0.20 mm and a weight of 5 kg / pcs.
    c. The material used is Steel Assab. With dimensions of 150 mm x 30 mm x 10 mm.
    d. The tools needed in this research are the jig and L key.
    e. The measuring instrument used is the Nikon V -10 projector profile.
    f. Mitutoyo surface roughness tester.

2. Prepare cutting drawings of specimens according to the standard module 3-16 DIN (Deutsches Institut für Normung).

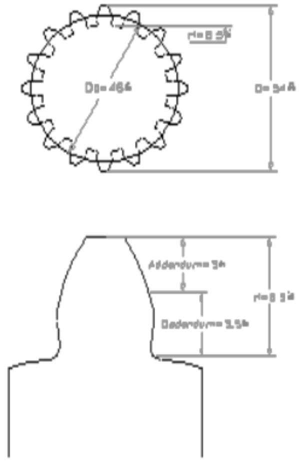


Figure 1. DIN 3-16 cutting gears and paths

3. Parameters for cutting on Wire EDM In accordance with the machining characteristic data of E-pack Number (Eno) 1021, current on time 6 A -10 A, off time 1 A, wire speed 10 m / min and wire tension 8 N. adjusted to the dimensions of the workpiece.
4. Cutting process
   In the process of cutting the workpiece it is repeated five times then the workpiece is taken from the machine table by removing the chuck on the jig.DIN 3-16 cutting gears and paths
5. Parameters for cutting on Wire EDM In accordance with the machining characteristic data of E-pack Number (Eno) 1021, current on time 6 A -10 A, off time 1 A, wire speed 10 m / min and wire tension 8 N. adjusted to the dimensions of the workpiece.
6. Cutting process
   In the process of cutting the workpiece it is repeated five times then the workpiece is taken from the machine table by removing the chuck on the jig.

2.2 Data Retrieval Process

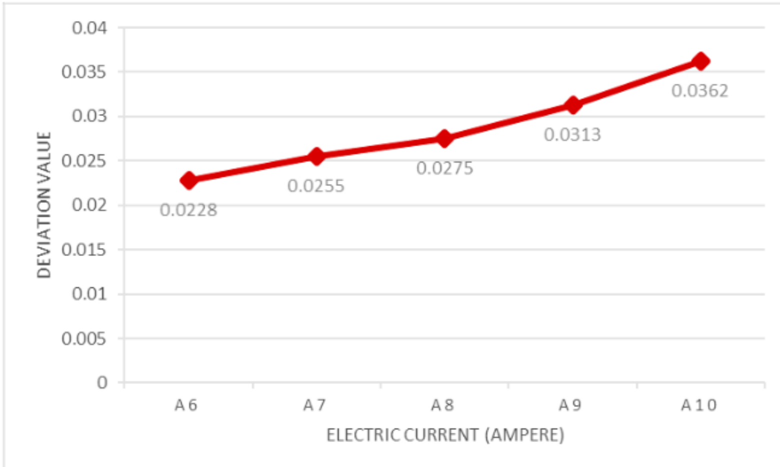
1. Clean the EDM wire cut specimen.
2. Measure the cutting width of the workpiece using the projector profile.
3. Cutting surface roughness test sample.
4. Testing the surface roughness of the EDM wire.

3. Result and Discussion

Analysis of Sides Deviations

Table 1. Data on the Results of Measurement of Deviation from Each side

Measuring point	Electrical current				
	6	7	8	9	10
1. Circular cutting (A)	0.0225	0.0255	0.0275	0.0315	0.0400
2. Straight cutting	0.0230	0.0260	0.0285	0.0365	0.0380
3. Circular cutting (B)	0.0225	0.0265	0.0280	0.0290	0.0360
4. Straight cutting	0.0215	0.0220	0.0225	0.0240	0.0275
5. Circular cutting (C)	0.0240	0.0285	0.0325	0.0350	0.0405
6. Straight cutting	0.0225	0.0260	0.0265	0.0300	0.0370
7. Circular cutting (D)	0.0240	0.0245	0.0275	0.0335	0.0345
Total	0.160	0.179	0.193	0.2195	0.2535
Average	0.0228	0.0255	0.0275	0.0313	0.0362



Graph 1. The relationship between the magnitude of the electric current and the deviation of the gear profile cutting groove

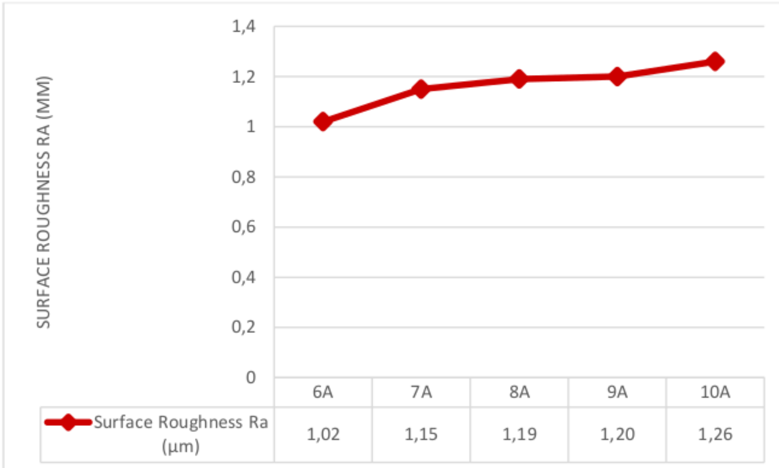
From the data and graph 1, the relationship between the parameters used is the amount of electric current with the deviation of the cutting path where the deviation value is influenced by the amount of electric current (6, 7, 8, 9, 10) amperes each of which occurs the average deviation is as follows:

1. At cutting with a current of 6A the deviation that occurs is 0.0228 mm (22.8)
2. In cutting with a current of 7A the deviation that occurs is 0.0255 mm (25.5)
3. At cutting with a current of 8A the deviation that occurs is 0.0275 mm (27.5)
4. In cutting with a current of 9A the deviation that occurs is 0.0313 mm (33.3)
5. At cutting with a current of 10A the deviation that occurs is 0.0362 mm (36.2)

From each of these data, that the amount of electric current in the Wire EDM process affects the deviation of the cutting path results. The largest deviation occurs at an electric current of 10 A, which is 0.0362 mm. While the smallest deviation occurs at 6 A electric current, which is 0.0228 mm. This is because the large increase in electric current in the Wire EDM cutting process will increase the value of the deviation. This shows that the use of an increasingly large electric current will cause the spark of the spark (Sparking) to get bigger too, resulting in the movement of the flow of electrons to hit the surface of the workpiece faster, resulting in an increase in temperature which results in erosion of the surface of the workpiece, this will change truncation results due to a larger amount of slash than it should be.

Table 2. Data on Surface Roughness Test Results.

Sample	Electric current	Surface Roughness Ra (μm)						Average (μm)
		Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	
1	6A	0,88	0,84	0,82	1,16	1,22	1,15	1,02
2	7A	1,25	1,25	1,25	1,17	1,07	0,96	1,15
3	8A	0,96	1,01	1,04	1,38	1,35	1,43	1,19
4	9A	1,28	1,29	1,26	1,07	1,10	1,18	1,20
5	10A	1,29	1,19	1,23	1,20	1,32	1,37	1,26



Graph 2. The relationship between the amount of electric current and surface roughness

From the data and graph, the surface roughness value varies. At 6 Ampere electric current, the roughness average value is 1.02. In the same process, but the electric current is increased to 7 Amperes to get an average surface roughness value of 1.15. By increasing the current to 8 Ampere, get an average surface roughness value of 1.19 by increasing the current to 9 Ampere getting an average surface roughness value of 1.20 and when the maximum current is 10 Ampere getting an average surface roughness value of 1.26.

From each of these data, it can be concluded that the higher the electric current, the higher the roughness value resulting from the working process. What is meant by work process flow here is the flow used in the work process. The higher the current, the greater the temperature produced by the machine which is transmitted to the electrodes and the higher the level of surface roughness produced by the Wire EDM machine.

For the campus of the National Institute of Technology Malang, this activity is a tangible manifestation of the participation of the world of education in community service through education and training as well as the application of technology so that people can use it in running their business.

In community service through this training can provide information about the duties and authorities of welding examiners. Provides an understanding of the basis for calculating the strength of a weld joint, which is then focused on reading the table.

Understand the deviation phenomenon after the welding process. Provides an understanding of how to repair welding defects. Also, in this training can get a welding process using welding procedures, so that the welding process management can run well. Reducing the welding failure rate, resulting in more effective use of materials. Improve the quality of welded joints.

4. Conclusion

From the research that has been done, it can be concluded that the amount of electric current applied affects the size deviation and the surface roughness of the straight gear profile cutting groove. Based on the research results, it is found that the value of deviation and roughness increases with the increase in the amount of electric current. The largest deviation value of 0.0362 mm with a roughness of 1.26 is obtained in the large variation of the electric current of 10 amperes which is the largest variation used. and the smallest deviation is 0.0228 mm with a roughness of 1.02. obtained in a large variation of electric current of 10 amperes which is the largest variation used.

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