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Design and Performance Evaluation of Desktop Rod Electrode Discharge EDM Machine in Pure Water

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***Abstract*—**Home EDM wire cutting technology has an irreplaceable position in special processing with continuous development and improvement [1]. The current EDM machine tools on the market are almost large and medium-sized. It is easy to cause waste of resources when cutting small parts. In the case of special processing courses offered by many colleges, vocational and technical schools. The laboratory is equipped with industrial-grade electric discharge wire machines. it requires a lot of floor space. The cost of cutting machine tools is very and it is not convenient for unprofessional to understand its processing principles and actual processes, if we are not very careful and system failure may happen such as wire breakage or other problem and so on. In recent years, the equipment is moving in the direction of miniaturization. Desktop-level 3D printers, milling machines have already appeared, and the field of small wire-cut EDM machine tools is in a blank paper. In this context, this article proposes to design desktop-level WEDM on the basis of industrial-grade machine tools based on the use of Small-diameter rod-shaped electrodes cutting. The mechanical structure of desktop-level EDM machine tool is designed so that it can be used for cutting small workpieces and teaching demonstrations. Compared with industrial-grade machine tools, it also greatly reduces the energy consumption of cutting small samples. It is more convenient for EDM machine equipment and transportation and popularization in the laboratory. Important parts such as ball screws were checked, various supporting parts were self-designed and the machine tool motion control system was designed.

Keywords: WEDM, desktop machine, rod electrode, dielectric as water.

I. INTRODUCTION

EDM (Electrical Discharge Machining) is a special processing method for etching the residual material of conductive workpiece by immersing the working fluid and connecting the two poles of the pulse power supply. EDM (WEDM) is an important part of EDM. Its machining principle is essentially the same as that of EDM: using moving wire (copper wire or molybdenum wire) as tool electrode to connect the negative electrode of pulse power supply. Conductive material or semi-conductive material to be processed parts connected to the positive electrode of pulse power supply, and add sufficient working fluid with good insulation between the poles. When the pulse power gives off a continuous high frequency pulse signal, a certain potential difference is formed between the tool electrode and the workpiece to be processed. If the distance between the two reaches the normal discharge gap, the electrolyte with insulation performance will be broken down. An instantaneous spark discharge is formed between the poles. Discharge produces a large amount of heat, instantaneous high temperature (up to more than 1000℃) makes the workpiece local metal material quickly melt to melting point, even to boiling point until a small amount of gasification, gasification of metal vapor and working fluid will instantly expand, accompanied by local micro-explosion, Under the force of thermal expansion and micro-explosion, the candle removal product will be thrown out of the cutting seem to realize the cutting of the workpiece[2, 3]. The electric motor drives the running of the wire storage tube during the machining of the industrial grade EDM machine, thus driving the operation of the electrode wire, while the workpiece to be machined is fixed on the coordinate table of the machine tool. According to the input NC program control processing to obtain a certain shape of the workpiece [4].

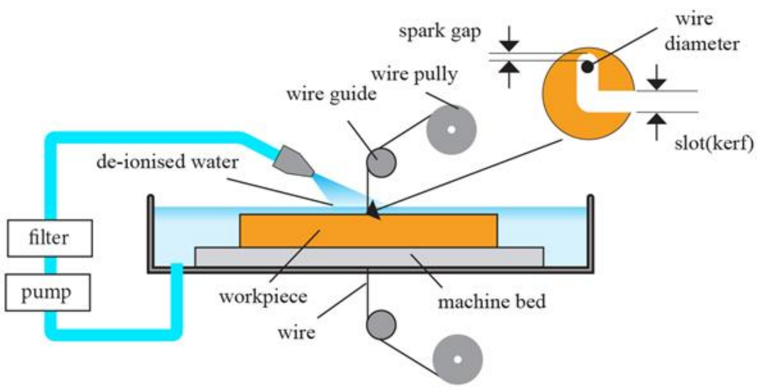


Figure 1: Basic principles of EDM

There are many researchers has been working on EDM since its birth in 1970, after decades of development, the machining performance of high-speed EDM wire cutting machine has been continuously improved, and it is in the leading position in the machining of large thickness and large taper workpiece. Before the 1980s, its machining accuracy and machining efficiency are equal to that of low-speed EDM machine. However, in recent years, the high-speed WEDM machine has been gradually surpassed by the low-speed WEDM machine in addition to maintaining certain advantages in the cutting of large thickness workpiece. The fundamental reason is that the theoretical research of high-speed WEDM machine is very slow [5,6].

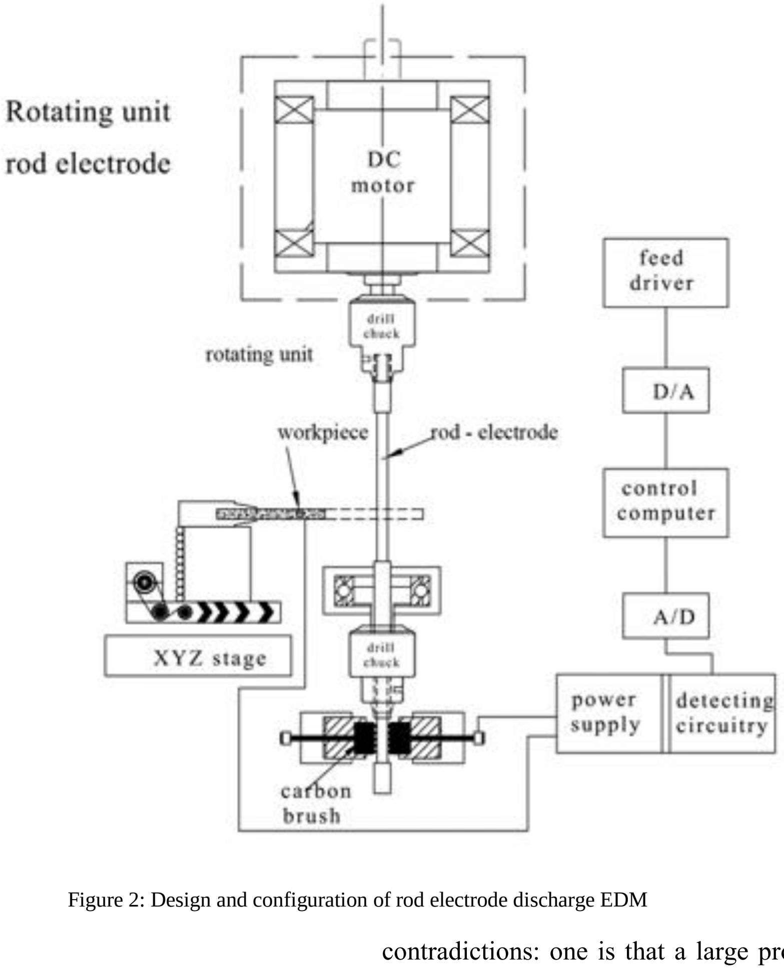


Figure 2: Design and configuration of rod electrode discharge EDM

At present, most of the WEDM machines in the market are large and medium, covering a large area, complex structure, high price, and difficult to maintain. This creates two contradictions: one is that a large proportion of the parts and products processed by WEDM are small, small in size and quality, and that the use of large and medium-sized machine tools is overused of large materials, which is actually a waste of resources and economy; the other is that many universities and vocational and technical schools with machining-related courses contain EDM-related contents and require various EDM teaching experiments, but they do not have specific production tasks, and generally do not need large and medium-sized expensive EDM machines[7, 8].

In recent years, the equipment is developing towards miniaturization, and miniaturization manufacturing is also a new field and new development in the future of mechanical manufacturing. It aims to optimize the allocation of resources and sites with the least amount of resources and reduce investment to improve the utilization rate of resources. As a result, the table-top lathe milling machine and so on have come out one after another, the table-top machine has the advantages of small volume, small inertia mass, small calorific value, low energy consumption, low cost and high efficiency, which can save energy, save manufacturing space and resources, and meet the requirements of contemporary energy saving and environmental protection [9]. Industrial WEDM machine tools are widely used and are standard equipment in large machining laboratories. There is no desktop-level wire-cutting machines, however, and processing equipment such as industrial-grade 3 D printers and milling machines have emerged, and for example 3D printers have been widely used [10, 11, 12].

In this context, this paper proposes to design desktop level EDM machine to consider the basic principle of EDM where the pulse spark generates between the tool and work piece (positive, negative electrode) and metal start to remove material and get in required in shape in Fig. 1. So, for. This desktop level EDM tools can be used for small sample cutting, mainly for small workpiece, so that everyone can understand their working principle. It is difficult for unprofessional to see the process of EDM in special machining laboratory. In this paper, the mechanical structure determined by the original function of WEDM machine is reduced and optimized, and the small diameter rod electrode is used to realize the cutting, so that the rod electrode EDM machine is modified to make it suitable for teaching demonstration and small sample cutting.

II. SYSTEMATIC DESIGN OF ROD ELECTRODE EDM

The systematic design of rod electrode discharge EDM is present in Fig. 2. The rotating unit is considered main part to rotate rod electrode and workpiece used to move forward and backward in the feed direction for the electrode feeding. The wire electro discharge function is similar as grinding phenomena which rotate together with workpiece and rod electrode and a computer-controlled system is established for this system.

The rotating unit is mounted on top an aluminum profile and connected with various supporting plates. The electrode is rotated together with the inner spindle of the rotating head supported by precision ball bearings and driven by a DC motor [13]. This led to bring the addition of an indexable rotation axis of the workpiece which tolerable the advance of effectively different WEDM grinding and turning procedures, but also to the machining positioning subsystem of the workpiece by its rotation round an axis [14]. As for the rode electrode discharge machine tool making, there are a few conventional strategies such as wire changing, capillary tube. Design configuration of rod electro discharge machine and reverse of WEDM. But compared with these, the wire electro discharge grinding is proficient of getting higher accuracy both in estimate size and shape [15]. Its distinct strongpoint is that the diameter of machined electrode is precisely kept by the wire movement along the wire guide, thus compensating the wire wear in its radial direction [16]. As shown in Fig. 1, a rode electrode is shaped by compound movements of wire moving, electrode feeding and rotating, based on the electro-discharge machining rule.

Theoretically, material volume remove by a single pulse in EDM process is proportional to its discharge energy. The discharge energy Wp of a single pulse can be expressed as in [Eq. (1)

$$Wp = \int_0^T u(t) \cdot i(t) \cdot dt \qquad (1)$$

where T, t are pulse width and discharge duration time, and u(t), i(t) are discharge voltage and current respectively. The minimization of discharge energy Wp of a single pulse, down to the order of 0.1–1 μJ, is needed for rod electro-discharge machining. From Eq. (1), there are some possibilities and ways to reach it, by decrementing either the value of voltage and current or the pulse width. But it is additionally kenned that only when the discharge voltage and current reach up to a certain range, though it varies with the different electrode and workpiece materials, electro discharge machining can be kept perpetually. Thus, the feasible method for the minimization of discharge energy of a single pulse is to decrement the pulse width. Then an RC circuitry is considered opportune for the rod-electrode discharge generation.

III. DESIGN OF HARDWARE SYSTEM

The desktop rod electrode wire cutting machine adopts small diameter rod electrode and pulse power supply as energy. Its non-contact machining form makes the machining process without macroscopic force and can almost process any conductive material. Because it is difficult for small machine tools to realize high speed wire walking, in order to ensure that small machine tools can be processed normally and reduce wire breakage rate as much as possible 0.8 mm small diameter rod copper rod is used as electrode material, that is, rod electrode. In order to make full use of the electrode material cutting, this paper starts with the synchronous rotation structure of the cutting electrode. Thus, the table level EDM machine will be composed of a mechanical structure frame, coaxial rotary motor, NC coordinate table, pulse power supply, working fluid circulation system, several modules and other detail designing procedure will be discussing below. In Fig. 3. 3D CAD model of present invention machine is illustrated.

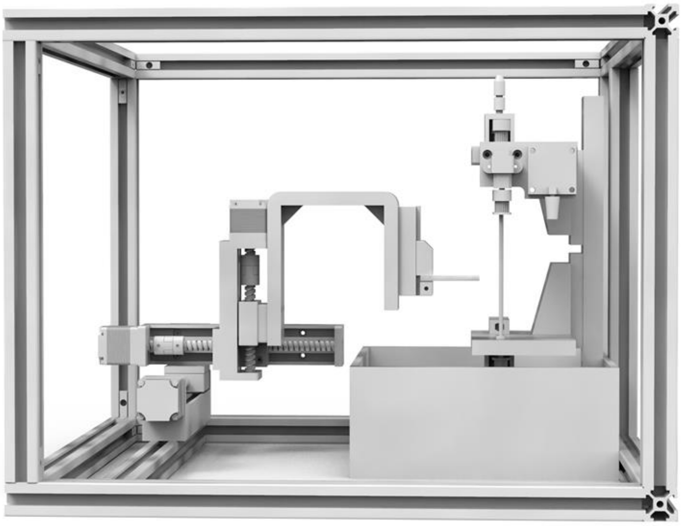


Figure 3: 3D CAD model of present invention rod electrode discharge EDM

A. External supporting frame

Taking into account all the mechanical structure and the overall size of the desktop EDM machine designed in this paper is 370 mm ×410 mm ×300 mm, in Figure 3-a. Select TDT industrial aluminum profile to form an outer frame, mainly to play a supporting role. Density of this material is only g/cm 2.73. Angle slot connectors are used to connect aluminum profiles with M5 inner hexagonal disc head screws and special trapezoidal nuts. The angle slot connectors are used for right-angle connections between the two profiles. The connectors are corrosion-resistant, reliable, waterproof and rust-resistant It has excellent corrosion resistance in most environments and aluminum profiles are not ferromagnetic. It is an important feature in the electrical and electronic industries. Arrange the Y shaft working slide table and coaxial rotary motor on the outer frame and give the center of gravity to working system and make system more stable. The connection mode structure is shown in Fig. 4(a).

Figure 4(a): Mechanical structure of EDM

B. Alignment of rod electrode

The EDM depends on the electrode to discharge the workpiece. In order to ensure the machining quality and reduce the wear of the electrode in the machining process, the electrode needs to maintain a certain stability. That is, in the process of processing will not be pulled and compressed and other problems. In order to realize the rotation of rod electrode, the main effect of rotation of the rod electrode changes the unilateral wear of the rod electrode to circumferential wear, which can make the wear more uniform, reduce damage electrode, maintain sparking and improve the motion stability during the working process. It can achieve high precision by rotating motion under small tension.

The Alignment of rotating unit is similar to mini lath, which is composed of various parts in Fig. 4(b). A fixed motor on the right side of the upper support plate is connected to 12 V of power supply, and the motor shaft and the synchronous pulley installed on it are transitioned to drive the synchronous pulley to rotate at a certain speed. The shaft 1 and the upper and lower support plates are equipped with bearings to reduce friction. The electrode material is clamped on shaft 2, both ends are fixed with chuck, and the rod electrode can pass through from top to bottom in turn. This synchronous rotation can realize the rotation of different cutting electrode materials (copper wire or small diameter tungsten rod) with certain diameter.

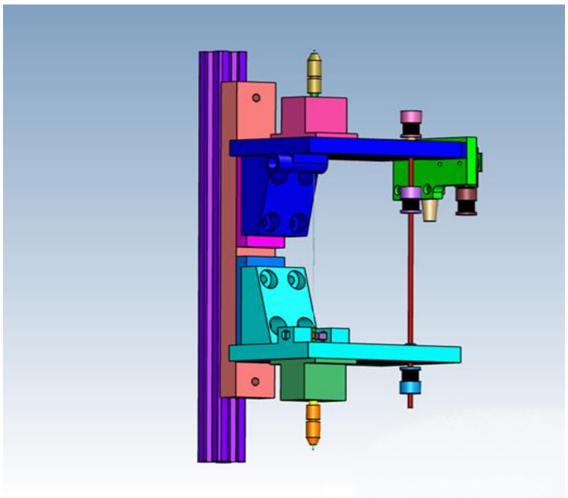


Figure 4(b): Rotating electrode clamp design

The coaxial rotary motor module should realize the adjustable rod electrode speed of 10~200 r/min, select the micro-DC motor with rated voltage of 12 V, no-load speed of 300 r/min, load speed of 240 r/min, model of N20, and with rated current of 5 mini PWM governor to achieve speed adjustment. The specific parameters micro-DC motor and PWN governor are shown in Table 1 and 2 respectively.

Table 1. N20 DC motor technical parameters

DC/V of rated voltage	r/min no-load speed	Load speed r/min	kg/cm of rated torque
12	300	240	0.50
m A rated current	kg/cm of blocking torque	m A of blocking current	Slower than 1:00
300	4.00	300	100

Table 2. PWM Governor technical specifications

DC/V of operating voltage	Control power W	Static current A	PWM duty cycle	PWM frequency KHz	Net kg
5~30	120	0.015	1%~100 %	12	0.01 5

C. *NC coordinate table*

The worktable on which the workpiece will be installed for the cutting track as known as NC coordinate table, which include fixture with supporting beam piler and three small micro precision linear actuators with stepper motors, which respectively control the X, Y and Z direction of the workpiece. The X direction is fixed at one on the aluminum profile, the other two stepper motors are connected by dual-purpose connectors. The cutting size range of workpiece is 100 mm×100 mm and X/Y linear actuators with travel range of 100 mm is selected. While the Z axis is mainly used for workpiece moving up and down with travel range of 50 mm. In Fig. 4(c) shows combination of workbench X, Y, Z – motion.

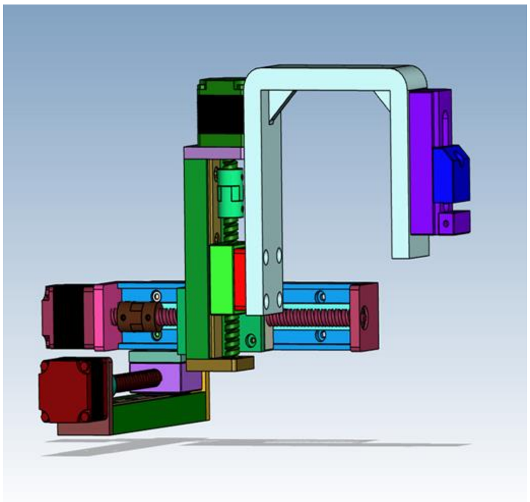


Figure 4(c): combination of workbench X, Y, Z – motion

The construction each linear actuator table is that a two-phase four-wire 28 step motor drives the ball screw rotation through a flexible coupling, and the screw rotation drives the slide table above the lead screw to move in a straight line. The tail end of the screw is equipped with deep groove ball bearings (Type 603) to ensure the coaxiality of the screw and reduce friction between the screw and the slide baffle.

Motor selection: Since the size of the motor should not be too large, thus, in this paper selects a two-phase four-wire motor with a step angle of 1.8° . The thickness of the fuselage is 30 mm and the model is 28 HB30-401A.The specific technical parameters of the stepping motor as shown in Table 3.

Stepper motor is controlled DM430 two-phase four-wire stepping motor driver, and 400 subdivision is adopted, that is, each 400 pulses are rotated once to overcome the low frequency vibration phenomenon.

Table 3. stepper motor parameter table

Step angle	Phase voltage	Phase current	Phase resistance	Phase Electrical
° step 1.8	2.4 V	0.6 A	4.0Ω	2.2 mH
Static moment	Positioning torque	moment of inertia	Number of leads	Weight
0.045 N ·m	0.003 N ·m	g ·cm 6^2	4	105 g

Ball screw selection: ball screw with small friction resistance, high transmission efficiency, high precision, high axial stiffness. To adapt to the size of the external frame and to maintain the portability of whole EDM machine, according to the required cutting workpiece size range 100 mm ×100 mm, select the X 、Y direction slide table travel range 100,100 wire screw distance 1 mm, precision 7, Select ball screw model GB17587-6×1×100.

Fluid circulation system: In the bottom a water tank provides a place for water circulation, and a water pump is placed in the water tank, which is connected to a water spray plate also installed on the aluminum profile, through a water pipe to procced the function of water circulation. The water circulation function begins when the workpiece is processed. Water to achieve the effect of cooling the workpiece and the electrode.

IV. CONTROL SYSTEM

In this paper, the control system of desktop wire cutting machine tool is not only the speed control of coaxial stepper motors, but also the machining track control. The control system accuracy and stability are related to the overall machining effect of the machine This control system mainly the control of the X, Y, Z coordinate worktable and continuously generates vertical and horizontal motion by given instructions. To obtain the target shape and size of the workpiece the design precision of this paper is not high, the open loop servo system is chosen, the cost is low, the structure is simple, and it is convenient for maintenance [17]. From the SD card input to process the track coordinate information, then by the single chip microcomputer to process the track interpolation operation, and send motion instructions to the stepper motor driver to drive the stepper motor motion, to achieve cutting function. The control functions of the control system include:

i. System initialization;

ii. Table reset;

iii. Input machining trajectory coordinates;

iv. Emergency shutdown, keyboard scanning;

v. Worktable over-range display, installed on the machine limit switch, when the worktable displacement over the stroke, can immediately stop the worktable movement;

vi. Manual control of the worktable;

vii. Automatic control and linkage control of workbench.

In figure 5. the controls system consists of display panel (including keyboard and LED display screen), main STM32 controller, three stepper motor drivers, three stepper motors and pulse power supply.

(a) LED display screen (b) STM32 Single-chip (c) Progressive Motor Driver

Figure 5: Control system main component

A. process motion control process

Stm32 the single-chip microcomputer starts, the first step is to manually control the motor part. The function of the manual control part is to adjust the step motor by keyboard scanning before cutting to make the clamping part reach the best position and complete the cutter of EDM wire cutting so that the back can be cut smoothly. In Fig. 6 shows the motor drive diagram system

The automatic control part requires the input of coordinate information in the SD card first, and then stm32 will read the coordinates from the SD card and cut automatically according to the coordinates. The cutting algorithm is a interpolation algorithm, which is basically divided into two categories: straight line interpolation and arc interpolation. It can be modified according to the existing interpolation algorithm, and the code of Z axis motion can be changed to make the Z axis move up and down. In order to avoid cutting process, rod electrode consumption is too fast.

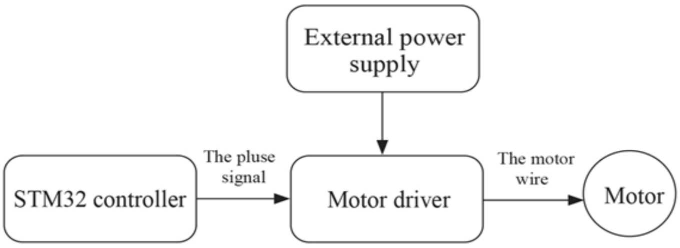


Figure 6: Motor drive diagram

B. *interpolation algorithm selection*

The interpolation refers to the process of calculating the moving path of the X, Y direction tool in the NC system of machine tool, in which the interpolation algorithms commonly used in the NC system are point by point comparison method and digital integral method (Digital Differential Analyzer, abbreviated as DDA method).

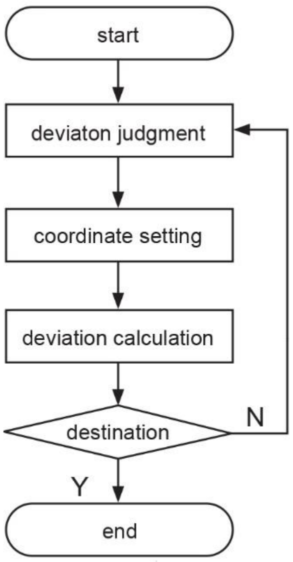


Figure 7: Principle of point-by-point comparison

The basic principle of the point-by-point comparison method is that the relative position between the tool and the machined part contour is continuously compared in the process of the tool moving according to the required trajectory, and the feed direction of the next step is determined according to the previous comparison results. The algorithm program diagram is as follows in Fig. 7.

V. Experiment Setup

The experiments were conducted using the present invention prototype desktop-level machine tool based on a small diameter rod electrode in Fig. 8. The relaxation type pulse generator is selected which is able to generate a pulse at different levels of energy. Capacitance with five different levels (stray capacitance, 10pf, 100pf, 220pf, 3300pf) has been set for this machining process, and the open-circuit voltage range from 20V – 120V. The polarities of the tool electrode and workpiece can be reversed for testing. The dielectric fluid used for the experiment was pure water, a wide range of pulse energy level can be achieved by setting the machining parameters.

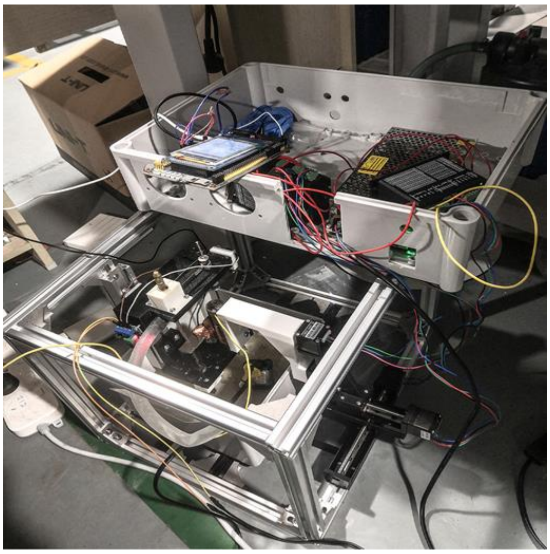


Figure 8: Prototype design desktop rod electrode discharge EMD

Silicon, Iron, and steel are used as a workpiece for this experiment. Iron and are steel are highly conductive materials, their superior hardness, toughness, and corrosion resistance make them ideal for structural components, building, automotive applications, chemical processing, power generating equipment, roads, railways, and other infrastructure. Most large modern structures, such as stadiums and skyscrapers, bridges, and airports, etc. while silicon is hard, dark grey, and lustrous semi-conductive metal that is used to manufacture steel, solar cells, and microchips.

As for tool electrode concern, a variety of tool metals can be used such as copper, brass, aluminum alloys, silver alloys, etc. therefore, the electrode used in this experiment was a rod copper with a 0.8mm diameter regarding the machining parameter settings up, three levels of voltage, two levels of capacitance, and positive and negative workpiece polarities were considered. Table 4, shows the details of the experimental parameters.

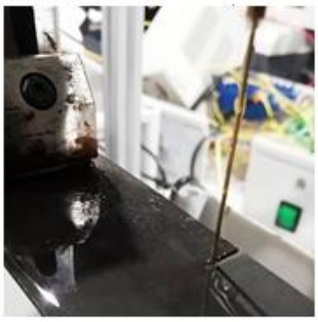
Table 4. Experimental parameters

Workpiece	: 304 stainless steel/ Irone/ Silicon
Tool electrode	: Copper rode with 0.8mm diameter
Dielectric	: pure water
Pulse generator	: RC circuit
Open circuit voltage	: 60V, 90V, 120V
Capacitance (pf)	: q3:220 pf, q4:3300 pf
Pulse duration	: 28-30 µs
Pulse interval	: 270 µs
Workpiece polarity	: Positive (+), Negative (-)

A. *Experimental procedure*

For a smaller scale base on rod electrode discharge EDM, the sensitive plan is requested for the development of this mechanical structure, but the machining strategies were complicated. In common, there are numerous factors affecting EDM procedure, such as cathode, setup alignment, electrode vibration, and workpiece materials, dielectric fluid, electro discharge energy release vitality each pulse and the pulse recurrence, in order to limit the variety of the trial's experiments, a standard experimental procedure was recognized

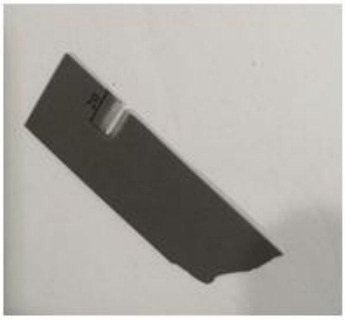
The first three samples were prepared; 1 mm thickness silicon sheet metal used to prepare the workpiece which was cut into 20 mm long. Second sample, 5 mm thickness 304 stainless steel sheet metal workpiece which was cut into 15 mm long, and the final sample, 1 mm thickness iron sheet metal which was cut into 25 mm long. In all of the following machining experiments, water is being used as the dielectric liquid, and the tool electrode was a copper rod with a 0.8mm diameter. The power supply output voltage is set up at 100V ant the resistance used in the RC circuit is 850Ohm. The electrode rod's rotation speed is set at 50 r/min.



(a) Workpiece installation

(b) Spark generated during process

(c) Iron and steel experimentally cut



(d) Silicon experimentally cu

Figure 9: experiment samples

Figure 9 (a) and (b) show the workpiece installation and spark generating during the process of the experiment while figure c and d show the selected respectively workpieces Iron, steel, and silicon experimentally cut by the present invention rod electrode the discharge machine, by means of the rotation speed of rod electrode of 50 r/min. The feeding step is 25-27 µm. power supply with 05 amperes and the output voltage was set at 100V for each step. The feeding step is smaller, and the machining accuracy in shape will be better in such condition but one of the main drawbacks of this present invention machine was overcut increasing due to the unitability of tension in between two at endpoints of the electrode [18, 19] main reason behind was this because two chucks cannot tightly hold at the end point of the electrode and vibration gradually increase along with rotating speed.

Figure 10: Over cut

B. measuring current and voltage

According to this Eq. (2), the total energy of a single discharge can be determined

$$P = \sum_{0}^{t_{on}/\Delta t} V(t) \cdot I(t) \cdot \Delta t \qquad (2)$$

where $\boldsymbol{V(t)}$ is voltage and $\boldsymbol{I(t)}$ is current data over the discharge duration; ton is the pulse on time; $\Delta \boldsymbol{t}$ is the sampling interval. Tektronix TPS2024 oscilloscope was used to record the discharge voltage and current data. The schematic of the information securing framework appears in Figure 11. Tektronix CT-2 current probe was used to convert from voltage signal to current signal

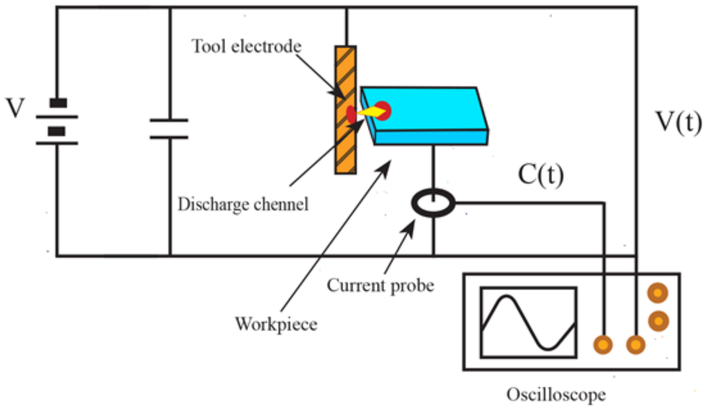


Figure 11: current and voltage signal acquisition schematic

Bight discharges are getting fire during the single discharge experiment. By representing the input factors for each experiment condition, the average current and voltage are analyzed. Before calculating the average, the data needs to be ranged. Figure 12, shows the data reconstruction process. At the spot where the current changes from 0 to positive value, it will be set as time 0. The nature of the discharge station is equivalent to the metal in EDM, then the average values for each sample time are considered based on the new 0 times. Figure 13 shows the condition discharge voltage and current waveforms, where the blue dash line is five measured current and voltage waveforms, which are loaded together. The red lines are their average. This shows high keep changing of the current and voltage signals. The various adjustment between each tool electrode workpiece V C(t) Current probe Oscilloscope V(t)42 is small. It shows the user the averages of the voltage and current to characterize separate voltage and current is practical.

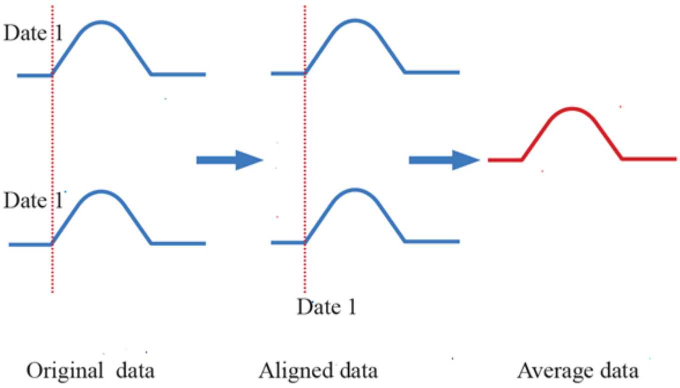


Figure 12: Data reconstruction process

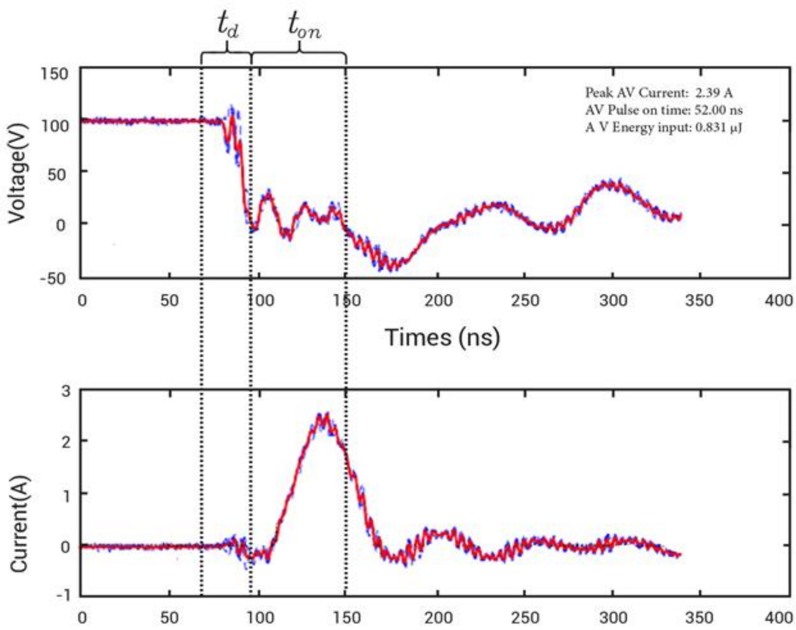


Figure 13: Average current and voltage waveforms

By estimating the release current and voltage waveforms. The pulse ignition delay and pulse on time can be determined by calculating the release current and voltage waveforms. Figure 13 shows the pulse injection timing and pulse on time as td and ton, respectively

VI. Results

In this portion, the results and other factors during the experiments using prototype rod electrode discharge EDM, include flow discharge energy, peak current, pulse on time are discussed. Figures 14 to 16 show the discharge energy, peak current, and pulse on-time independently, they are Perform feature analysis which were introduced in the previous section

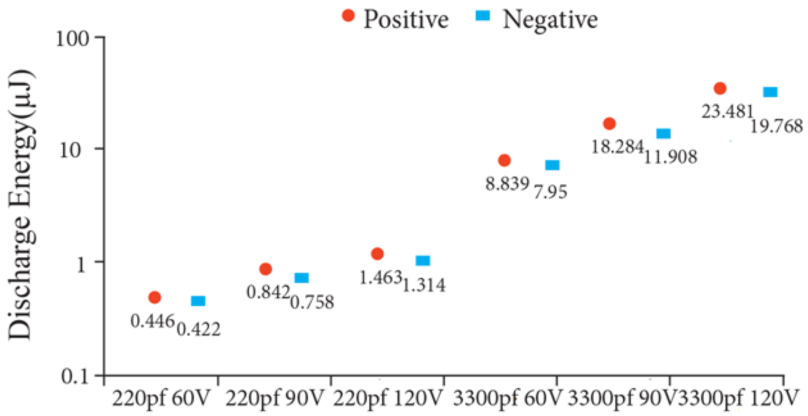


Figure 14: Average discharge energy

The average discharge energies under in various experimental conditions are shown in Figure 14. The discharge energy is just 0.42 J at the lowest point. Results of ANOVA show that the flow of discharge is greatly influenced by voltage, capacitance, and polarity, If the capacitance increases then discharge energy also increase. The estimated discharge power is 17.85 times that of the average discharge power using the 220 pf to 3300 pf respectively. In addition, by increasing the open circuit voltage range which will increase the discharge energy. Energy stored in the capacitor 1/2 CV2 where C is the capacitance and V is the open-circuit voltage. This equation Partly explains why the pulse energy is positively associated with voltage and capacitance level.

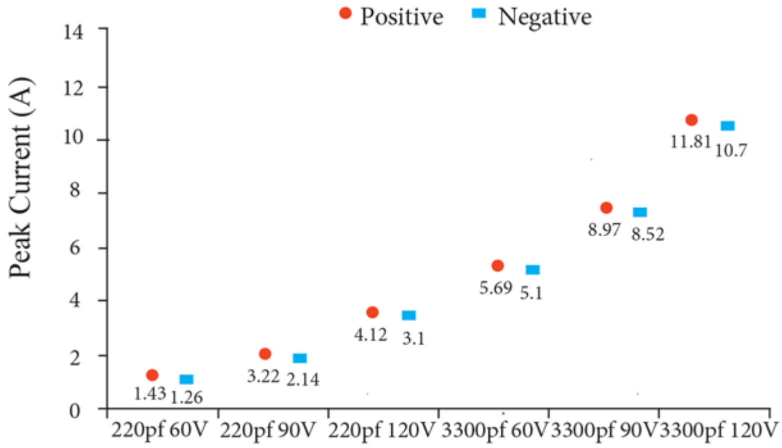


Figure 15: Peak current & average current waveform. [20]

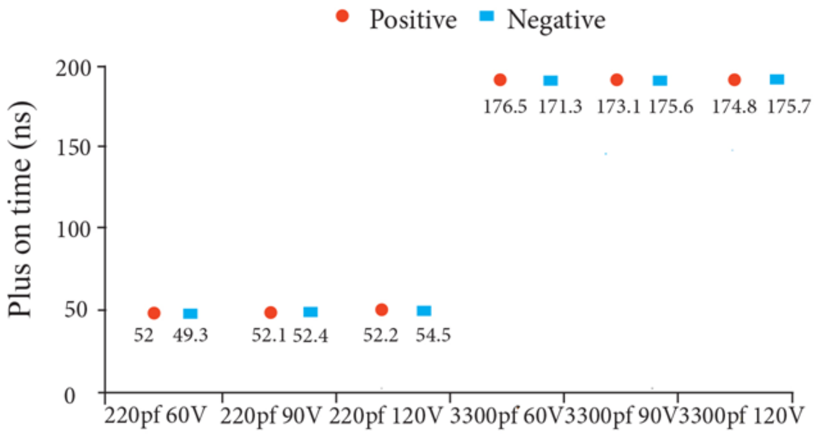


Figure 16: Pulse on tim

In any case, the released energy isn't equivalent to the energy put away in the capacitor. The average limit in the circuit is by one reason causing the distinction. Therefore, when a positive extremity is applied the released energy is higher than a negative extremity is applied. The figure 15 is showing the peak current of the corresponded to the usual average current waveform. The peak current flows are up to 12.4 A, which shows the release discharge process is exceptionally strong. Investigation shows that the peak current is expanding by utilizing the huge capacitor. The increasing of the open-circuit voltage likewise increasing the peak current altogether. Moreover, the change of polarization shows no impact on the peak current.

The Pulse on time appears in Figure 16. The pulse on-time is around 50 ns when utilizing the 220pf capacitor, and around 180 ns when utilizing the 3300pf capacitor. The beat on time is just essentially influenced by the capacitance. Since the releasing time consists of an unwinding type discharge generator is controlled by the hours of opposition and capacitance. The progressions of open-circuit voltage and extremity are not showing critical impact and also will increase because of extreme temperature in the discharge side [21 ,22]; therefore, the continuous discharge are in average limit. If the positive polarity discharge is adopted then the discharge current will increase and the process efficiency will improve

CONCLUSION

A method commonly used in the field of machining in EDM, in which EDM wire cutting uses EDM etching reaction to cut workpiece, which can theoretically process any conductive material and belongs to non-contact machining. Therefore, in this paper, the design of desktop rod electrode EDM machine tool is proposed and uses small-diameter rod-shaped electrodes with a diameter in the range of 0.3mm-3mm with pure water. The size of the workpiece cut by the present invention desktop level rod electrode EDM tool can be as small as the metal plate of 200×200×50mm. The overall frame size of the EDM desktop machine tool is 370 mm×410 mm×300 mm. Coaxial rotating unit, stepping table and the machine tool motion control system was designed which include DC switching power supply, M3S main board, LCD display and DM320, DM420 and other drivers.

The desktop machine tool of the present invention has the advantages of small quality, low cost, small size and simple operation, and can complete processing tasks anytime and anywhere. After appearance design, it can be used in mass production. In addition, there are some improvements in this design, such as improving the accuracy of motion control system, optimizing appearance, further reducing weight and volume, etc.

The machining experiments were conducted on selected workpieces were silicon, Iron and steel using the present invention of desktop level rod electrode EDM tool. The polarity of the electrode was set as positive while that of workpiece was negative. In all of the following experiments, water is being used as dielectric liquid and copper is the material of the electrode rod with 0.8mm diameter. The power supply output voltage is set up at 100V and the resistance used in the RC circuit is 850Ohm. The electrode rod's rotation speed is set at 50 r/min. And the various factors and issues were also discussed the experiment.

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