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**SOME POSSIBILITIES OF PLASTIC DEFORMATION OF THE MACHINE
PART SURFACES BY SUPERPOSITIONING THE INDENTER WITH
ULTRASOUND OSCILLATIONS ALONG THE RESULTANT FORCE
PROCESSING**

New possibilities of the ultrasonic plastic deformation process of the machine part working surfaces with radial ultrasonic vibrations are shown. The peculiarities of the new method of ultrasonic surface plastic deformation with superimposing on the indenter, as well as ultrasonic vibrations along the resultant force and some of its processing advantages over the known methods of ultrasonic hardening surfaces are introduced.

Keywords: ultrasound, indenter, plastic deformation, work surface, parts of machines.

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**THE REVIEW OF DIELECTRIC MEDIUMS FOR ELECTRICAL
DISCHARGE MACHINING
(Gyumri)**

The review of dielectric media used at electrical discharge machining is presented. The influence of the dielectric medium type on electrical and non-electrical characteristics of electrical discharge machining is presented. The liquid dielectrics, dielectric liquid with different additives, and gaseous medium properties and their behavior during electrical discharge machining are discussed.

Keywords: electrical discharge machining, dielectric mediums, dry electrical discharge machining, near-dry electrical discharge machining.

Electrical discharge machining (EDM) is a non-conventional, direct contact free machining process. It has a wide range use, especially for hard, rough materials and a difficult shape machining of mainly electroconductive materials and not only. EDM enables to successfully machine where other machining processes are impossible to apply.

The main non-electrical characteristics of efficiency of EDM are the material removal rate (MRR), the tool-electrode wear, the machined (eroded) surface quality.

As it is known, the work piece and electrode tool are connected to the opposite polarities. There is a gap between the electrodes, they do not contact to each other. The gap is filled with dielectric fluid or medium which insulates electrodes and the small gap is called spark gap. An electric current is supplied to

the electrodes, it ionizes the dielectric medium and when the current reaches its critical value for the exact dielectric in the direct condition, a breakdown takes place. A spark takes place, the heat energy of the spark melts and vaporizes the material of the workpiece and the electrode tool and removes them, (Fig 1).

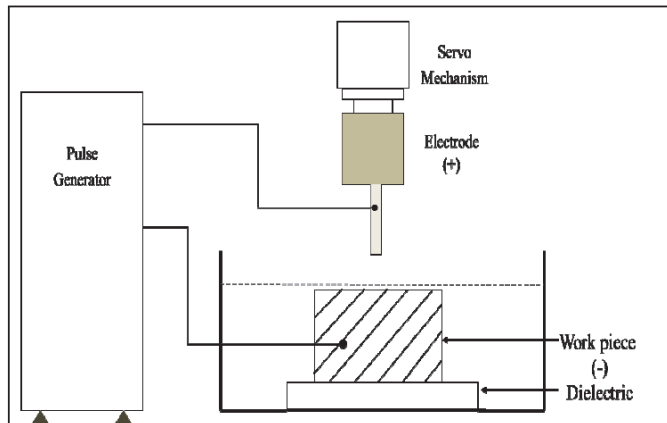


Fig. 1. A Basic scheme of an EDM system

The material removal is divided into three phases of sparking: breakdown, discharge and erosion. The entire mechanism of material erosion and its physics are not yet clear, and only acceptable models are available.

The material removal is divided into three phases of sparking: breakdown (pre-discharge phase), discharge (discharge phase) and erosion (post discharge phase), the phases are shown in figure 2. Yet the entire mechanism of material erosion and its physics are not yet clear, and only acceptable models are available.

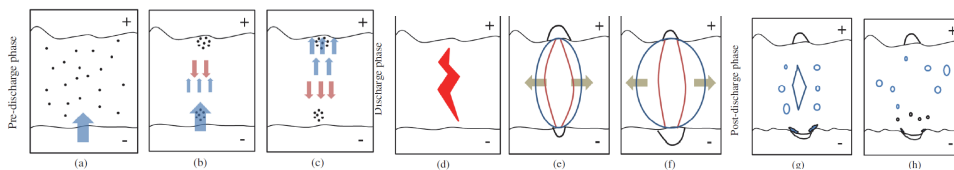


Fig. 2. Material removal phases

a) Initial stage, b) When electric voltage input is applied across the cathode and anode, the cathode emits electrons, c) The electrons emitted from the cathode collide with neutral atoms and particles in the presence of the dielectric medium, and as a result more electrons and ions are formed. In some cases, the debris of the previous discharges are concentrated and attracted to the areas with high electrical field intensity. The accumulation of particles helps create an abridging effect which reduces the inter-electrode gap and helps in the discharge initiation.

d) Due to the difference between the mass of the newly formed electrons and ions, the newly formed electrons move towards the anode and ions move towards the cathode, electrons get accelerated, more electrons and ions would generate due to the collision with neutral atoms and particles. This process results in impact ionization. After the abridgment of the gap by electrons, the dielectric breakdown occurs and the discharge phase begins, e) After the breakdown, the resulting conductive channel helps the easy movement of the emitted electrons from the cathode towards the anode and intensifies the impact ionization, this leads to the formation of a plasma channel which generates a high heat (to 10000 K) flux due to its high current density. This plasma channel causes melting of electrodes. f) The plasma channel continues to expand rapidly. In this phase, the high temperature from plasma vaporizes, disassociates and ionizes the dielectric at the plasma channel, and the dielectric and gas bubbles rapidly expand. Some molten metal are pushed out due to the pressure in the bubble. g) Heat decreases at the anode, and the plasma channel expands. This phase comes to an end when the applied discharge voltage is turned off or the discharge current stops. h) When the supplied voltage or discharge current is turned off, the plasma channel collapses. The molten metal solidifies at the anode. This minimizes the anode wear. The molten material solidifies as well and forms debris. The rapid temperature change forms a recast layer with alternate properties to the main material.

As we see, the dielectric medium has an important role in the EDM process and MRR. The electrical resistance of the dielectric medium influences the discharge energy and the time of the spark, discharge duration, for larger resistance the charge is higher. [1]. The insulating, electrical and physical properties of the dielectric medium are key factors affecting EDM.

The material removes both from the workpiece and the electrode tool, and the eroded particles and vaporized gases-debris gases evacuate from the gap with the dielectric medium flow. The eroded surface composition alters from the initial material composition and properties, and it is called a white layer or recast layer.

As dielectric media are used, liquid dielectrics, dielectric liquid with a different additive, and a gaseous medium (in this case EDM is called Dry EDM, or DEDM). In the article, we will review the advantages and disadvantages of the dielectric liquid, dielectric liquid with different additives and gaseous medium use, and their influence on electrical and non-electrical characteristics of EDM.

The traditional dielectric liquids are hydrocarbon oil or de-ionized or tap water.

Hydrocarbons have low viscosity, but have a low flash point, and it can react with the skin and cause pollutions. Hydrocarbon allows to have lower surface roughness and smaller heat affected zone on the workpiece. The use of hydrocarbons decreases year by year and few countries still use it as a dielectric fluid.

Machining in hydrocarbon allows to have high machining surface quality though MRR in this case is low.

Machining in water produces high MRR and low electrode wear, high thermal stability due to good cooling properties of water and high power can be achieved. Water enables to produce a green process compared to hydrocarbons. The main problem of water usage is corrosion[2]. Water causes high electrode tool wear[3]. Water is more economical, safe and preferred to hydrocarbons [4].

The way to reduce the negative aspects of water and hydrocarbon usage is to mix additives which can approve required machining properties. In some cases special additives allow to increase the spark frequency and decrease ignition. An additive can be mixed to water or hydrocarbons. The additives can be electrically sensitive or not. An electrical field sensitive additive can polarize, decreasing the required current. Fine powder of copper, aluminum, iron and carbon is used as additives, which is dispersed in the dielectric. It decreases the insulating strength of the dielectric and enables to enlarge the spark gap. For increasing the productivity of water organic compounds such as sugar, polyhydric, alcohols are used. Even 10 % solutions can provide an increase in MRR twice. The larger the compound molecular weight the higher is MRR.

Another way to combine the positive properties of water and hydrocarbon is to combine these liquids. As it is known water and hydrocarbons don't make solutions. The only way to get combination (mixture) of water and hydrocarbons is to emulsify them. An emulsified system of water and hydrocarbons with required ratio of component concentration can be formed. In our earlier research, complex emulsion dielectric fluids were produced implemented during EDM. The produced emulsions were oil-in-water type. During investigations, distilled water and tap water were used. The experiments showed that tap water proved to have the best machining rate, and the electrode wear was almost zero, depending on the electrode tool material and the polarity of electrodes. We succeeded in producing stable emulsion systems with experimentally proved improvement of EDM process [5].

When instead of a dielectric liquid, a gas is used, we call it dry EDM. It was first presented by Kuneida. As a dielectric medium, oxygen gas was used, which resulted in very high MRR, but the machined surface was rough. High pressured gas flow is inlet into the machining gap through a thin pipe. To reduce the poor surface quality, a near ly dry EDM is offered, when the mixture of gas and liquid is supplied into the gap [6]. For -dry EDM, two -phase system dielectric liquid/air is used. In two-phase systems water, oils and glycerin can be used as dielectric liquids. So near-dry EDM is an environmentally friendly process. The higher the fluid viscosity the better results it produces. The recast layer was also insignificant.

The MRR for glycerin/air mixture is three times higher than for other liquid mixtures. The tool wear during near-dry EDM is insignificant compared to the EDM in dielectric fluids. Near-dry EDM enables to apply finishing operations. The tool-electrode wear for this case is insignificant. The higher the gas flow speed is, the better debris evacuates from the machining gap and the higher the precision of machining is. The electrode material reacting with the oxygen in the air oxidizes and increases MRR [7]. The dielectric liquid supply can be controlled, and depending on the required pulse energy, MRR, and the surface quality can be obtained.

One of the general problems of EDM is debris evacuation from the gap. The better the debris evacuates the higher is precision, and MRR and the flushing conditions are better. Debris evacuation has different mechanisms for liquid and gaseous mediums. High viscosity dielectric liquids need special circulation system to evacuate the debris from the machining gap. For the gaseous medium, the debris evacuates with a high pressure gas flow, without special efforts and filtrations.

In conclusion, dry EDM and EDM in water are environmentally friendly and safe. They both produce economic machining. Water and water mixed dielectrics are inflammable. Debris evacuation for dry EDM from gaseous dielectric medium is more efficient. Debris are blowing out from the gap by the same high pressure gas flow which is more efficient than the debris evacuation by liquids. Dry EDM produces poor machining quality. If higher surface quality is desired, than near-dry EDM is preferred. The presented dielectric fluids have their recommendations of use, depending on the desired MRR and surface quality.

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ԷԼԵԿՏՐԱԵՐՈԶԻՈՆ ՄՇԱԿՄԱՆ ՀԱՄԱՐ ՆԱԽԱՏԵՍՎԱԾ ԴԻԷԼԵԿՏՐԻԿ ՄԻՋԱՎԱՅՐԵՐԻ ՎԵՐԼՈՒԾՈՒԹՅՈՒՆ

Ներկայացված է էլեկտրաէրոզիոն մշակման համար նախատեսված աշխատանքային միջավայրերի վերլուծությունը: Բերված է դիէլեկտրիկ միջավայրի՝ էլեկտրաէրոզիոն մշակման (ԷԷՄ) էլեկտրական և ոչ էլեկտրական հատկությունների վրա ազդեցությունը: Քննարկված են հեղուկ դիէլեկտրիկների, տարբեր հավելանյութերով հեղուկ դիէլեկտրիկների և գազային դիէլեկտրիկների հատկությունները և վարքը ԷԷՄ ընթացքում:

Առանցքային բաներ. էլեկտրաէրոզիոն մշակում, դիէլեկտրիկ միջավայրեր, չոր էլեկտրաէրոզիոն մշակում, գրեթե չոր էլեկտրաէրոզիոն մշակում:

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АНАЛИЗ ДИЭЛЕКТРИЧЕСКИХ СРЕД, ПРЕДНАЗНАЧЕННЫХ ДЛЯ ЭЛЕКТРОЭРОЗИОННОЙ ОБРАБОТКИ

Дан анализ диэлектрических сред, используемых для электроэрозионной обработки. Представлено влияние типа диэлектрической среды на электрические и неэлектрические характеристики электроэрозионной обработки. Обсуждены свойства и поведение жидких диэлектриков, жидких диэлектриков с различными примесями и газообразных диэлектриков в процессе электроэрозионной обработки.

Ключевые слова: электроэрозионная обработка, диэлектрические среды, сухая электроэрозионная обработка, электроэрозионная обработка, близкая к сухой.