EDM Process by Using Copper Electrode with INCONEL 625 Material

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Abstract. Electrical discharge method (EDM), based on the thermo electrical energy of the workpiece and the mechanical electrical machining, are non-traditional machining methods. Current development of the nano mixed dielectric discharge device has the latest trends in tough and soft materials finishing. This research assesses the impact on nano-particle mixed electric discharge extraction of the inconel 625 product by means of a copper electrode of the material removal frequency (MRR), device wear level (TWR), and superficial surface roughness. In contrast to dielectric fluid are the output parameters such as current, period and frequency, and nano-substances of titanium carbide. During this phase, a sequential, separate discharges between the electrode and the workpiece contribute to the product removal electro thermally. The method quality largely depends on the Electrode content, the production of the electrode workpiece product. Appropriate electrode choice may reduce machining costs. Die-Sinker EDM with the copper electrode is therefore able to provide for improvement of output parameters and reduction of production costs. In case of surface roughness, a copper electrode has improved efficiency and is better suited for nano powdered dielectric medium.

1. Introduction

EDM is a proven processing method for the manufacturing of geometrically complicated and/or hard material parts, which by traditional machining methods are extremely difficult to operate.

The company's production method for complex shapes and narrow apertures with high accuracy is one of the most popular and widely accepted methods. This process is typically used for the profile joining of diamond wheels in plastic, the development of micro nozzles, boiling of composites and the creation of moulds and dies in hardened steel. Such rough and fragile machining products create an excessive wear and cost of equipment. For many years, the mechanical properties of tool steels have been thoroughly studied.

For EDM the device or job component are broken down into dielectric fluid and is divided up by a small distance. The release energy is produced on the surface of the workpiece at the spark point with very high temperatures. The sample has a temperature increase of up to 40 000 K, which results in the melting and vaporization of a minute portion of the workpiece. The top layer of the workpiece resolidifies and cools very quickly afterwards.

The fundamental cycle of EDM is very straightforward. Between an electrode and a workpiece is an electric spark formed. The light indicates that the energy streams. It induces intense heat and temperatures hitting between 8000 and 12000 ° C, nearly burning everything. This is an electronic
flame. The fire is managed and positioned with great care so that it impacts only the product layer. The heat treatment under the surface is not normally influenced by the EDM system. In this process, the material removal is occurred electro thermally by a series of successive discrete discharges between electrode and the work piece. The performance of the process, to a large extent, depends on the Electrode material, Work piece material manufacturing method of the electrodes. A suitable selection of electrode can reduce the cost of machining. So Die- Sinker EDM using copper electrode will give for optimizing Performance parameters and reducing cost of manufacturing, and it is that a copper electrode will give better performance in certain characteristics and is more suitable with nano powder mixed dielectric medium in case of surface roughness.

2. Literature Survey
A study of state of the art technology for advanced materials processing using Die Sinking EDM, WEDM, Micro-EDM, Dry EDM and RDE-EDM was performed by Anand Pandey et al. [1].

A. A. Khan et al. [2] also examined the use of aluminum or mild steel with copper and blade electrodes in the measurement of electrode damage along the cross-section of an electrode contrasted with that throughout its duration throughout EDM.

M. R. Shabgard et al. [3] have researched the most effective, practical chromium-based product welded steel study in the FW4. The use of selling product raises mold life by about 150% and the regular maintenance duration up to 200% relative with moulds made from normal metal.

El Taweel et al. [4] researched the relationship of system parameters with a tool content, like the composite of Al-Cu-Si-Tic, created from powder metallurgy (P/M) manufacturing, in electrical discharge of CK45 iron.

The study of surfaces roughness work and MRR for brass-machined and copper electrical-discharge electrode machined device metal (EDG) methods was performed by Helmi et al. [5].

The key process of making tungsten carbide (WC-Co) moulds and dies is Pichai Janmanee et al. [6] conducted a study of the mechanical electrical discharge machining (EDM). The EDM method usually creates microcracks on the workpiece layer.

Prasad Bari et al. [7] have analyzed the right dielectric fluid for a given work piece and instrument content to improve MRR and minimize TWR.

Mohd Amri Lajis et al. [8] have studied about an analysis on Experiments were performed using a Charmilles Electrical Discharge Machine, Series-Roboform. An electrode was used with a flat graphite ring with a diameter of 9 mm.

In an experiment on CNC regulated die sinking form EDM, Rajesh Choudhary et al. [9] analyzed the study. The EN31 metal is constructed of 25 mm x 25 mm x 20 mm length.

3. Problem Definition
The challenge found by the previous study is that many machining parameters have an effect on surface ruggedness and it was difficult to achieve an optimal surface performance by these parameters. We are able to achieve optimal surface quality through the use of the various parameters such as pulse current, pulse time, pulsation pause time, voltage, dielectric liquid and the electrical material. With rising current and voltage, the surface finish is degrading. A higher voltage or current gives the work surface a stronger spark and makes it more profoundly crater. It renders the ground redder. The existing effect on the ground finish on other electrodes is greater. Brass electrodes absorb more fluid than other electrodes which build up in the space between job and electrode. As a consequence, the job surface becomes gritty by further uncoordinated sparks.

Therefore, during EDM activities, this work can produce more information and experience.

1. To learn more about the method of electric discharge.
2. Analysis of ground rigidity with an electrical discharge device of Inconel 625.
3. In order to determine the right parameter array in EDM for the extraction frequency and wear level of devices.
4. Material Selection
Inconel 625 is a strong nickel-based nickel alloy with a high strength, resilient temperature (HSTR). It is commonly used in aerospace systems as gas turbines, rocket engines, rockets, pumps and machinery. Due to its poor thermal stability, low strength, high stiffness, high work endurance, high carbide particle density and the strong tendency to weld to the device for the edge design, Inconel-625 is challenging to operate. Due to the wide range of applications in different fields the behavioural features of Inconel-625 are better known with EDM.

![Inconel 625 material](image)

**Figure 1.** Inconel 625 material.

The table.1 shows the Chemical Composition in inconel 625 Material

| Chemical Composition   | Percentage     |
|------------------------|----------------|
| Nickel                 | 58.23%         |
| Chromium               | 20.0-23.0 %    |
| Iron                   | 5.0%           |
| Molybdenum             | 8.0-10.0%      |
| Niobium (plus Tantalum)| 3.15-4.15%     |
| Carbon                 | 0.10 %         |
| Manganese              | 0.50 %         |
| Silicon                | 0.50 %         |
| Phosphorus             | 0.015 %        |
| Sulfur                 | 0.015 %        |
| Aluminum               | 0.40 %         |
| Titanium               | 0.40 %         |
| Cobalt                 | 1.0%           |

4.1. Tool Material – Copper Electrode
The electrical choice depends on the necessary reliability parameters (MRR, machining stability and surface roughness) and the output constraints of the electrode. The first to establish the discharges is to choose a good electrical conductor. To order to ensure geometrical integrity of an electrode, this substance must have a low melting and vaporizing temperature as well as moderate thermal diffusiveness.

This is the first EDM electrode device to choose from. Casting and machining may generate it. Copper electrodes are produced by chemical graving and electrical formation with very complex characteristics. Copper is the most appropriate EDM machine tool product.

![Copper electrode](image)

**Figure 2.** Copper electrode.
The table 2 shows the chemical composition in Copper electrode

| Chemical composition | Percentage  |
|----------------------|-------------|
| Copper               | 56.700%     |
| Aluminum             | 0.0025%     |
| Tin                  | 0.020%      |
| Phosphorous          | 0.020%      |
| Lead                 | 3.000%      |
| Iron                 | 0.100%      |
| Zinc                 | 39.850%     |
| Nickel               | 0.0770%     |

4.2. Titanium Carbide Nano Powder

Ceramics used in nano powders are more ductile than coarse grained ceramics and can be sintered at low temperatures at elevated temperatures. The strength for nano-sized iron and copper powders is about 4-6 times higher when bulk materials are dislocated.

In the conduction of ink and polymers, nano-sized copper and silver are used. It raises the storage capacity for hard disks on the device, while growing the physical dimensions of magnetic mono domains, which reduces oppressive compared to large particles.

5. Design of Experiment

The experimental input parameters considered for the present study includes the following:

- Current
- Pulse ON-Time
- Flushing pressure

Here, table 3 shows the results of input parameter in terms current ON time with Nano Powder and without nano powder
Table 3. Experimental Data with Nano Powder and without nano powder.

| Run Order | Input Parameter (with) | Input Parameter (without) |
|-----------|------------------------|---------------------------|
|           | Current (with) Amps    | Current (without) Amps    |
|           | Current (with) µsec    | Current (without) µsec    |
|           | F/Pr. (with) Kg/sq.cm  | F/Pr. (without) Kg/sq.cm  |
| 1         | 1                      | 1                         |
| 2         | 1                      | 2                         |
| 3         | 1                      | 3                         |
| 4         | 1                      | 4                         |
| 5         | 2                      | 2                         |
| 6         | 2                      | 1                         |
| 7         | 2                      | 3                         |
| 8         | 2                      | 4                         |
| 9         | 3                      | 1                         |
| 10        | 3                      | 2                         |
| 11        | 3                      | 3                         |
| 12        | 3                      | 4                         |
| 13        | 4                      | 1                         |
| 14        | 4                      | 2                         |
| 15        | 4                      | 3                         |
| 16        | 4                      | 4                         |

6. Conclusion

The study concludes that the copper electrode should enhance its efficiency, such as evaluation of the extraction speed, use of tools and roughness of the substrate. When the nano-particle is used, the electrodes absorb a significantly larger amount of working product than other electrodes collecting within the area between the workpiece and the electrode if applied to another component. The research would focus on Model of Experiment (DOE) and evaluation on product extraction speed, device level wear and surface roughness. There are several scopes that are to be conducted with some tests.

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