SNS COLLEGE OF TECHNOLOGY

(An autonomous institution)

Department of Mechanical Engineering

Unit – II

Topic

Electrical Discharge Machining

Prepared by

P.Divyakumar,

Assistant Professor / Mechanical Engineering

SNS College of Technology, Coimbatore

Electrical Discharge Machining

- In electrical energy process, the **electrical energy** is directly used to cut the material into final shape and size.
- Two types

- **Electrical Discharge Machining**
- **Wirecut Electrical Discharge Machining Process.**

Electrical Discharge Machining

- Working Principle
- In Electrical Discharge Machining also known as **Spark Erosion Machining or Electro erosion Machining,** metal is removed by powerful electric discharge between tool(Cathode) and workpeice material(Anode).

Electrical Discharge Machining

Construction

- The main components are
  - Electric Power Supply
  - Dielectric Medium
  - Workpiece
  - Tool
  - Servocontrol Mechanism

Electrical Discharge Machining

Construction

- The **workpiece and the tool** are directly **connected to a D.C power supply**.
- The workpiece is connected to positive terminal of the electric source, so that it becomes an **anode.**
- The **tool** is conncted to the **negative terminal** of the electric source, so that it becomes an **cathode.**
- The tool and workpiece is **submerged in an dielectric fluid medium.**
- Dielectric fluid medium such as **Paraffin, White Sprit, Transformer oil which has poor electricity.**
- **The function of Servomechanism** is to maintain a small gap known **as spark gap ranges of 0.005 to 0.05 mm** between the tool and the workpiece.

Electrical Discharge Machining

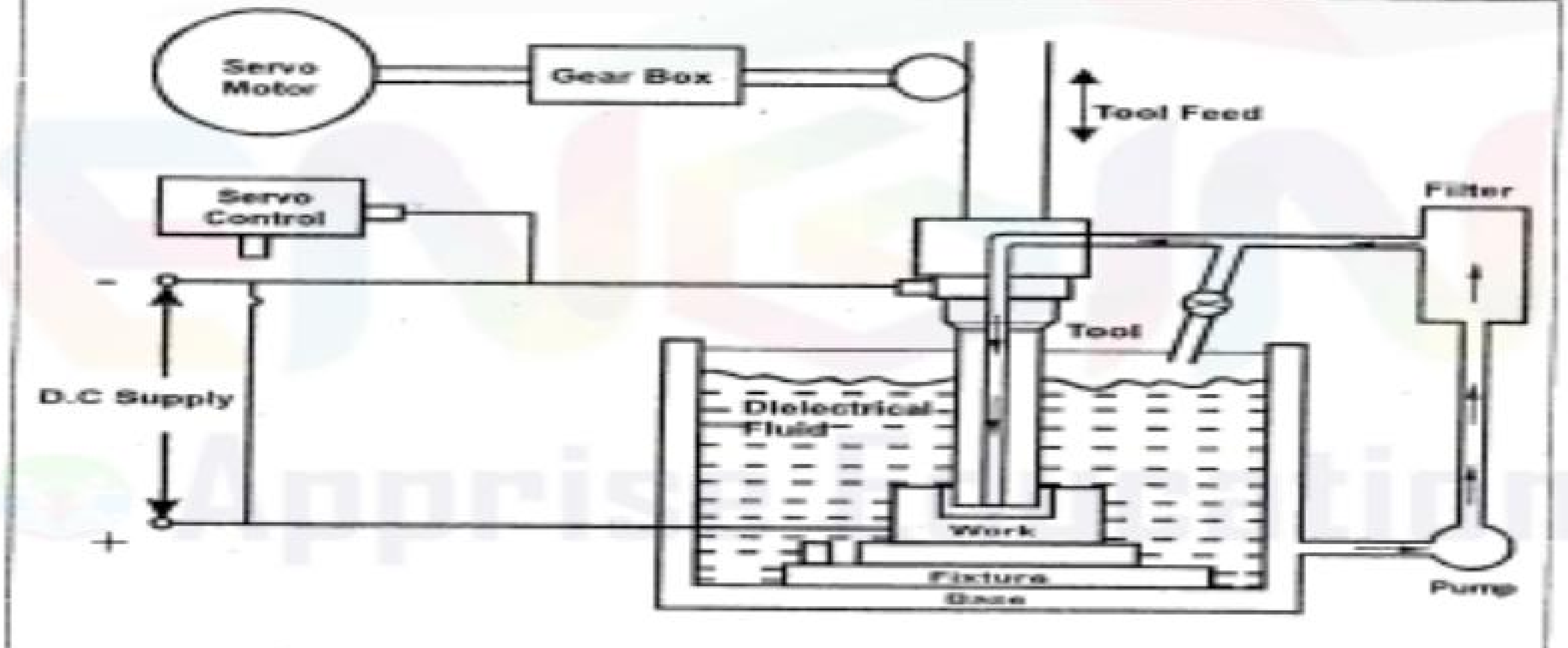


Fig 3.1. Schematic layout of EDM

Electrical Discharge Machining

Working

- When the **D.C supply is given to the circuit**, **spark** is produced across the gap between tool and the workpiece.
- When the voltage across the gap becomes sufficiently **larger (more than 250 v)**, the high power spark is produced. So the dielectric breaksdown and electrons are emitted from the cathode(tool) and the gap is ionized.
- **Spark across interval-**10 to 30 ms
- **Current density -** 15-100A per mm2.

Electrical Discharge Machining

- So thousands of spark discharge occur per second across the gap between the tool and the workpiece, results in
- **Temperature** - **10000 degree celsius.**
- At this high temperature and pressure, **workpiece metal is melted, eroded and vapourized.** In this way the metal is removed from the workpiece.
- The removed fine material particles are carried away by dielectric fluid circulated around it.
- MRR depends on spark gap maintained. If the anode and the cathode are made of same material, it has been found that greatest erosion takes place at anode. Therefore, in order to remove maximum metal and have minimum wear on the tool, the tool is made as cathode the w.p as anode.

Electrical Discharge Machining

- when the voltage drops to about 12 volts, the spark discharge extinguishes and the dielectric fluid once again become deionized. The condensers start to recharge and the process repeat itself.

Dielectric Fluid

- Dielectric fluid is a medium that **doesnot conduct electricity**.
- Tool and w.p are **submerged in dielectric medium.**
- Dielectric fluid generally used are
  - Petroleum based hydrocarbon fluids
  - Paraffin
  - White Spirit
  - Transformer oil
  - Kerosene
  - Mineral Oil

Dielectric Fluid

Dielectri fluid **must not be hazardous** to operators or corrosive to equipment.

The choice of any dielectric fluid depends on the

- **workpiece size**
- **Type of shape**
- **Tolerance**
- **MRR**
- **Surface finish**

White spirit- suited for machining tungsten carbide.

The dielectric fluid must **freely circulate** between tool and the workpiece.

The eroded particles should be carried away at the earliest since it reduces further MRR.

The dielectric fluid must be **filtered before reuse** so that chip contamination of the fluid will not affect machining accuracy.

Function of Dielectric Fluid

It acts as a **insulating medium.**

It **cools the spark region** and helps in keeping the tool and workpeice cool.

It **carries away the eroded metal particles** along with it.

It maintains the **constant resistance across the gap.**

It remains **electrically non conducting** until the requried breakdown voltage has been reduced.

It **breakdown electrically** in the shortest possible time once the breakdown voltage has been reached.

Tool Materials

Generally used tool materials are

- Metallic Materials(Copper, Brass, Copper-Tungsten etc..)
- Non metallic (Graphite)
- Combination of Metallic and Non metallic materials.

Tool Materilas

Copper, Yellow brass, Alloy of Zinc, Copper Tungsten, Silver Tungsten, Tungsten Carbide and Graphite

Copper- Commercial applications

Al - Die sinking

Castiron - Rough Machining

Process Parameters of EDM

The following process parameters influence the process parameters in EDM

- **Operating Parameters**
- **Taper**
- **Surface finish**
- **Current Density**

Process Parameters of EDM

The following process parameters influence the process parameters in EDM

Operating Parameters

Operating process involves the removal of the heat from the w.p and tool as a measure of electrical energy input.

$$\text{Metal Removal Rate (MRR)} = \phi(E)\, f$$

$$= \phi \int_0^{\tau_p} vi\, dt$$

Where

- ϕ - Function
- E - Electrical Energy
- v - Voltage
- i - Instantaneous current
- dt - Time interval
- f - Torque
- τ_p - Pulse width

$$\text{Tool Wear Rate (TWR)} = \psi(E)\, f = \psi \int_0^{\tau_p} vi\, dt$$

Process Parameters of EDM

Based on the above consideration it is well understood that MRR and TWR are governed by the following

- ✓ **Energy content of the pulses**
- ✓ **The rate at which the energy is supplied**
- ✓ **Servo sensitivity**
- ✓ **Gap width**
- ✓ **Dielectric Parameters**

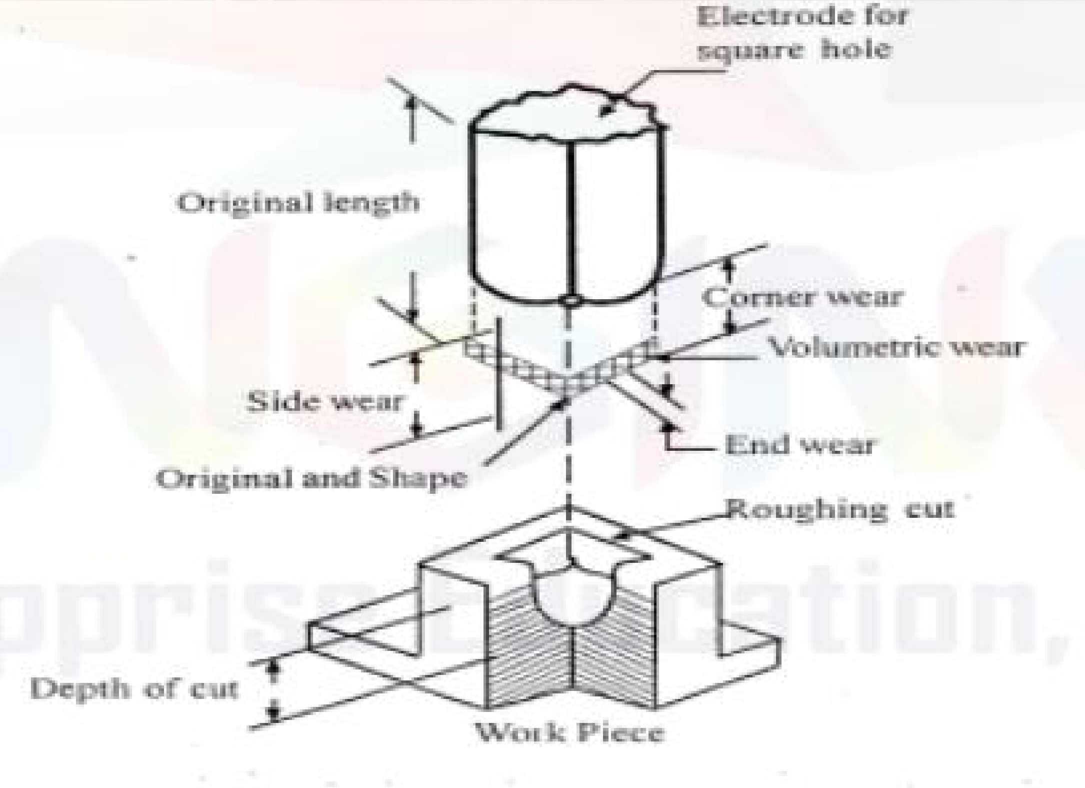
Process Parameters of EDM

Tool wear rate is requried to calculate **tooling cost, Machining accuracy and estimate the time of machining for a desired depth of cut**.

There are three types of wear observed in the tool

They are

- **End wear**
- **Corner Wear**
- **Side Wear**



Process Parameters of EDM

Taper

Tappering effect is observed due to the side sparks which is shown. Under high dielectric pollution, side sparks are more pronounced as compared to frontal sparks.

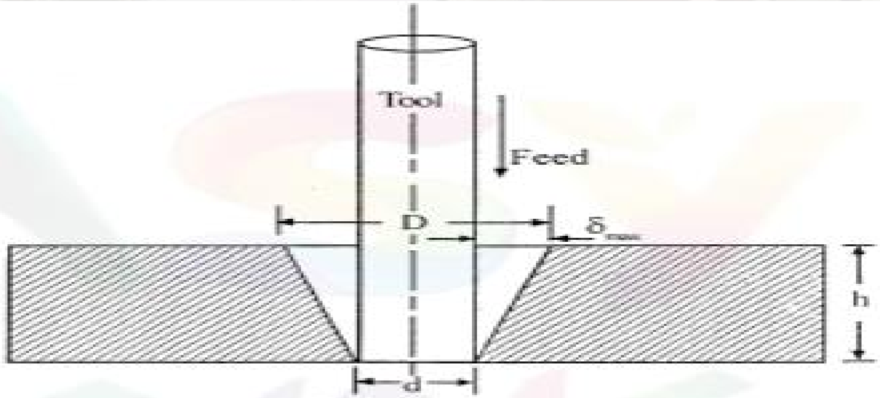


Fig. 3.8 Scheme of Taper

In this case, over cut at any instant is given by

$$\delta = C_3\left(\frac{\pi}{4}d^2\right)h$$

At maximum,

$$\delta_{max} = C_3\left(\frac{\pi}{4}D^2\right)h$$

where

h – Depth of machining at any instant.

$$\Rightarrow \quad \text{Taper } T_p = \frac{D-d}{2h} = \frac{\delta_{max}}{h} = \frac{C_3\frac{\pi}{4}D^2}{h}$$

$$T_p = C_3\frac{\pi}{4}D^2$$

Process Parameters of EDM

Surface finish

The surface finish of the material depends upon the following factors

- ❑ Energy of the pulse
- ❑ Frequency of the operation
- ❑ The roughness of the material is observed within a bandwidth depending upon single or multispark conditions.

Process Parameters of EDM

Current Density

- The current density is the most important parameter which **determines the material removal rate and surface condition.**
- Current density is affected by **either changing the current or changing the electrode(tool) - workpiece gap**.
- When the current is increased, each individual spark removes a larger crater of metal from the workpiece. But it also increases surface roughness.
- Increasing spark frequency results in decrease in surface roughness and reduces the removal of crater of metal from the workpiece.
- The gap between the electrode(tool) and the workpiece is determined by spark voltage and current.
- A small gap produces more accuracy with a better surface finish and slower metal removal rate.

Advantages of EDM

- Used for machining various materials such as tungsten carbide, electrically conductive materilas and other hard materials.
- It gives good surface finish.
- Machining of very thin section is possible.
- It does not leave any chips or burrs on the workpiece.
- It is well suited for complicated components.
- Since there is no cutting forces act on the job, error due to elastic deformation is eliminated.
- High accuracy is obtained.
- Fine holes can be easily drilled.
- It is a quicker process, so harder materials can also be machined at much faster rate than conventional machining.
- The process once setup doesnot need constant operators attention.

Limitations of EDM

- Only used for machining electrically conductive materials. So **non metallic** such as plastics, ceramics or glass cannot be machined by EDM.
- Suitable for **machining small workpieces.**
- **Electrode wear and over cut** are serious problems.
- Perfectly **square corners cannot** be made by EDM.
- MRR is slow.
- Power requriement is high.
- In many cases, surface machined has been found to have **microcracks.**

Applications of EDM

- Production of complicated and irregualar shaped profiles.
- Thread cutting in jobs.
- Drilling of microholes.
- Helical profile drilling.
- Curved hole drilling.
- Resharpening of cutitng tols and broaches.
- Remachining of die cavities without annealing.

Thankyou