ELECTRICAL DISCHARGE MACHINING

Principle of Electrical discharge Machining.

Electrical discharge machining also reffered as Spark machining or Spark erosion. of machining is controlled by metal removal process based on the principle of erosion effects of electrical discharge taking place between two electrically conducting material immersed in a dielectric fluid. The Shape of the tool is similar to the Shape of desired workpiece. As the potential difference is sufficiently high due to application of DC current, electrical Spark is generated due to which metal removal takes place.

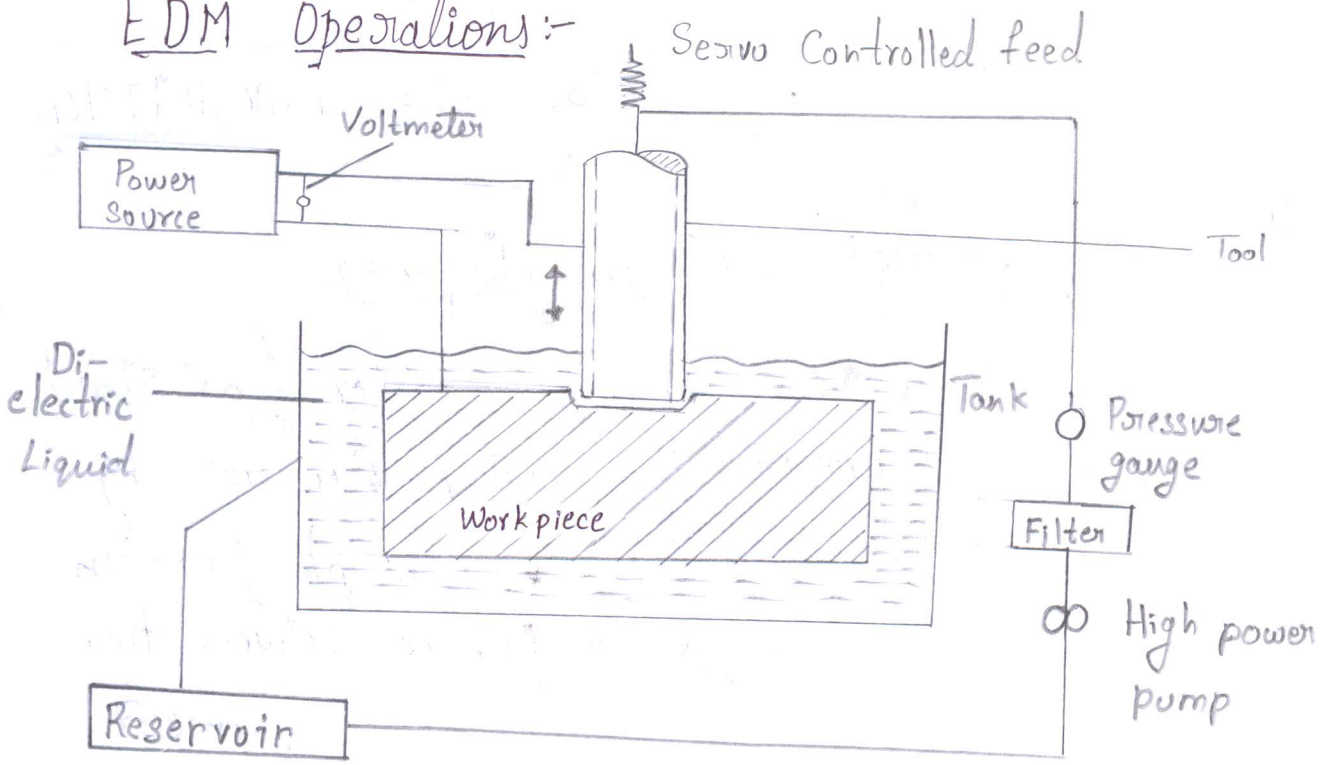
Need for EDM:-

→ Materials like tungsten or tungsten Carbide are difficult to machine with conventional machining methods.

→ Very small workpiece is difficult to machine using Conventional methods due to the excessive cutting tool pressure.

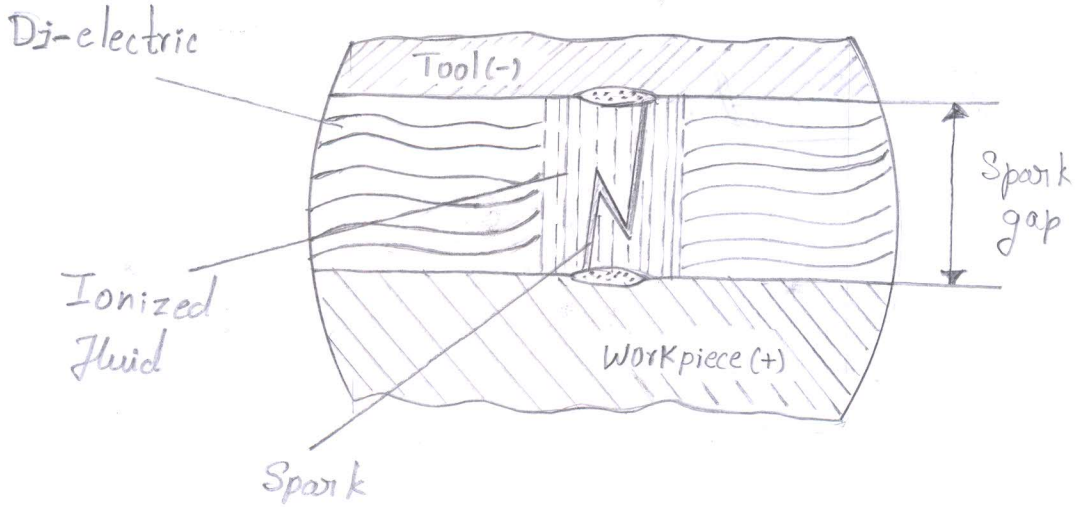
→ EDM over comes these limitations and gives comparative end results, proving to be very useful in manufacturing applications.

EDM Operations :-



The Set up for EDM process is as shown in the above figure. In operation, the tool is connected to the -ve terminal, while the workpiece to the +ve terminal of the power source. The tool and the workpiece are separated by a small gap known as Spark gap, filled by the dielectric fluid as shown in figure. The spark gap usually ranges from 0.01 - 0.05mm. When the potential difference between the tool and the workpiece is sufficiently high, a transient spark discharge through the fluid removing a very small amount of material from the workpiece.

Mechanism of metal removal



1) Initially, the gap between the tool & the workpiece, which consist of di-electric fluid, is not conductive. But, under the pulsed application of DC, the dielectric fluid in the gap is ionized, causing the spark to discharge or jump between the tool & the workpiece as shown in figure.

2) The spark impinges on the elevated surface of the work-piece at a very high temperature of around 10000°C causing a small portion of the workpiece to melt and/or vapourize as shown in the figure

3) The force of electric and magnetic fields caused by the spark produce a tensile force resulting in tearing of particles of molten and softened metal from the work surface thereby causing metal removal to takes place. These continously flowing fluid & flushes away the excess of matrix removed

From the machining gap.

Dielectric Fluid :-

In EDM process, the dielectric fluid which may be used are deionized water, transformer oil, paraffin oil, kerosene, lubricating oils, or other petroleum distillate fractions.

Functions of Dielectric fluid are as follows :-

1) Acts as spark conductor concentrating the heat energy to a very narrow region on the worksurface.

2) Acts as a flushing medium to carry away the tiny particles of metal removal.

3) Acts as a cooling medium to quench the spark and cool the tool electrode during machining.

The dielectric fluid for EDM should have the following requirements:-

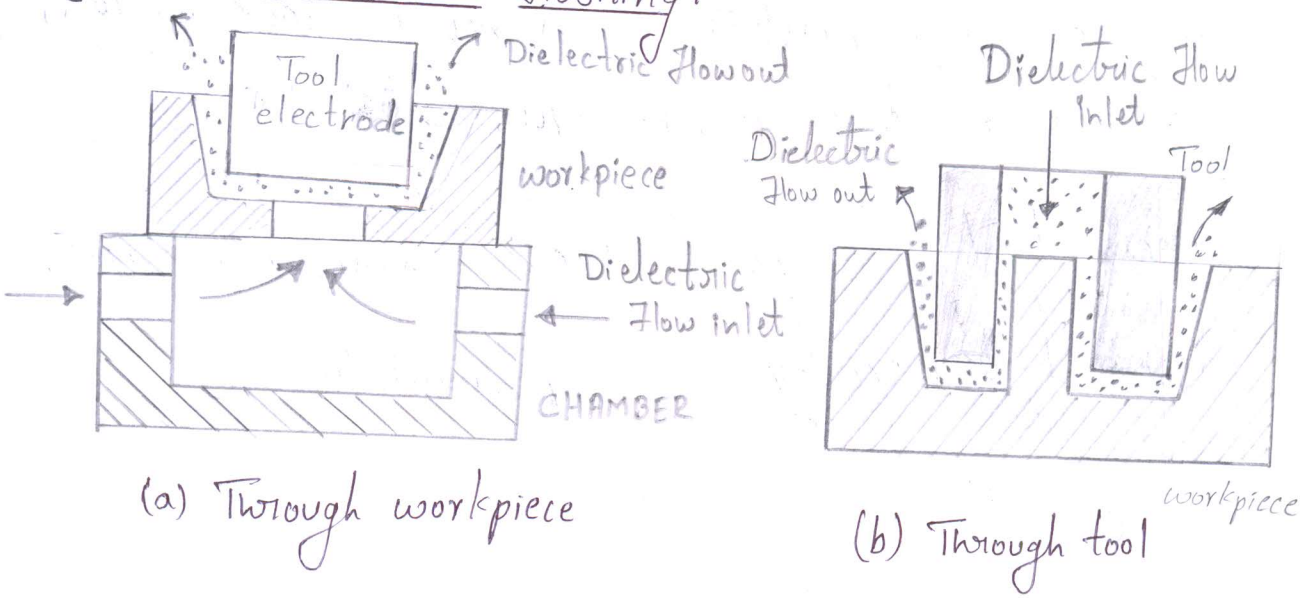
1) Possess sufficiently high di-electric strength to remain electrically non-conductive untill the required breakdown voltage is reached.
2) Deionize rapidly after the spark discharge has taken place.
3) Be chemically neutral so as not to attack the tool, workpiece, or other machine equipments.
4) Possess high flash point to avoid any fire hazards.
5) Possess high viscosity for easy circulation and wetting capacity.
6) Should not emit any toxic vapours or have unpleasant odours.
7) Provide an effective cooling medium to the tool.
8) Be cheap and easily available.

Flushing:-

It is the process of circulating the dielectric fluid between the tool electrode and the workpiece in a proper way so as to maintain a clean environment for efficient machining of the workpiece.

The Different methods of flushing are as follows:-

a) Injection or Pressure flushing:-



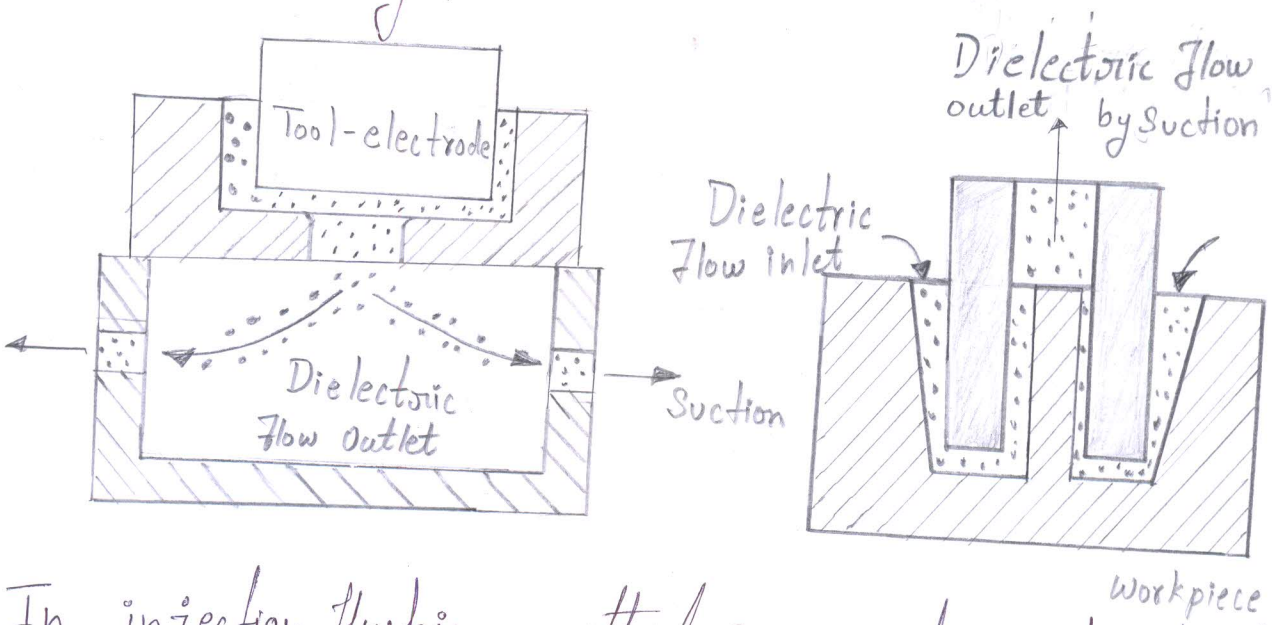
(a) Through workpiece

(b) Through tool

→ The dielectric fluid is injected continuously into the spark gap either through the hole drilled in the workpiece or tool.

→ The workpiece is predrilled and mounted on a chamber connected to the flushing supply. Alternately the tool can also be drilled through which the dielectric fluid is made to flow directly into the spark gap as shown in the figure

b) Suction flushing :-



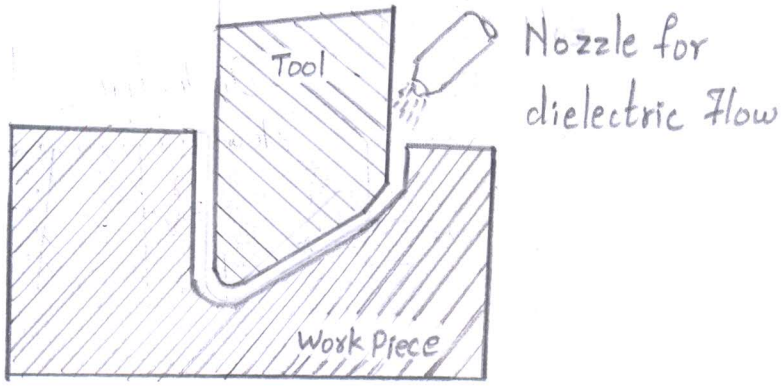
In injection flushing method component machined get slightly tapered due to flushing of fluid on the sides of the tool also resulting in sparking action machining debris and the side wall of the tool, to overcome this Suction flushing is employed.

→ The dielectric fluid is sucked either through the pre-drilled tool or workpiece

→ Flushing through the tool has comparatively proved to be more efficient.

→ The vaccum required for Suction is provided by the same pump unit by changing the pump and the filter output connections.

c) Side Flushing :-



→ Side flushing method is adopted when it is impossible to drill flushing holes either in the tool or in the work-piece.

→ This method use of nozzles which are carefully adjusted to flow or force the flow of fluid evenly around the periphery of the tool electrode

→ It is very important to adjust the direction of flushing so that the flow is parallel to the tool surface. Otherwise which, due to turbulence, only a small proportion of the dielectric fluid enters the gap leading to inadequate flushing and inefficient machining.

→ Further, with side flushing, the wear on the side of the tool electrode where flushing is provided will be higher, which are the disadvantages of this method.

Advantages :-

a) Extremely hard materials can be easily machined with close tolerances.

b) Thin and small sized workpiece can be easily machined.

c) There is no direct contact with the tool and the workpiece. Therefore, delicate sections be easily machined without any distortion.

d) Fine holes can be easily drilled with this process.

e) Appreciably high value of MRR can be achieved when compared to other NTM processes.

Disadvantages :-

a) Suitable for electrically conductive workpiece materials only.

b) Slow MRR when compared to conventional machining process.

c) Inability to machine sharp corners.

d) Specific power consumption is high.

e) Overcut is formed due to side sparks.

f) Tool wear occurs during machining, hence additional costs for the tool.

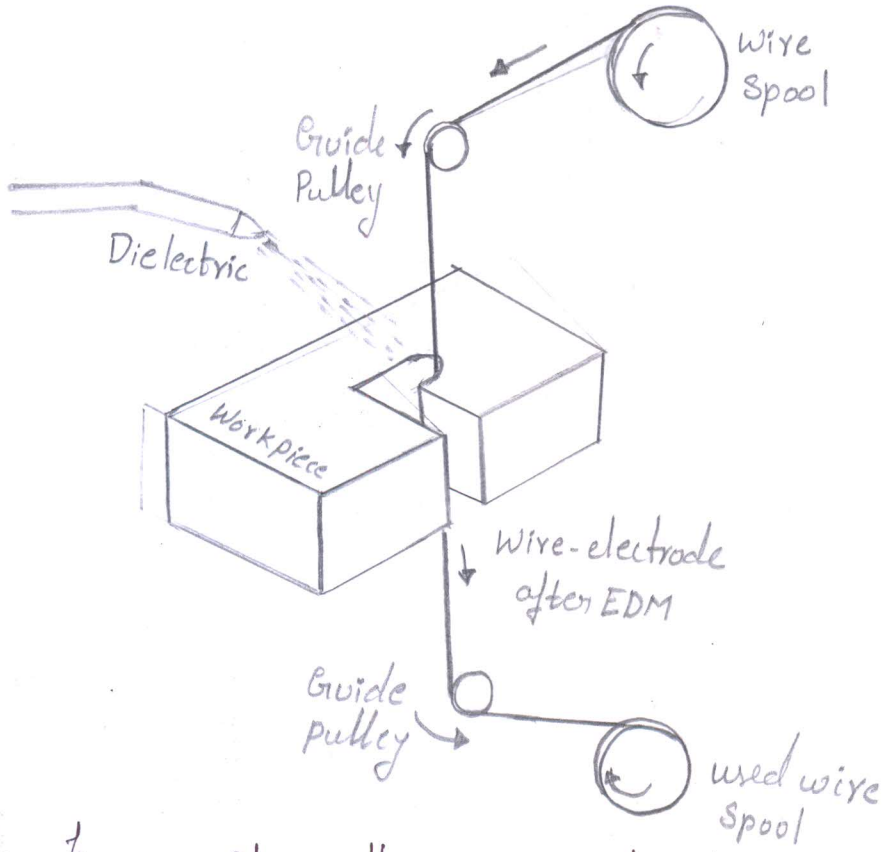
Applications:-

1) It is widely used in producing turbine blades, nozzle holes and other aerospace parts.

2) In mould making producing die/mould cavities, small holes, narrow slots, stamping tools, wire drawings on a dies, intricate mould cavities can be economically machined with EDM process.

3) Re-sharpening of cutting tools and broaches, trepanning of holes with straight or curved axis are a few other possible application of EDM.

TRAVELLING WIRE EDM



The figure shows the principle of wire EDM process. The process make use of a traveling wire made from copper or brass, typically of diameter 0.05 to 0.3mm to act as the tool electrode. The wire unwinds from a spool, feeds through the workpiece and is taken up on a second spool with constant wire tension, all of which is monitored precisely by CNC System.

Deionized water is used as the dielectric fluid and is injected through nozzles into the spark gap coaxially with the wire so that a fresh portion of the tool is always presented to the workpiece during machining. A small gap of about 0.025 to 0.05mm is maintained between the traveling wire and the workpiece.

In operation, when Sufficient voltage is applied, the dielectric fluid ionized resulting in a controlled Spark discharge between tool & workpiece. The Spark precisely erodes a Small portion of workpiece causing it to melt and vapourize. The circulating dielectric fluid cools the vapourized metal and forces the resolidited eroded particle from the gap. The eroded particle coming with deionized water increases the Conductivity of the deionized water to raise. A pump automatically forces the water through a filter and a resin tank which helps in the removal of conductive elements to make the water pure. To maintain efficient machining & part accuracy, the deionized water flows through a chiller so to maintain Constent temperature of the water.

During machining, Spark discharges occur at the leading Surface of the wire, and as a result, there is a Small erosion in the travelling wire also, and for this reason, fresh wire is always fed from a Spool.