Wire Cut Electric Discharge Machining (WEDM)

The Wire Electric Discharge Machining (WEDM) is a variation of EDM and is commonly known as wire-cut EDM or wire cutting. In this process, a thin metallic wire is fed on-to the workpiece, which is submerged in a tank of dielectric fluid such as de-ionized water. This process can also cut plates as thick as 300mm and is used for making punches, tools and dies from hard metals that are difficult to machine with other methods.

The wire, which is constantly fed from a spool, is held between upper and lower diamond guides. The guides are usually CNC-controlled and move in the x–y plane. On most machines, the upper guide can move independently in the z–u–v axis, giving it a flexibility to cut tapered and transitioning shapes (example: square at the bottom and circle on the top). The upper guide can control axis movements in x–y–u–v–i–j–k–l–. This helps in programming the wire-cut EDM, for cutting very intricate and delicate shapes.

In the wire-cut EDM process, water is commonly used as the dielectric fluid. Filters and de-ionizing units are used for controlling the resistivity and other electrical properties. Wires made of brass are generally preferred. The water helps in flushing away the debris from the cutting zone. The flushing also helps to determine the feed rates to be given for different thickness of the materials. The schematic of wire cut EDM is shown in Figure 3.11.1
The WEDM process requires lesser cutting forces in material removal; hence it is generally used when lower residual stresses in the workpiece are desired. If the energy/power per pulse is relatively low (as in finishing operations), little changes in the mechanical properties of the material are expected due to these low residual stresses. The materials which are not stress-relieved earlier can get distorted in the machining process. The selection of process parameters is very crucial, as in some cases the workpiece undergoes significant thermal cycles that can be very severe. These thermal cycles can form recast layers and induce residual tensile stresses on the workpiece which are undesired.

**Process of Material Removal in Wire-Cut EDM**

In the WEDM process, the motion of wire is slow. It is fed in the programmed path and material is cut/removed from the workpiece accordingly. Electrically conductive materials are cut by the WEDM process by the electro-thermal mechanisms. Material removal takes place by a series of discrete discharges between the wire electrode and workpiece in the presence of a di-electric fluid. The di-electric fluid gets ionized in
between the tool-electrode gap thereby creating a path for each discharge. The area wherein discharge takes place gets heated to very high temperatures such that the surface gets melted and removed. The cut particles (debris) get flushed away by the continuously flowing dielectric fluid.

WEDM is a non-conventional process and is very widely used in tool steels for pattern and die making industries. The process is also used for cutting intricate shapes in components used for the electric and aerospace industries.

**Applications of Wire-Cut EDM**

Wire EDM is used for cutting aluminium, brass, copper, carbides, graphite, steels and titanium. A schematic of the cutting through wire EDM is shown in Fig. 3.11.2. The wire material varies with the application requirements. Example: for quicker cutting action, zinc-coated brass wires are used while for more accurate applications, molybdenum wires are used.

The process is used in the following areas:

- Aerospace, Medical, Electronics and Semiconductor applications
- Tool & Die making industries.
- For cutting the hard Extrusion Dies
- In making Fixtures, Gauges & Cams
- Cutting of Gears, Strippers, Punches and Dies
- Manufacturing hard Electrodes.
- Manufacturing micro-tooling for Micro-EDM, Micro-USM and such other micro-machining applications.
The Subsystems of Wire EDM

- Power supply.
- Dielectric system.
- Wire feeding system.
- Positioning system.

The power supply and di-electric system used in WEDM is very similar to that of the conventional EDM. The main difference lies only in the type of dielectric used.

In wire cut EDM, a moving wire electrode is used to cut complex outlines and fine details in the required workpiece. The wire is wound on a spool and is kept in constant tension. The drive system continuously delivers the fresh wire on-to the work area. New wire is continuously exposed to the workpiece hence the wear of the wire (tool) is not the major issue in WEDM process. The wire feeding system consists of a large spool of wire and rollers which direct the wire through the machine. The presence of metal contact provides power to the wire and guides it further in-order to keep it straight throughout the cutting process. The other parts are the pinch rollers which provide drive and wire tension, a
system to thread the wire from the upper to the lower guide and a sensor to detect when the wire runs out or breaks.

**Process Parameters in WEDM**

The process parameters that can affect the quality of machining or cutting or drilling in WEDM process are shown through an Ishikawa cause-effect diagram as shown in fig.3.11.3. The major parameters are as follows:

- Electrical parameters: Peak current, pulse on time, pulse off time and supply voltage and polarity.
- Non-electrical parameters: Wire speed; work feed rate, machining time, gain and rate of flushing.
- Electrode based parameters: Material and size of the wire.
- Dielectric System: Type, viscosity, and other flow characteristics

**Fig. 3.11.3 Ishikawa Cause and effect Diagram for EDM**