CO2	**Appreciate the principle of Non-conventional machining process**		
M 2.01	Describe the significance of non-conventional machining process and their classification.	3	Understanding
M 2.02	Illustrate various non-conventional machining processes.	10	Understanding
M 2.03	Demonstrate the applications, advantages and limitations of various non-conventional machining processes.	4	Applying
	Series Test – I	1	

Contents:

Non-conventional Machining Processes: Introduction – need- classifications- brief overview Ultrasonic Machining-principle, -Description of equipment, applications- Electric Discharge Machining: Principle, Description of equipment, Dielectric fluid-tools (electrodes)-applications-Wire cut EDM: Principle, Description of equipment- applications- Abrasive Water Jet Machining- principle, description of equipment, application; Laser Beam Machining: principle, description of equipment, application- Electro Chemical Machining-comparison

CHAPTER 1: NON CONVENTIONAL MACHINING

In conventional machining the cutting tool is in direct contact with the workpiece and removes workpiece material in the form of chips.

There are situations where these processes are not suitable for the following reasons.

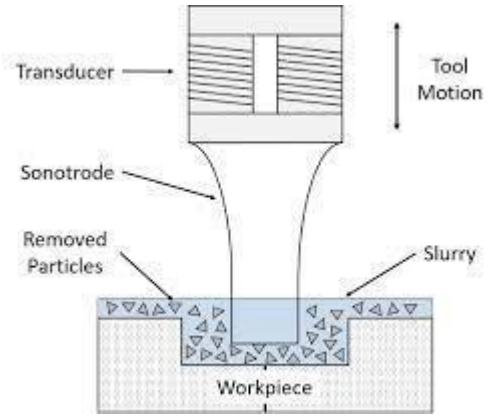
- The hardness and strength is very high
- The workpiece is flexible and delicate to withstand the cutting force
- The shape of the part is complex
- Residual stresses in the workpiece are undesirable

These requirements led to the development of modern machining processes and are generally referred to as non-conventional or non-traditional methods of machining

1. Mechanical process
   a) Ultrasonic machining (USM)
   b) Abrasive Water Jet Machining (AWJM)
2. Thermal processes
   a) Electrical-discharge machining (EDM)
   b) Laser beam machining (LBM)
3. Electrical processes
   a) Electro-chemical machining (ECM)

1) ULTRASONIC MACHINING(USM)

Principle: -In this process, metals particles are removed by using abrasive grins which are made to hits on the work piece by a tool vibrating at ultrasonic frequency.



Process: -

Components used: - 1. Oscillator with output amplifier

2. Transduce
3. Tool holder
4. Tool
5. Work fixture
6. Circulating system for abrasive

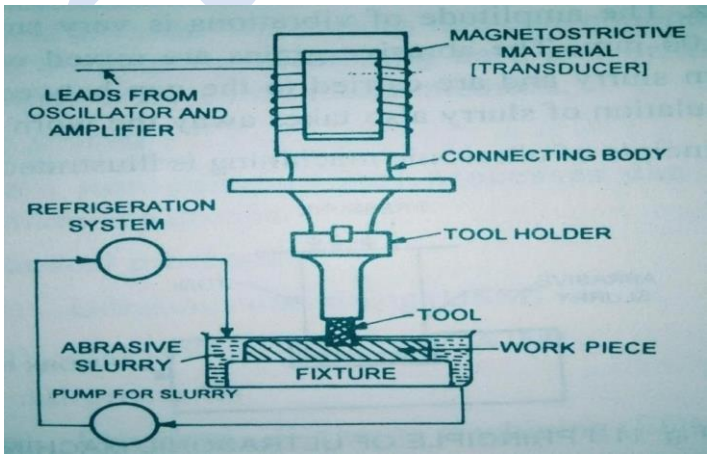
Power supply - 50 Hz

Frequency of vibration- 15 to 30 kHz

Tool - Steel/brass/Cu

Abrasive - Boron carbide/Silicon carbide

Refrigeration system to cool the abrasive slurry



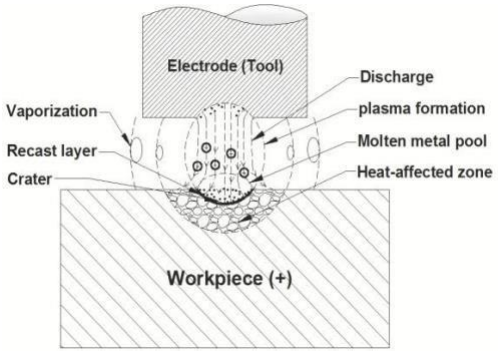
Applications: Drilling, Cutting screw threads etc

Advantages: - No heat is generated during machining, Ability to machine hard materials, It is a distortion-less process, Good surface finish, Complex shape can be machined, Conducting as well as non-conducting materials can be machined

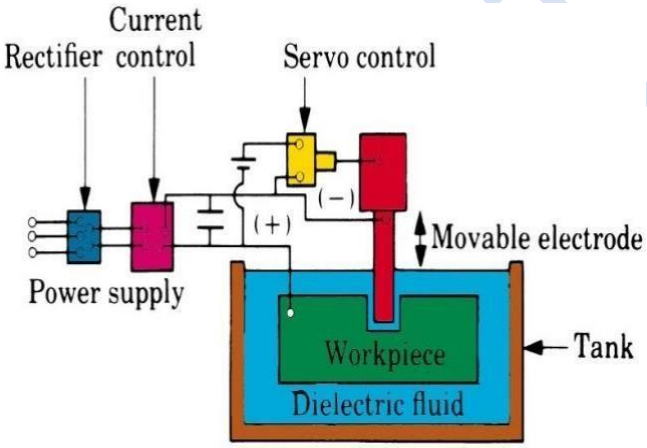
Disadvantages: - Cannot remove a large amount of material, Maximum metal removal rate is 3 mm^3/s, Power consumption is high, Tooling cost is high, Abrasive slurry needs to be replaced periodically Difficulty to machine deep holes

2) ELECTRICAL DISCHARGE MACHINING(EDM)

Principle: -Also known as spark erosion. In this process, the metal is removed by the intense heat of the electric spark by the process of vaporization. The spark is generated because of the gap between the tool and work



Process:-



Components: -Work table

Tool (Cu, Al) Servo motor (for controlling tool movement) Tank Tool holder

Dielectric fluid (Kerosine) D.C power supply Pump

Applications: -Drilling, Machining, Making complex shapes

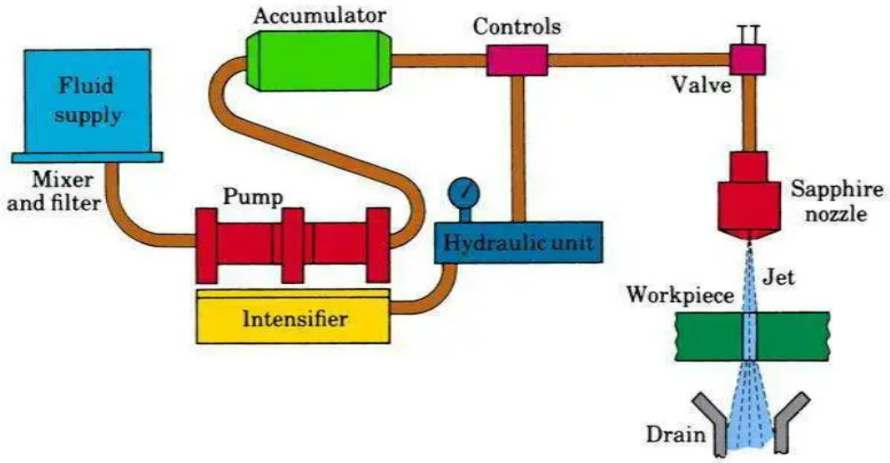
Advantages: -Harness is not a problem, High surface finish, Tool and work does not contact, Complicated parts can be made

Disadvantages: -Low metal removal rate, Costly, High-power consumption

3) ABRASIVE WATER JET MACHINING(AWJM)

Principle: - This process works on basic principle of water erosion. In this process, a high speed well concentrated water jet is used to cut the metal. It uses kinetic energy of water particle to erode metal at contact surface. The jet speed is almost 600 m/s. It does not generate any environmental hazards.

For cutting hard materials, abrasive particles are used in water jet These abrasive particles erode metal from contact surface.



Process: -

Components used: -

Hydraulic Pump:

In the water jet machining process, a **hydraulic pump** is used to pump the water from storage tank for machining process. It is connected by an electric motor of about 100 Horsepower.

Hydraulic Intensifier:

As the name implies, it is used to increase the water pressure for further process. Hydraulic intensifier accept water from pump at a small pressure about 4 bar. The water pressure at outlet of intensifier is about 3000-4000 bars.

Hydraulic Accumulator:

Hydraulic accumulator is used when large amount of pressure energy is required for an instant. It used to eliminate pressure fluctuation It supplies fluid at high pressure when required.

Tubing System:

Tubes are used to supply high pressure water to the nozzle for further cutting process. It increases the kinetic energy of fluid. Its diameter is about 10-14 mm. It provides flexible movement and does not allow any significant loses.

Flow regulator:

Flow regulators are used to regulate the flow according to cutting requirement. For high cutting load, high pressurized water is supplied at high rate.

Abrasive:

Abrasive particles are used in abrasive water jet machining for machine hard material. Generally Aluminium oxide, Silicon carbide etc. used as abrasive particles.

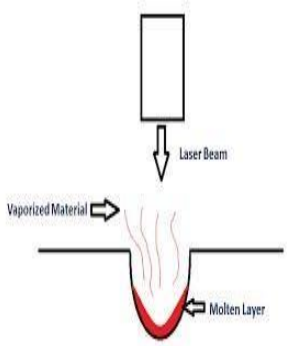
Applications: -Drilling, Machining materials like glass, quartz, mica etc., manufacturing electronic devices

Advantages: - High surface finish, it can machine heat sensitive materials, It is free from vibration, Initialization cost is low, Thin section can be machined

Disadvantages: - Low material removal rate, Nozzle life is limited, Abrasive particle cannot be reuse in this process, it cannot use for machine soft and ductile material

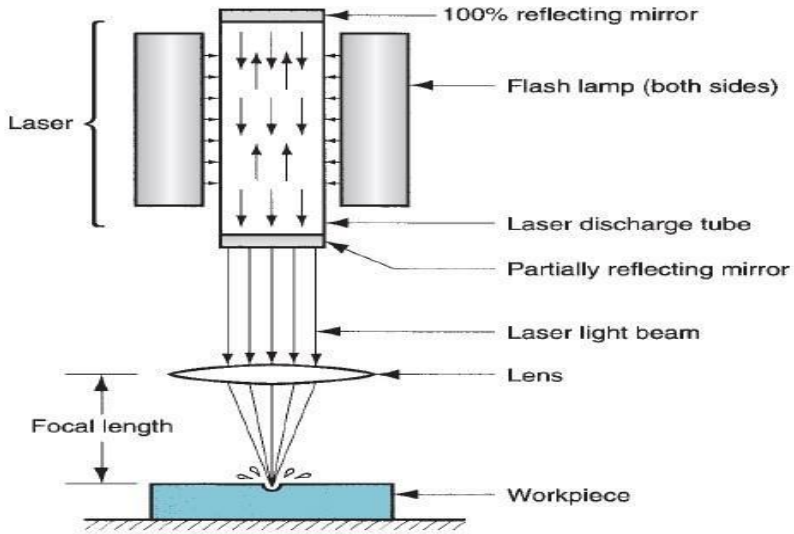
4) LASER BEAM MACHINING(LBM)

Principle: -Laser means light amplification by stimulated emission of radiation. When a laser material is placed in the presence of some energy source, It absorbs energy at some extend and release when it reaches its absorbing limit. This laser beam can be used for cutting materials.



Process: -

Components used: -Laser material, Flash lamp, Mirrors, Lens, discharge tube



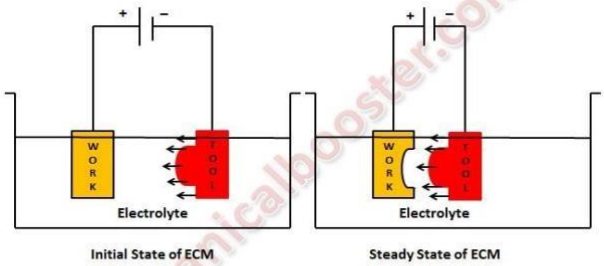
Applications: -Drilling, Electronics industry, Automotive industry, Aero space industry

Advantages: -Hardness is not a problem, Can be used for all types of materials, No tool is used, High accuracy, Flexible

Disadvantages: -High capital cost, High maintenance cost, Safety problems

5) ELECTRO CHEMICAL MACHINING(ECM)

Electrochemical Machining process, the combination of electrical energy and chemical energy makes the removal of material from the surface of a workpiece. It works on the principle of Faraday's law of electrolysis.

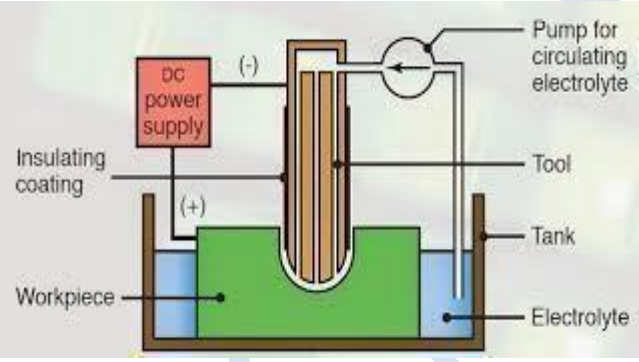


Working Principle of Electrochemical Machining

Principle: -Based on the principle of Faraday's law of electrolysis. High rate of electrolyte movement in the tool work gap help to remove the metal.

Process: -

Components used: -Work piece (Anode),Tool(Cathode),Electrolyte(NaCl or KCl),Pump(For circulating the electrolyte),Tool(Al, Cu, Brass, Bronze),Power supply(D.C)



Working of Electrochemical Machining (ECM) Process:

The electrolyte is pumped to the work region by the pump via a filter, pressure gauge, flow meter and finally, it enters the work region from the passage. When the Power supply is given, an optimum gap is maintained between the tool and workpiece because of Faraday's laws of electrolysis, the ions have started displacing from the workpiece and trying to deposit over the tool. Before the ions are depositing on the tool, the electrolyte present between tool and workpiece is pumped out. Then, the ions also moving along with electrolyte without depositing on the tool.

From the above, the mechanism of material removal is Ion displacement and because there is no disturbance taking place in the tool, the same tool can be used for producing an infinite number of components. Hence, we can say that the wear ratio of the tool is infinity(because of no tool wear)

Applications: -Machining of turbine blades, Die sinking, Grinding, Drilling, Micro machining

Advantages: - Hardness is never a limitation, High degree of surface finish, Tool and work not in contact

Thin section can be machined, Complicated shape can be machined, Compatible with CNC

Disadvantages: - Metal removal rate is low, only suitable for electrically conducting material, High heat is produced, Excessive tool wear, Power consumption is high