CH-01 NON- TRADITIONAL MACHINING PROCESS

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1.INTRODUCTION:-

Conventional Machining Process:-

Conventional machining processes mostly remove material in the form of chips by applying force on the work material with a wedge shape cutting tool that is harder than the workpiece under machine condition.

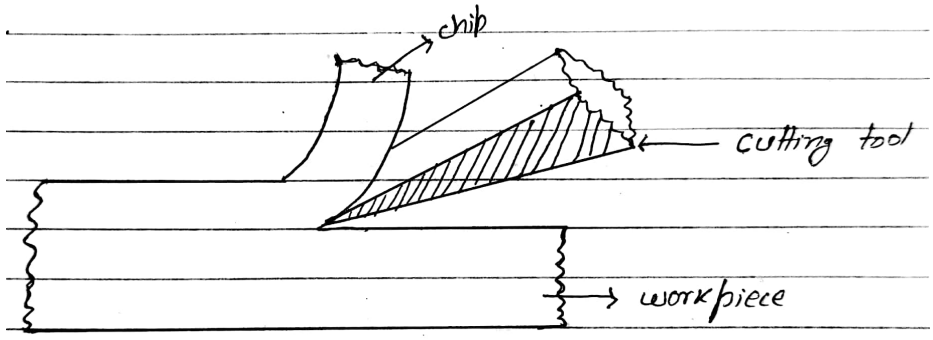

Fig:- 01

Non traditional machining process:-

Non traditional machining process:-Non traditional machining process defined as a group of process that remove excess material by various techniques involving mechanical, thermal ,electrical or chemical energy or combination of this energies. But do not use a sharp cutting tool as it need to be used for traditional machining process.

Need of non-traditional machining process:-

1. To machine the exotic materials those were difficult to machine by conventional machining processes.

2.To fulfill the requirements of new age like innovative design, tighter tolerances and micromachining.

3. To overcome difficulty to machine the material.

4. To fullfill the requirement of low stresses grinding.

5. To obtain complex shapes.

6. Drilling deep hole with small hole diameter.

7. Machining of composite.

Comparison between traditional and non traditional machining process:-

Traditional Process	Non traditional process
1.In this process for machining the tool and work must be in contact with each other. 2.Machinability depends on hardness of the work material. 3.Excess tool wear in this process because of direct contact with workpiece. 4.Simple shapes can be machind easily. 5. MRR is high.	1. In this process for machining no need for contact between tool and work. 2. Machinability depends on process parameters like current, voltage, temperature ,reaction. 3. As compared to traditional process less tool wear because no contact with work. 4. Complex shapes can be machied easily. 5. MRR is low.

Classifications of non traditional machining process:-

Classification is done on the basis of the type of energy used in working zone for material removal action.

1.Mechanical Energy:-

a) Abrasive jet machining. (AJM)

b) Water jet machining.(WJM)

c) Ultrasonic machining. (USM)

2. Thermo electrical energy:-

a) Electric discharge machining.(EDM)

b) Wire cut EDM (WEDM)

c) Laser beam machining.(LBM)

d)Plasma arc machining.(PAM)

e) Electron beam machining.(EBM)

3. Electro chemical energy:-

a) Electro chemical machining.(ECM)

4. Chemical energy:-

a) Chemical machining.

2) Mechanical energy based process:-

a) Abrasive jet machining (AJM):-

In this machining process the process of material removing takes place due to impingement of abrasive particles with high velocity on the work surface, due to this localized impact of abrasive particles the Workpiece material gets fracture, due to brittle fracture which is responsible for removal of material.

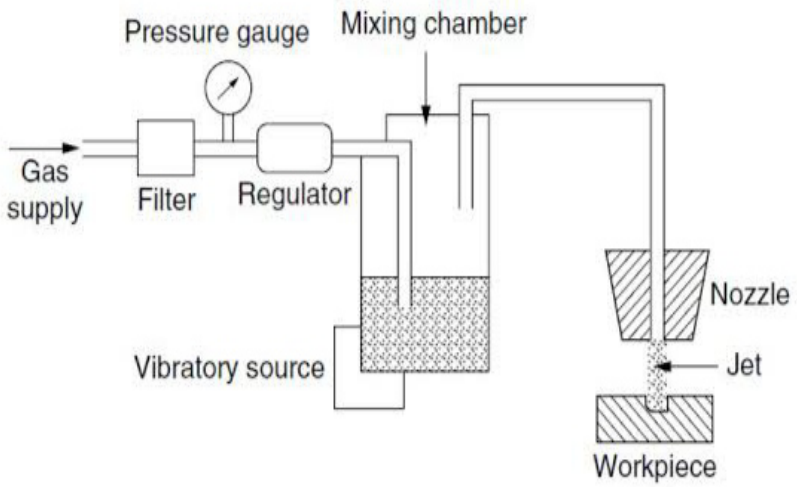

Fig:-02

Working :-

A typical set-up of abrasive jet machining is shown in Fig.. The abrasive particles are held in the hopper through which it is fed Into the mixing chamber. A regulator controls the flow of abrasive particles. Gas at high pressure is supplied to the mixing chamber through a pipeline . A pressure gauge and a regulator is incorporated in the pipeline to control the gas flow and its pressure. The mixing chamber, the abrasive particles is vibrated by the device and the amplitude of thesevibrations controls the flow of abrasive particles. These abrasive particles travel through the hose and enter into the nozzle . The control valve and pressure gauge controls the flow of abrasive particles. This outgoing high speed steam that comes out of the nozzle is known as abrasive jet.When such jet impinges on theworkpiece, the erosion caused by their impact enables the removal of metal. Lbs aa

Process parameters:-

1. Abrasive material used is Aluminium oxide or silicon carbide or sodium bicarbonate the grain size should be 10 to 50 micro metre.

2. Pressure of gas 2-10 atm and gas used is air, nitrogen, CO2.

3. The nozzle must be of hard material like tungsten carbide.

Application:-

1. Find drilling and cutting thin section of metal.

2. The process is made the used for surface etching.

,3. Fasting and abrading of glass articles.

4. Machining of brittle materials like glass, ceramic, refractories etc.

b) Water jet machining (WJM):-

Water Jet Machining (WJM) also called water jet cutting, is a non-traditional machining process in which high-velocity jet of water is used to remove materials from the surface of the workpiece. WJM can be used to cut softer materials like plastic, rubber or wood. In order to cut harder materials like metals or granite, an abrasive material is mixed in the water. When an abrasive material is used in the water for the machining process than it is called Abrasive Water Jet Machining (AWJM).

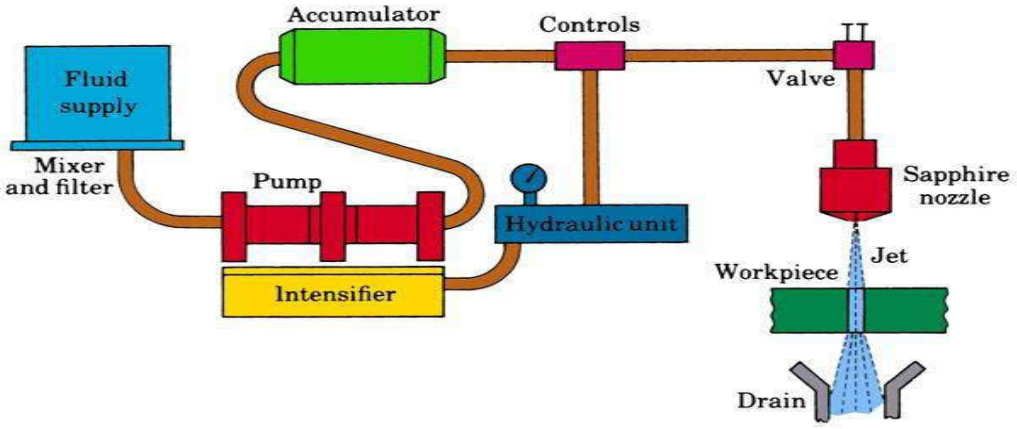

Fig:-03

WORKING:-

First water is filled in water reservoir. It provides water for cutting operation.

A pump sucks water from water reservoir and send it to intensifier.

Intensifier increases the water pressure from 4 bar to 4000 bars. It sends water to accumulator which store some pressurize water.

This high pressure water now sends through tubing system to nozzle. The water passes through flow regulator valve which regulate the flow.

Now this high pressure water enters into nozzle. Nozzle converts some pressure energy of water into kinetic energy.

A high speed high pressurize water jet is available at nozzle exit.

This water jet send to strike at work surface. It erode metal from the contact surface. Thus metal removal take place.

APPLICATION:

1.It is used in aerospace industries.

2.Abrasive jet machining is used to cut hard metal like stainless steel, titanium, Inconel etc.

& It is used to machining or cutting reinforced plastic.

3.Use to cut stone which reduce dust in environment.

4.Used to machining PCB.

C) Ultrasonic machining (USM):-

Brittle fracture of workpiece material due to ultrasonic impact of abrasive grain.The term ultrasonic refers to waves of high frequency, generally above the hearing range of normal human ear, i.e. generally above 20 kHz. In this process, a cutting tool is gives mechanical vibration so that it oscillates axially at high frequency in abrasive slurry against the stationary workplece.The tool has the same shape as the shape to be machined. The impact of the abrasive cause the metal removal from the workpiece. This method is generally used to machine hard and brittle materials.

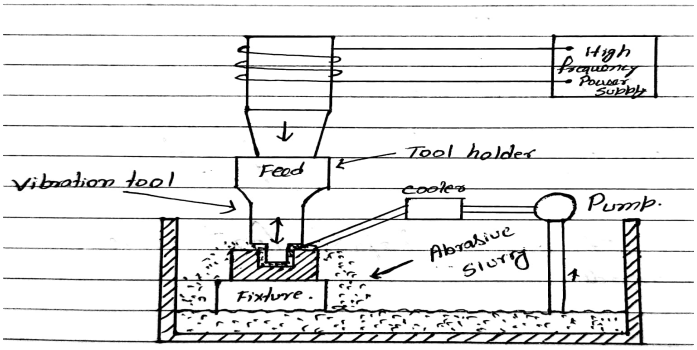

Fig:- 04

Working:-

In this process a soft ductile material tool is allowed to vibrate at very high frequency and at a constant flow of abrasive slury is maintained in the gap between tool and workpiece. Due to vibrating tool, the impact of tool which are coming on the abrasive grain are going to be transferred to the workpiece material. This vibrating impact of abrasive grain on the work surface is responsible for brittle fracture of the work material. The constant flow is also helping in removal of fractured work material.

Application:-

1. Cutting internal threads in ceramic and glasses by rotating the workpiece

2. Cutting of industrial diamonds.

3. Manufacturing of wire drawing, punching and blanking dies.

4. Coining of glass and ceramics.

2) Thermo electrical energy based process:-

a) Electric discharge machining (EDM):-

EDM works on principle that heat energy is generated by a spark is used to remove material from the workpiece. Also known as spark erosion. It is the process of material removal based on the principle of erosion of metal by an interrupted electric Spark discharge between electrode tool (cathode) and workpiece (anode).

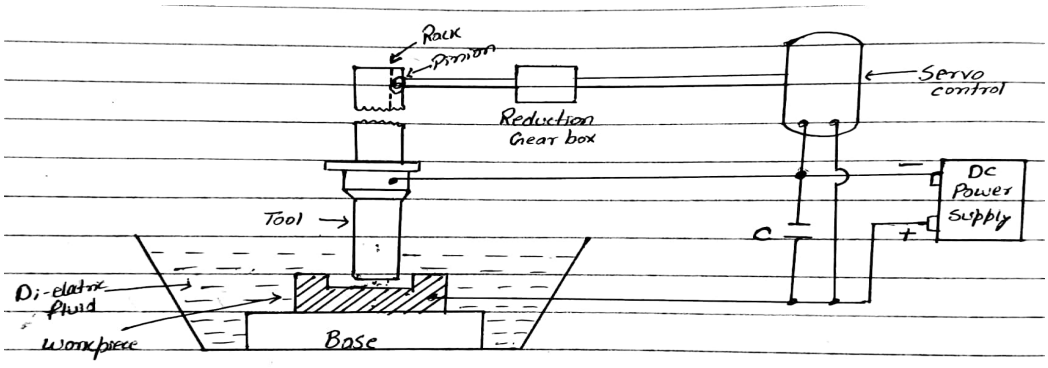

Fig:-05

Working:-

In this process both the tool and workpiece are immersed in dielectric fluid. The workpiece is connected to positive terminal and tool is connected to negative terminal. The tool end is brought near the workpiece by a servo motor. Asmall gap of about 0.1 to 0.5 mm is maintained in between tool and Workpiece. When a difference of potential is applied between two conductors the dielectric fluid will ionise . The potential difference reaches at high ,Spark will occur.The repetitive Spark release its energy in the form of heat and melts the metal.

Dielectric fluid:-

1. It acts as a conducting medium when ionised and conveys the spark.

2. It flushes out the eroded particles from the working gap.

3. It cools the Spark region and keeps the electrode and workpiece cool.

Characteristics of di- electric fluid:-

1.It should have high dielectric strength so it does not breakdown electrically.

2. Should have low viscosity.

3. It should have controlled level of toxicity.

4. It should have high fluidity.

5. It should be cheap and easily available.

Ex:- Kerosene oil, distilled water, mineral oil etc.

Process parameters:-

1. Spark gap:- keeping the spark gap at constant value. If the gap increases MRR gets slower and poor surface finish is obtained.

2. Supply voltage and current:- it ranges between 0.5A to 400 A and 50V to 400V DC supply.

3. Resistance and capacitance:- Increase in capacitance will result in increase of material removal rate and decrease in resistance will result in increase of metal removal rate.

4. Pulse duration:- The pulse duration ranges from 2 to 2000 micro second. Decrease in pulse duration will result in high tool wear. Increase in pulse duration result in lower MRR.

5. Spark frequency:- It is about 1000 spark/sec. The increase in spark frequency result in

improved surface finish.

Application of EDM:-

1. It is extensively used for machining exotic materials used in aerospace industry, refractory materials, hard carbide and Harden Steel.

2. For drilling micro holes in fuel injector nozzles.

3. In tool making. example:- Press tool, Extrusion dies, forging dies and moulds.

4. For producing intricate and irregular shaped profile.

b) Wire cut EDM (WEDM):-

Electric discharge wire cutting is a process of producing complex 2D and 3D shapes using a simple wire eroding the material from an electrically conducting material.

The electrode wire is typically made of copper or brass with a 0.05 to 0.25mm diameter which is wound between the two spools. The wire moves past the workpiece at fast rate up to 3 m/minute. The Spark is struct between the moving electrode wire and Workpiece, there by removing the material. The dielectric most commonly used is a deionised water applied as a localised stream rather than submerging the whole workpiece.

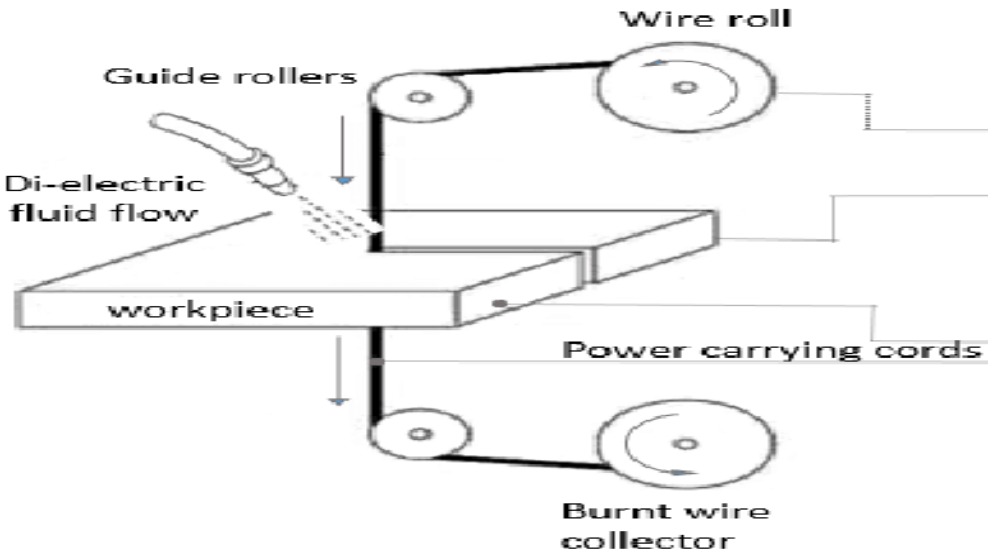

Fig:-06

Process parameters:-

1. Discharge current:- The wire being small in diameter and cannot carry current more than 30A .Material removal rate increases with the increasing current.

2. Pulse duration:- increase in first relation result in more removal of material and reduce surface roughness.

3. Pulse frequency:- MRR increases with the increases pulse frequency. This result in better surface finish.

4. Wire diameter and wire speed:- the world diameter should be uniform otherwise it will affect the intensity of spark. The wire speed is in range 0.5 to 150 mm/sec. The cutting rate depends upon the thickness of workpiece.

5. Wire tension:- A series of tension roller is provided to keep the required tension. The wire tension is 50%-60% of its tensile strength.

6. Di-electric flow:- The supply of dielectric fluid should be continuous. It should have low viscosity and high cooling rate.

Applications:-

i) Punches and dies used in press tools can be made.

ii) For the production of moulds and dies.

iii) Used to cut out complex contours in electrically conductive work pieces.

iv) Simple, flat shapes, which usually would be stamped, may be a job for wire EDM when

they require a superior quality edge.

v) Cylindrical pins as small as 5 mm in diameter can be machined.

c) Laser beam machining (LBM):-

In this process, material is removed by melting and vaporization due to heat produced from conversion of kinetic energy of photons from laser beam. In this laser is generally used which is generated by using Ruby crystal.

A Xenon coiled tube is placed around a Ruby rod and the complete system is placed inside a

container with internal surface highly reflecting. Through a triggering circuit a flash is produced in xenon tube which directly or indirectly falls on the Ruby rod and due to this Ruby rod gives laser beam. This emitted laser beam is further focused using a lens system to meet the work surface at a point the heat so produced is responsible for instant melting of work material.

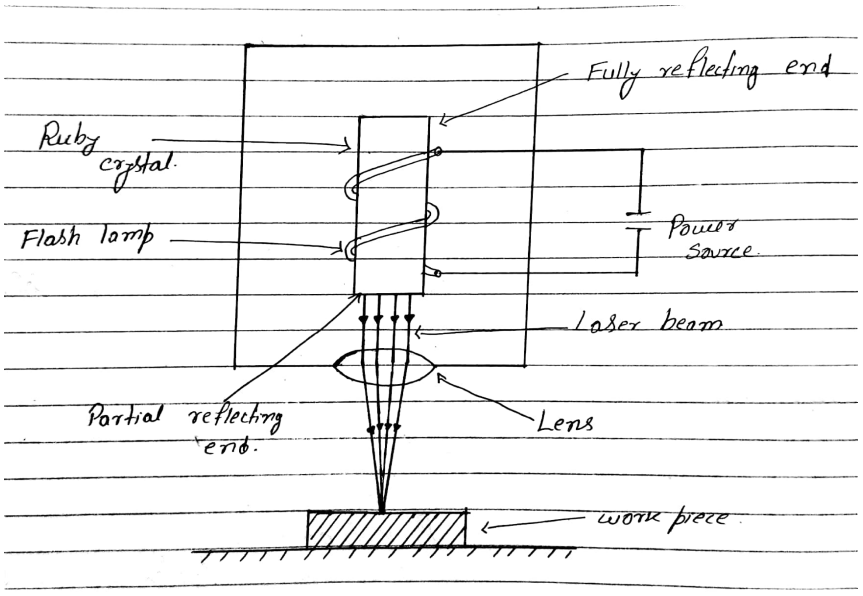

Fig:-07

Working of solid state laser:-

Solid state laser are laser based on solid state gain medium such as crystalline Ruby. The crystalline Ruby is used for laser action. It is Aluminium oxide doped with chromium ions impurities. Chromium ions concentration is about 0.05%. The chromium plays an important role for laser beam production. Chromium absorb any radiation it receives. Flash lamp surrounding the Ruby road produces light. This light excite the chromium ions of Ruby crystal to high energy level , while on return journey to the normal state this excited ions at high energy level release the photons . This desired energy is obtained in the form of short duration pulse.

Process parameters:-

a) Focal length:- The workpiece should be placed closed to the lens for machining. If focal length is less, straight hole will be produced.

b) Flash lamp:- It operates at a rate of 12 flashes every single minute. It should be kept warm to obtain maximum efficiency.

c) Power density:- For machining operation the power density should be higher (1.5×10^7 w/ cm2).

Applications of LBM

i) Drilling holes in surgical needles, diamond wire drawing dies, nylon buttons etc.

ii) Cutting or engraving patterns on thin films.

iii) Trimming of sheet metal and plastic parts.

iv) Non-circular holes can be machined with the aid of CNC

v) It is also used for welding of metals.

d) Plasma arc machining (PAM):-

When gases are heated to a temperature above 5500°C , they are partially ionized and exit in the form of mixture of free electrons, positively charged ions and neutral atoms. This mixture is termed as plasma. The heat content of plasma is responsible for melting of work material. The plasma Jet heat up the workpiece where the jet impinges, causing a quick melting.

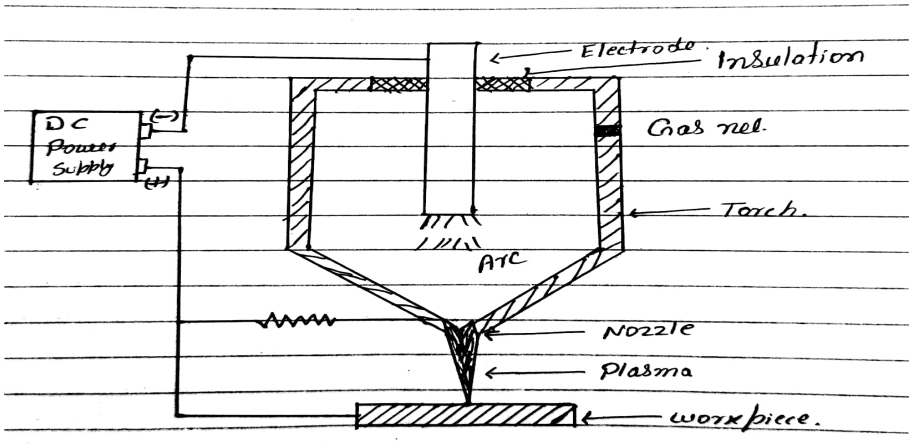

Fig:-08

Working:-

The plasma is generated by subjecting a flowing gas to the electrons bombardment of an arc. For this arc is set up between electrode and anodic nozzle. The gas is supposed to flow through this arc and the high velocity of electrons of the arc collide with the gas molecules causing ionization. These ionised particles and free electrons recombined into atoms and then to molecules this gives rise to exothermic reaction. Due to this the temperature of gas increases and when it comes out through the nozzle plasma jet is obtained. The temperature in this plasma is responsible for melting while the velocity of plasma is responsible for plastic action of molten material.

Process parameters:-

1. Stand off distance:-The stand of distance depends on the thickness of the metal to cut. Typical value of stand up distance varies from 5 mm to 10 mm.

2. Cutting speed:- Increase in cutting speed reduces the depth of immersion of the plasma jet ,leading to narrowing of the cut in lower portion, whereas, decrease in the cutting speed will cause the opening of the cut at the bottom.

3. Power supply:- A DC power supply of 400 V ,200 KW and upto 1000 A is supplied yo the nozzle.

4. Gas supply:- The flow rate of gas is directly proportional to the thickness of the material.

Application:-

i) For stock cutting ,plate beveling, shape cutting and piercing.

ii) In manufacture of automotive and rail load components.

iii) it can cut hot extrusion to desired length.

e) Electron beam machining (EBM):-

Electron beam machining is a thermal process used for metal removal during the machining process. In the electrical beam machining, electrical energy is used to generate the electrons with high energy. In the Electron Beam Machining process, a high velocity focused beam of electrons are used to remove the metal from the workpiece. These electrons are traveling at half the velocity of light i.e., 1.6 x 10^8 m/s. This process is best suited for the micro cutting of materials.

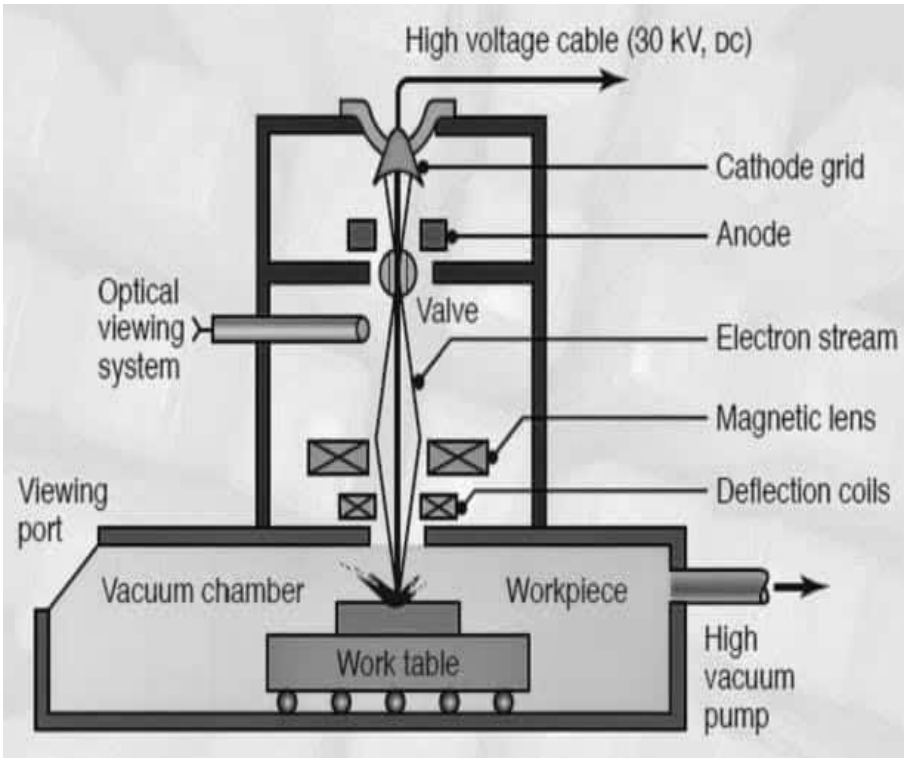

Fig:-09

WORKING:

1.In EBM, first the electron is generated by the cathode and an annular biased grid does not allows the electron to diverge.

2.From the annular bias grid, the electron produced by the cathode is attracted towards the anode and gradually its velocity increases. As the electron beam leaves the anode section, its velocity reaches to half of the velocity of the light.

3.After that, it passes to the series of magnetic lenses. The magnetic lenses allows only convergent beam to pass through it and captures the divergent beam from the fringes. And then a high quality electron beam is made to pass through the electromagnetic lens and deflector coils.

4.The electromagnetic lens focuses the electron beam to the desired spot on the workpiece. The deflector carefully guides the beam to the desired locations and improves the shape hole.

APPLICATION:

1.Used for making turbine blades for supersonic aero engines.

2.It is also used to manufacture field emission cathodes, integrated circuits, and computer memories.

3. Used for making drawing dies and flow orifices.

4.Used for frilling synthetic jewels in the watch industry.

5.Used for micro-machining of thin materials

3) Electro Chemical energy:-

a) Electro chemical machining (ECM):-

This process is based on reverse electrolysis process. In this process the removal of material takes place due to ion displacement. According to the principle of electrolysis the flow of current through any electrolyte is always accomplished with dissolution of matter.

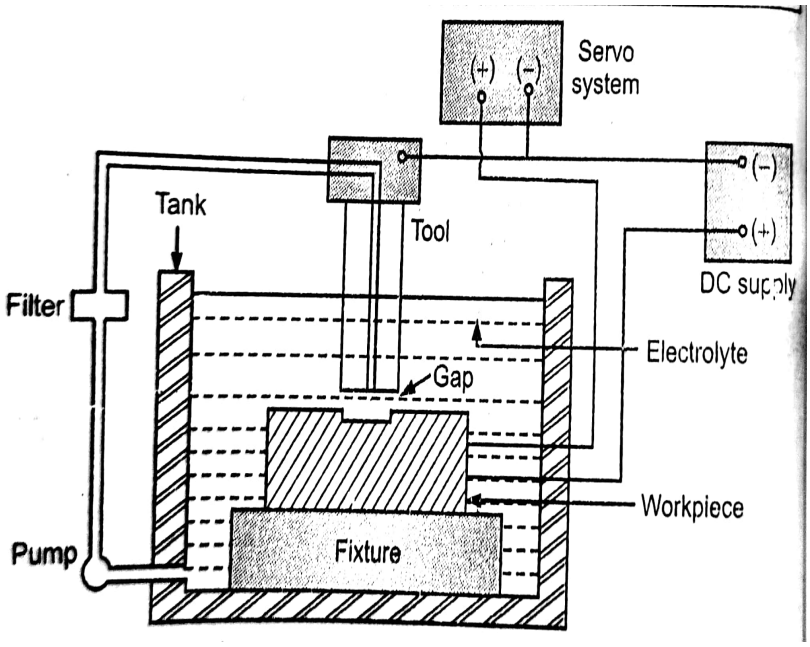

Fig:-10

Working:-

The objective in electrolysis is to deposit material on the workpiece ,while in ECM our objective is to remove material from the workpiece. That is why the Workpiece is made anode and tool is made cathode. When current of high ampere and low voltage is supplied through the electrolyte. The dissolution of anode occurs, however dissolution occurs at both the electrode but dissolution rate at anode is high and it is proportional to the gap between workpiece and the tool. The first dissolution occurs when the gap is minimum and after sometime replica of tool shape is going to be developed on workpiece.

Process parameters:-

i) voltage :- 2 to 35 V (DC)

ii) Current:- 50 t0 40000A

iii) Working gap:- 0.1mm to 2mm

iv) Electrolyte temperature:- 20° to 50° C

v) Electrode material:- copper, brass and bronze.

vi) Electrolyte:- Sodium chloride, Sodium nitrate , potassium nitrite.

Application:-

1) It can be used for die-sinking operations.

2) Drilling a jet engine turbine blade.

3) Multiple hole drilling.

4) Steam turbine blades can be machined within close limits.

4) Chemical machining:-

Chemical machining is the oldest of the non-traditional processes. It was based on the observation that chemicals attack metals and etch them, thereby removing small amount of materials from the workpiece.This process is carried out by using reagents or etchants, such as acids and alkaline solutions. The mechanism is to use chemical reaction between the material of the workpiece and some chemical reagent, so that the products of the reaction can be removed easily. Thus, the surface of the workpiece is etched away, exposing the lower layers, and the process is continued until the desired amount of material is removed.

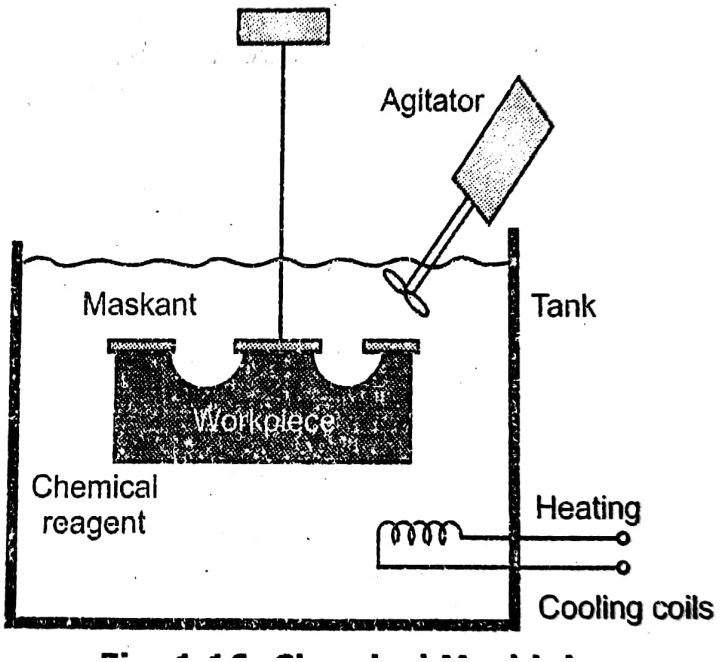

Fig:-11

Working:-

1. Cleaning :- In the cleaning process, the workpieces are cleaned to remove oil, grease, dust, or any substance from the workpiece so that further processing can be completed properly.Cleanings are necessary to ensure proper adhesion of masking material to the workpiece. In the case of masking debugging, stray Etching occurs.

2 .Masking :-Masking is done using masking. These masks are inert in nature and do not react with the chemicals used in the machining process. The masked to be used should be an easy stripe mask. In this masking process, the parts of the workpiece that are not machined are masked using a mask so that the machined part is exposed to the chemical used in the machining process.

3. Scribing:- After the masking process, masking is performed to remove from the area of

the workpiece that is to be mechanized so that a chemical reaction can occur on that part of the workpiece. After the scribe process, only those areas that are to be mechanized are exposed to chemical machining.

4. Etching:- After filtering the workpiece, it is immersed in a container containing a chemical that undergoes a chemical reaction with the workpiece. When the workpiece is immersed inside the chemical, the area that is masked does not undergo any chemical reaction, and the area that is not masked undergoes a chemical reaction with the chemical and the material unmasked area of the workpiece. I will start moving away from it.The etching process is usually performed at an elevated temperature

5. Demasking:- After the etching process, the masks are removed from the area of the workpiece, which is not mechanized, and the oxide layer is also removed from the area of the workpiece, which is mechanized.

6. Washing:- After the demasking process, the workpiece is thoroughly rinsed under fresh water to completely remove any substances, etc., from the surface of the workpiece.

Application:-

1) Shallow cavities produced on plates, sheets, forgings, and extrusions.

2) Chemical milling used in the aerospace industry for parts like wings.

3) To produce decorative surfaces on elevator doors, ashtrays, panels, instrument dials etc.

4) Process is also used for microelectronic devices like computers, television, electric mot

telephone system, medical instruments etc.

5) To produce special geometric shapes on radar reflectors, heat exchangers etc.