Course Code: 1960340 **Roll No:** **MLRS-R19**

MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)
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III B.Tech II Sem Regular End Examination, June 2022

Unconventional Machining Processes
(Mechanical Engineering)

Time: 3 Hours. **Max. Marks: 70**

Note: 1. Question paper consists: Part-A and Part-B.
2. In Part – A, answer all questions which carries 20 marks.
3. In Part – B, answer any one question from each unit.
Each question carries 10 marks and may have a, b as sub questions.

PART- A

(10*2 Marks = 20 Marks)

1.	a)	Write briefly about the recent developments in unconventional machining processes?	2M	CO1	BL1
	b)	Classify different modern machining processes?	2M	CO1	BL2
	c)	What do you mean by deburring process?	2M	CO2	BL1
	d)	Write about the economic aspects of electro chemical machining processes?	2M	CO2	BL1
	e)	Enumerate the applications of wire EDM process?	2M	CO3	BL2
	f)	Write about the mechanics of metal removal in EDM Process?	2M	CO3	BL1
	g)	Write the applications of water jet machining.	2M	CO4	BL2
	h)	What materials can be machined by using Laser Beam?	2M	CO4	BL1
	i)	Write the applications of electro stream drilling?	2M	CO5	BL1
	j)	Write the significance of using maskant in chemical machining process?	2M	CO5	BL1

PART- B

(10*5 Marks = 50 Marks)

2	a)	Explain in detail the effect of amplitude, frequency of vibration and abrasive grit size on material removal in ultrasonic machining?	5M	CO1	BL4
	b)	Differentiate the conventional and unconventional machining processes in terms of principles?	5M	CO1	BL2
		OR			
3		Explain in detail the feed mechanisms in ultrasonic machining and state some applications of ultrasonic machining?	10M	CO1	BL4
4	a)	Explain in detail the construction and working of electro chemical honing process and state its advantages and limitations?	5M	CO2	BL4
	b)	With the help of a neat sketch explain the construction and working of electro chemical machining process?	5M	CO2	BL4
		OR			

5		Explain in detail the construction and working of abrasive water jet machining process and state its advantages and limitations?	10M	CO2	BL4
6	a)	Explain the characteristics of spark eroded surface and machine tool selection in electric discharge machining process?	5M	CO3	BL4
	b)	Explain in detail the process parameters in electric discharge grinding process and state it advantages and limitations?	5M	CO3	BL4
		OR			
7		Write the principle and construction of wire EDM process and state its advantages and limitations?	10M	CO3	BL1
8	a)	Explain in detail the quality of machining and surface finish obtained using laser beam machining?	5M	CO4	BL4
	b)	Explain the principle of laser beam production and state the advantages and limitations of laser beam machining process?	5M	CO4	BL4
		OR			
9		Explain in detail the metal removal mechanism, process parameters, surface finish of electron beam machining process?	10M	CO4	BL4
10	a)	With the help of a neat sketch explain the construction of shaped electrolyte machining?	5M	CO5	BL4
	b)	Explain the principle and working of CHM. Mention any four advantages, limitations and applications of CHM.	5M	CO5	BL4
		OR			
11		With the help of a neat sketch explain the process of metal removal in plasma machining and state its applications and limitations?	10M	CO5	BL4

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EXAMINATION BRANCH

Academic Year	2021-22
Year & Semester	IIIrd IIsem
Regulation	R19
Branch	MECH
Course Code	1960340
Course Name	Unconventional machining Processes
Course Faculty's	K.Chaithanya
Course Moderator	K.Chaithanya
Date of Exam	22/06/22
Reporting Time & Sign	8.40

KEY PAPER

QNO	ANSWER	MARKS
1. a)	**Write briefly about the recent developments in Unconventional machining processes?** There are many new unconventional process which are developing buy changing the parameters . many composite materials are been machined. The accuracy of the components to be manufactured is improved.	
b)	**Classify different modern machining process?**	

Classification of Modern Machining Processes

Type of energy	*Mechanism of metal removal*	*Transfer media*	*Energy source*	*Processes*
Mechanical	Erosion	High velocity particles	Pneumatic/ hydraulic pressure	AJM, USM, WJM
	Shear	Physical contact	Cutting tool	Conventional machining
Electrochemical	Ion displacement	Electrolyte	High current	ECM, ECG
Chemical	Ablative relation	Reactive environment	Corrosive agent	CHM
Thermoelectric	Fusion	Hot gases	Ionized material	IBM, PAM
		Electrons	High voltage	EDM
	Vapourization	Radiation	Amplified light	LBM
		Ion stream	Ionized material	PAM

C)**What do you mean by deburring process?**

Deburring is the process of removing the small imperfections known as burrs from machined metal products

d)Write about the economic aspects of electro chemical machining processes?

It is cheap .
Running cost is low.
Accuracy of the tool will be obtained on the work piece

e)Enumerate the applications of wire EDM Process?

Prototype production.
Automotive parts.
Aerospace parts.
Medical devices for implantations.
Prototypes.
Small hole drilling.
Blanking punches.
Extrusion dies.

f)Write about the mechanics of metal removal in EDM Process?

Fundamentally the electro-sparking method of metal working involves an electric erosion effect which connotes the breakdown of electrode material accompanying any form of electric discharge, (The discharge is usually through a gas, liquid or in some cases solids)

g**) write the applications of water jet machining?**

Water jet machining is used in various industries like mining, automotive and aerospace for performing cutting, shaping and reaming operations.
It is even used in food industry.

h)**what are the materials can be machined by using laser Beam?**

Ceramics
plywood
polycarbonate

polyethylene
Perspex
Titanium
Gold
Copper
Aluminium

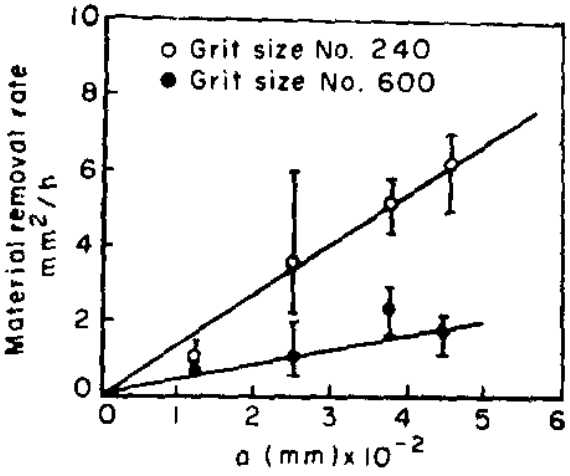
i)Write the applications of electro stream drilling?

Drilling rows of cooling holes in turbine blades and vanes.
• Machining of oil passages.
• Machining of fuel nozzles.
• In EDM drilling oil passages within the bearings can cause cracks.
• Drilling regular arrays of holes in corrosion-resistant metals of low machine

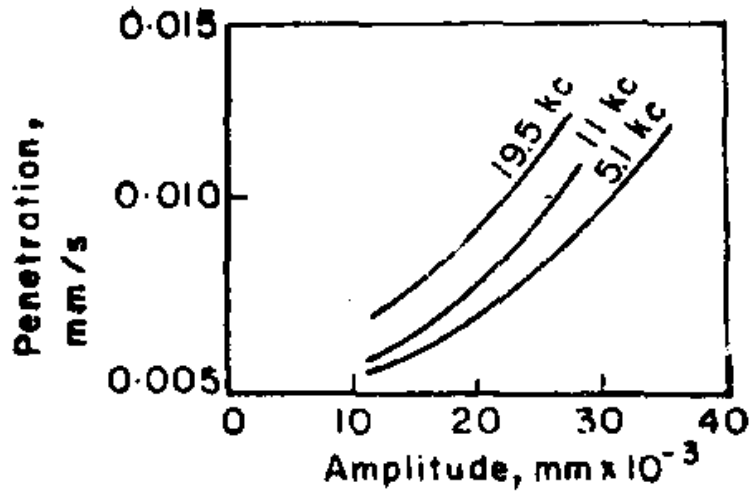
j) **write the significance of using maskant in chemical machining process?**

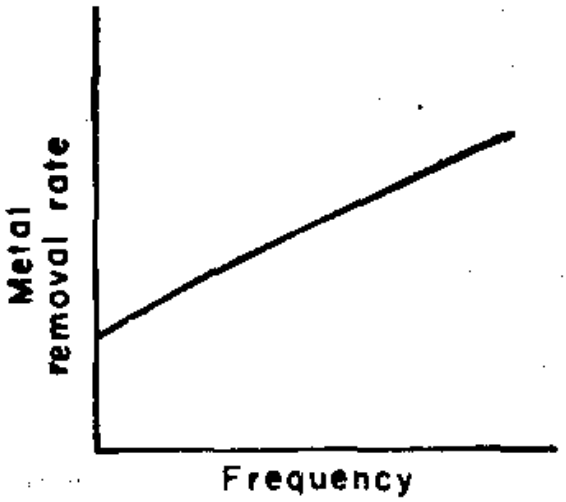
Maskant is used to protect the work piece from not to be machined. It will be used where machining is not necessary

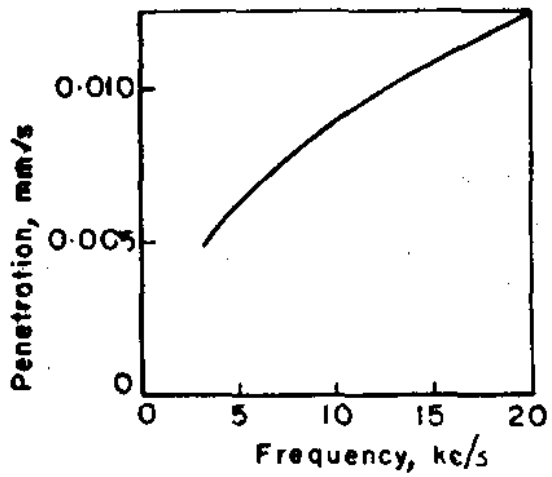
2.a) Explain in detail the effect of amplitude , frequency of vibration and abrasive grit size on material removal in ultrasonic machining?
(Fig 2M)

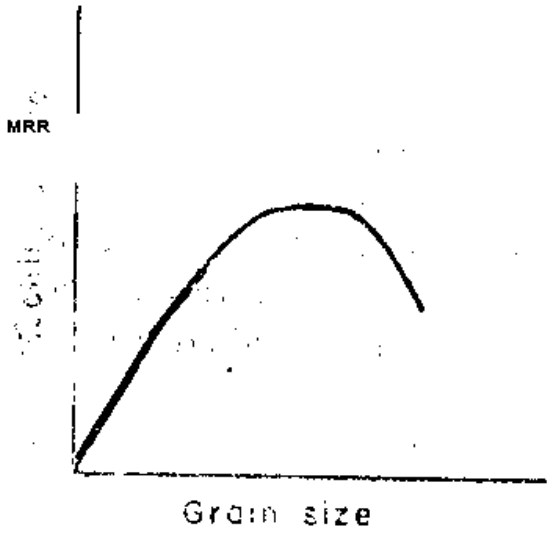


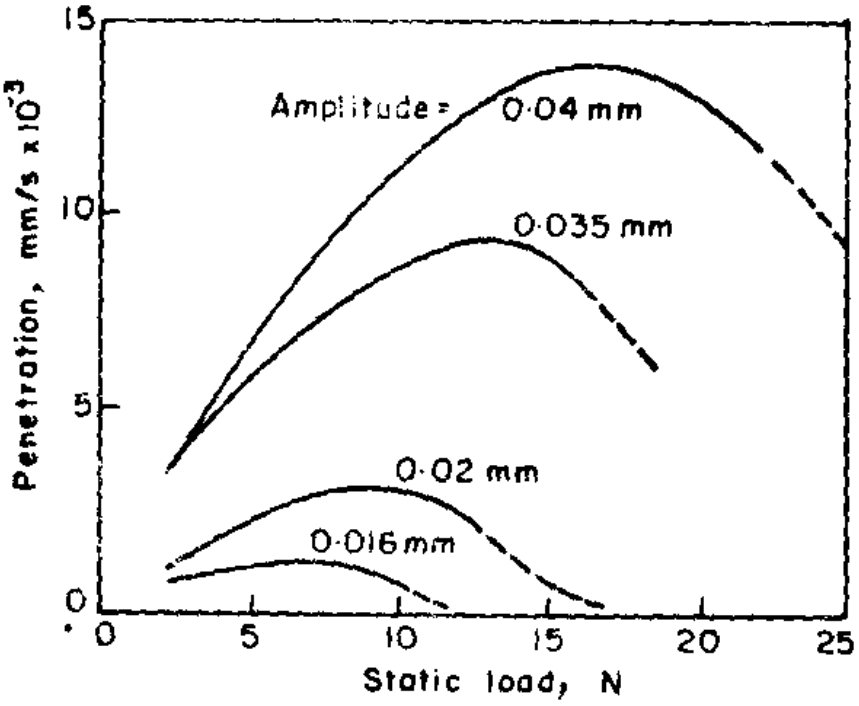
Relation between amplitude vibrations and material remov rate. Abrasive: Boron carbid Frequency: 25 kc/s; Tool mat rial: Ketos; Work material: Steel


0·015
0·010
0·005
Penetration, mm/s
19.5 kc
11 kc
5.1 kc
0
10
20
30
40
Amplitude, mm x 10⁻³


Metal removal rate
Frequency


0·010
0·005
0
Penetration, mm/s
0
5
10
15
20
Frequency, kc/s





Relation of the above graphs need to be written

QNO	ANSWER	MARKS

2b) differentiate the conventional and unconventional mshing process in term of principle.

Conventional machining process involves the direct contact of tool and work piece, whereas unconventional machining does not require the direct contact of tool and work piece. Conventional machining process has lower accuracy and surface finish while non-conventional machining has higher accuracy and surface finish

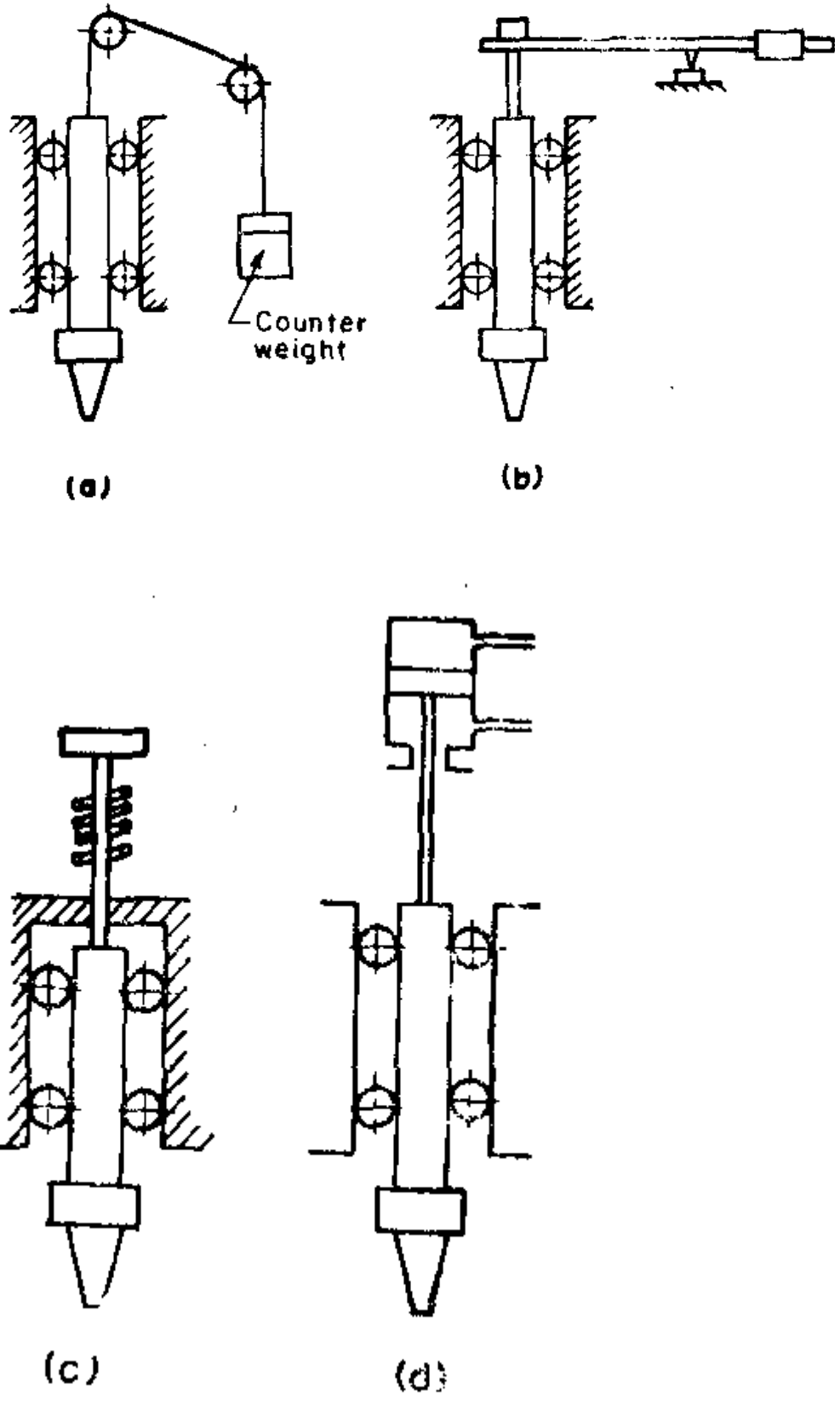
Conventional	Non-Conventional
Direct contact of tool and workpiece.	Tools are non-conventional technique like Laser beam, electric arc, etc.
Cutting tool is always harder than w/p.	Tool may not be harder and it may not be physical presence.
Tool life is less due to high wear.	Tool life is more.
Generally Macroscopic chip formation.	Material removal occurs with or without chip formation.
Material removal takes place due to application of cutting force.	It uses different energy like electrical, Thermo-Chemical etc. to provide machining.
Suitable for all material.	Not suitable for all material.
It cannot be used to make a prototype parts very effectively.	It can be used to produce a prototype parts very effectively

3) explain in detail the feed mechanisms in ultrasonic machining and state some applications of ultrasonic machining

(Fig 3M)

The feed mechanism must perform the following functions

- Bring the tool very slowly close to the work piece
- Provide adequate cutting force and sustain this during cutting
- Decrease the force at the specified depth
- Return the tool



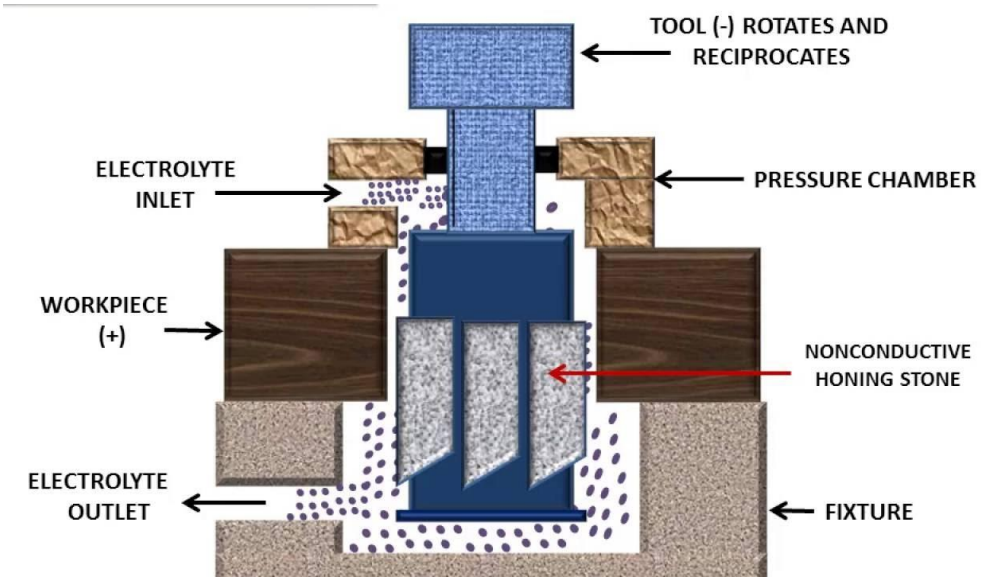
In systems shown in fig (a) & (b) counter weights are used. The force is adjusted through weights

- Figure (c) shows a compact spring loaded system which is quite sensitive

· For high rating machines, pneumatic or hydraulic systems are used (Fig (d))

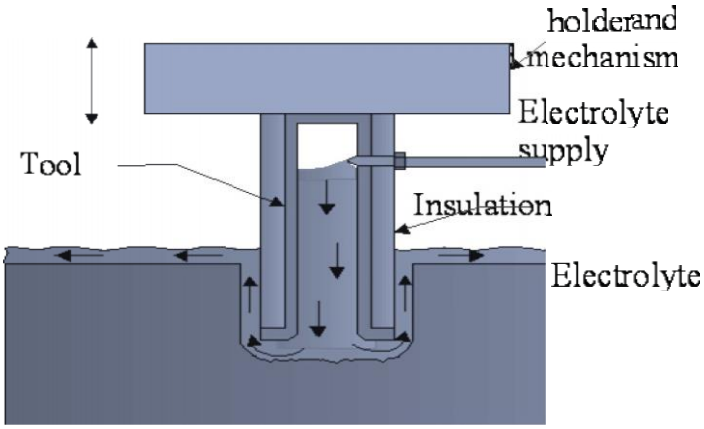
4a) Explain in detail the construction and working of electro chemical honing process and state its advantages and limitations.
(Fig 2M)

Electrochemical honing is one of the non-equilibrium gap processes in ECM and is a new technique, which in spite of being used in some industrial plants especially to smooth surfaces, is stillnot fully described due to the variety of the factors affecting the process. More information about the process is required especially the effects of the working parameters on the produced surface roughness. A special honing tool was designed by using different tool tip shapes (rectangular, circular, triangle & inclined) to study the ability for improving the surface roughness. This work presents a study for the factors affecting the electrochemical honing process especially the machiningtime, work piece material, initial working gap, tool rotational speed, tool tip shape and the inclined tool tip angle. The results are finally furnished with the aim to generalize a useful guideline for the user to enable proper selection of conditions for obtaining good surface quality.



4b) with the help of a neat sketch explain the construction and working of electro chemical machining process?
(Fig 3M)

Electrochemical machining (ECM) is a metal-removal process based on the principle of reverse electroplating. In this process, particles travel from the anodic material (workpiece) toward the cathodic material (machining tool). A current of electrolyte fluid



carries away the depleted material before it has a chance to reach the machining tool. The cavity produced is the female matingimage of the tool shape.

Figure:ECMprocess

Similar to EDM, the work piece hardness is not a factor, making ECM suitable for machining difficult-to –machine materials. Difficult shapes can be made by this process on materials regardless of their hardness. A schematic representation of ECM process is shown in Figure. The ECM tool is positioned very close to the work piece and a low voltage, high amperage DC current is passed between the work piece and electrode. Some of the shapes made by ECM process is shown in Figure.

Figure: Parts made by ECM

Advantages of ECM

- The components are not subject to either thermal or mechanical stress.
- No tool wears during ECM process.

- Fragile parts can be machined easily as there is no stress involved.
- ECM deburring can debur difficult to access areas of parts.
- High surface finish (up to 25 µm in) can be achieved by ECM process.
- Complex geometrical shapes in high-strength materials particularly in the aerospace industryfor the mass production of turbine blades, jet-engine parts and nozzles can be machined repeatedly and accurately.
- Deep holes can be made by this process.

Limitations of ECM

- ECM is not suitable to produce sharp square corners or flat bottoms because of thetendency for the electrolyte to erode away sharp profiles.
- ECM can be applied to most metals but, due to the high equipment costs, is usually usedprimarily for highly specialized applications.

Material removal rate, MRR, in ECMMRR = C .I. h (cm3/min)

C: specific (material) removal rate (e.g., 0.2052 cm3/amp-min for nickel); I: current (amp);

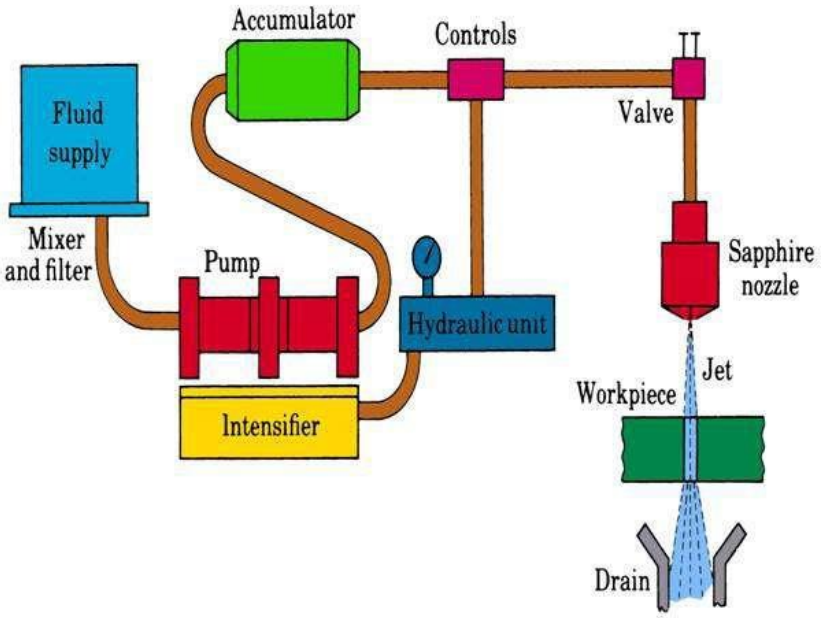
h: current efficiency (90–100%).

The rates at which metal can electrochemically remove are in proportion to the current passedthrough the electrolyte and the elapsed time for that operation. Many factors other than Current influence the rate of machining. These involve electrolyte type, rate of electrolyte flow, andsome other process conditions.

5) Explain in detail the construction and working of abrasive water jet machining process and state its advantages and limitations?

(Fig 3M)

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.



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 Horse power.

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 increase the kinetic energy of fluid. It diameter is about 10-14 mm. It provide 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.

Nozzle:
As we know, **nozzles** are used to convert pressure energy into kinetic energy. This nozzle convert high pressure of water into high velocity jet. This high speed water jet strikes at work surface which is used for machining. There is possibility of erosion at orifice of the nozzle due to high pressure water jet. Therefor high wear resistance material is used for nozzle. The size of nozzle is about 0.2 – 0.4 mm. If abrasive water jet machining is used, abrasive particles mixed in water stream before entering into nozzle.

Drain and Catcher
The drain and catcher system is used to remove debris and other machined particle form water. It separate metal particle from water and this water is further send to reservoir. It also used to reduce noise associate with WJM.

Working:
The working of water jet machining can be summarize as follow.

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.

This is whole working process of water jet machining.

Application:

It is used in aerospace industries.

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

It is used to machining or cutting reinforced plastic.

Use to cut stone which reduce dust in environment.

Used to machining PCB

6 a) Explain the characteristics of spark eroded surfaces and machine tool selection in electric discharge machining process?

(Fig 2M)

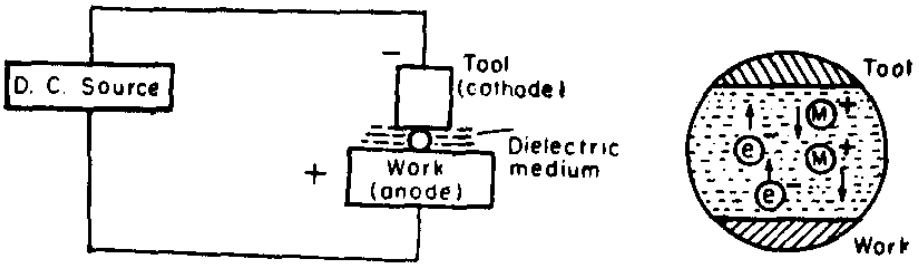
Spark erosion machining process

• Consider the case of a discharge between two electrodes (tool cathode and work anode) through a gaseous or liquid medium

- Suitable voltage is applied. The potential intensity of the electric field between them build up , until a predetermined value

• Individual electrons break loose from the surface of the cathode and impelled towards the anode under the influence of field forces.

• While moving in inter electrode space, the electrons collide with the neutral molecules of the dielectric detaching electrons from them and causing ionization.



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Ionization becomes such that a narrow channel of continuous conductivity is formed

• This results in momentary current impulse or discharge.

• This leads to generation of extremely high temperature between 8000 C and 12000 C causing fusion or partial vaporization of the metal and dielectric fluid at the point if discharge.

• This results in the formation of tiny crater at the point of discharge in the work

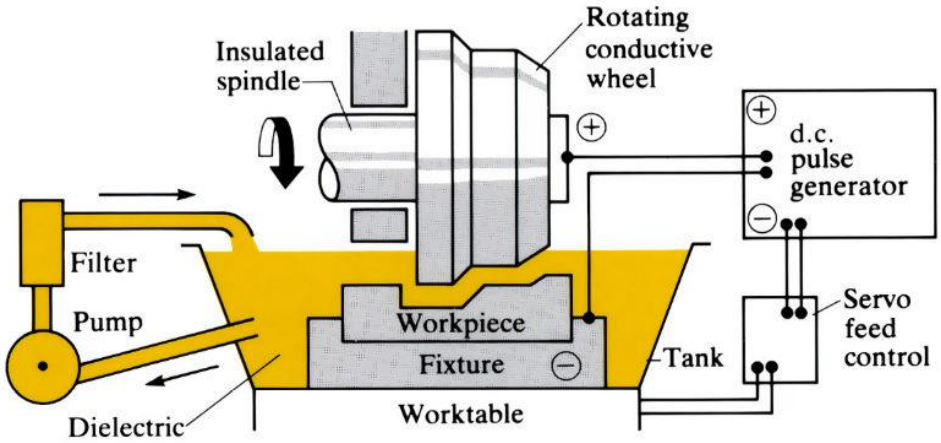
Selection of Electrode Material

Material	*Wear ratio*	*Metal removal rate*	*Fabrication*	*Cost*	*Application*
Copper	Low	High on rough range	Easy, can be sprayed also	High	On all metals
Brass	High	High only on finishing ranges	Easy	Low	On all metals
Tungsten	Lowest	Low	Difficult	High	Only where small holes are to be drilled
Tungsten copper alloys	Low	Low	Difficult	High	Used for higher accuracy work
Cast iron	Low	Low	Easy	Low	Can be used only on few materials
Steel	High	Low	Easy	Low	Can be used for finishing work only
Zinc based alloys	High	High on rough ranges	Easily die casted	Low	Can be used on all metals
Copper graphite	Low	High	Very delicate and hence difficult	High	Can be used on all metals

b) Explain in detail the process parameters in electric discharge grinding process and state its advantages and limitations.
(Fig 2M)

A workpiece made of electrically conductive material and a shaped tool are immersed in a dielectric fluid. Rapid pulses of electricity pass through the tool (+ve electrode) and the negatively charged workpiece, leading to a spark discharge. Plasma forms and, along with the sparks, vaporises the workpiece material removing material 'chips', which are then flushed away by dielectric fluid. EDG is a similar process, but the tool is replaced by a rotating conductive wheel.

Removes any electrically conducting material by high frequency sparks that arc through a dielectric fluid flowing between the negatively charged workpiece and the positively charged, tubular or solid tool. The tool is servo-controlled to give a constant spark gap, and is capable of vertical, orbital or eccentric motion, or complex combinations of all three. The dielectric fluid cools the vaporised material into "chips", which are then flushed away and filtered out. The spark produces a small crater in the workpiece with a "recast" and "heat affected" zone. These craters produce a "surface roughness" which decreases with reduced current and increased frequency. Erosion also occurs on the tool



advantages

Complex shapes that are difficult to produce with traditional cutting tools.

Extremely hard material with very tight tolerances.

For very small workpieces, traditional cutting tools may damage the parts due to excessive cutting tool pressure.

There is no direct contact between the tool and the workpiece. Therefore, fine parts and weak materials can be processed without deformation.

A good surface finish can be obtained.

Disadvantages

Material removal speed is slow.

Potential fire hazards associated with the use of fuel oil-based dielectrics.

Extra time and cost for creating electrodes for stamping/electric hammer EDM.

The power consumption is very high.

High power consumption.

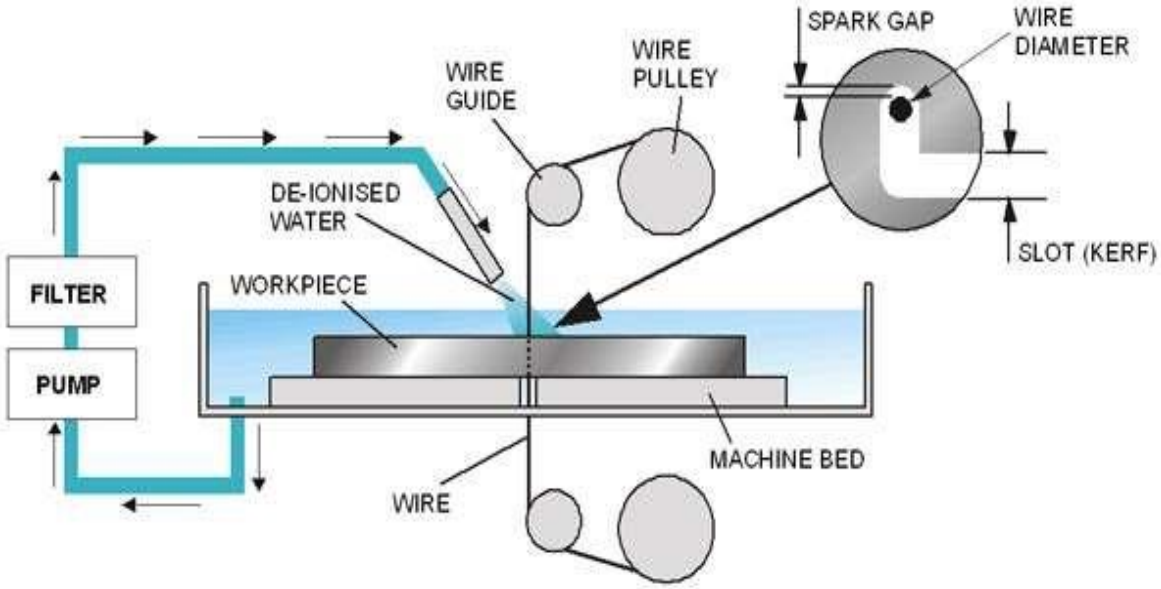
Non-conductive materials can only be processed through specific process settings

7) Write the principle and construction of wire EDM process and state its advantages and limitations?

(Fig 3M)

Wire EDM uses a traveling wire electrode that passes through the work piece. The wire is

monitored precisely by a computer-numerically controlled (CNC) system



Like any other machining tool, wire EDM removes material; but wire EDM removes material with electricity by means of spark erosion. Therefore, material that must be EDMed must be electrically conductive.

Rapid DC electrical pulses are generated between the wire electrode and the workpiece. Between the wire and the workpiece is a shield of deionized water, called the dielectric. Pure water is an insulator, but tap water usually contains minerals that causes the water to be too conductive for wire EDM. To control the water conductivity, the water goes through a resin tank to remove much of its conductive elements—this is called deionized water. As the machine cuts, the conductivity of the water tends to rise, and a pump automatically forces the water through a resin tank when the conductivity of the water is too high

When sufficient voltage is applied, the fluid ionizes. Then controlled spark precisely erodes a small section of the workpiece, causing it to melt and vaporize. These electrical pulses are repeated thousands of times per second. The pressurized cooling fluid, the dielectric, cools the vaporized metal and forces the resolidified eroded particles from the gap.

The dielectric fluid goes through a filter which removes the suspended solids. Resin removes dissolved particles; filters remove suspended particles. To maintain machine and part accuracy, the dielectric fluid flows through a chiller to keep the liquid at a constant temperature

8a)Explain in detail the quality of machining and surface finish obtained using laser

beam machining.

LBM is based on the conversion of electrical energy to light energy and then in to thermal energy. In a typical system, charged capacitors are discharged through a gas filled flash lamp with a power source of 250 w – 1000 w in order to produce and intense flash of white light. Radiation from the lamp is directed into the laser, where the light is amplified and emitted as a coherent, highly collimated beam of single wave length. This narrow beam is focused by an optical lens to produce a small intense spot of light on the work surface. Optical energy is converted into heat energy upon impact and temperatures generated can be made sufficient to melt and vaporize every known material.

Since the machining is done due to vaporization of metal at high temperature . The surface obtained is very high the tolerance which will be obtained will be good.

The finishing operations are not need due the quality of machining process. Again the finish of machining depends on what type of the laser is being is used.like solid , gases or liquid.

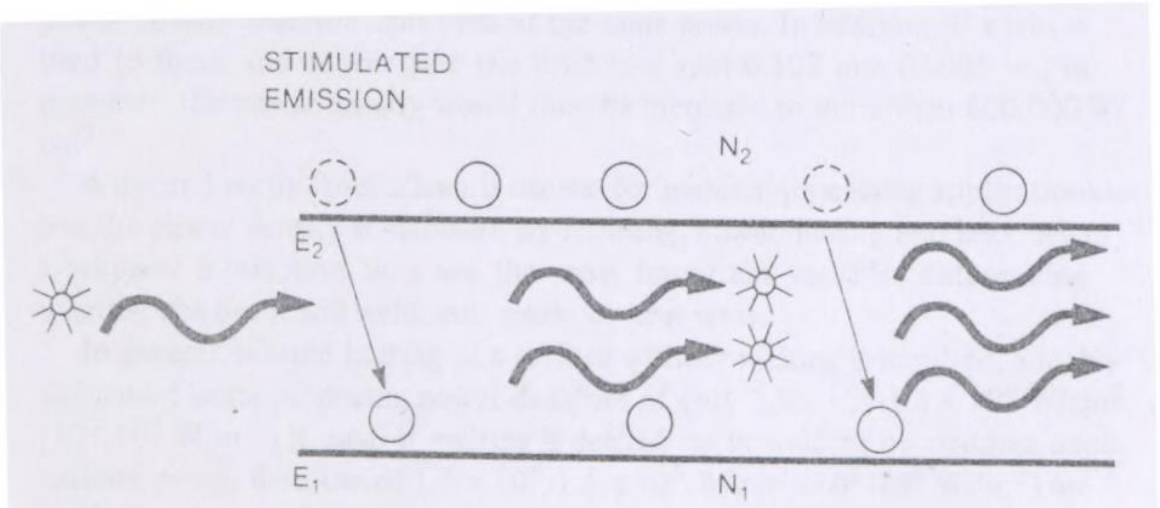


Figure 20.1 Interaction of photons and atoms to produce stimulated emission (*Source*: courtesy, Coherent General, Inc., Palo Alto, Calif.).

8b)explain the principle of laser beam production and state the advantages and limitations of LBM?

(Fig 2M)

LBM is based on the conversion of electrical energy to light energy and

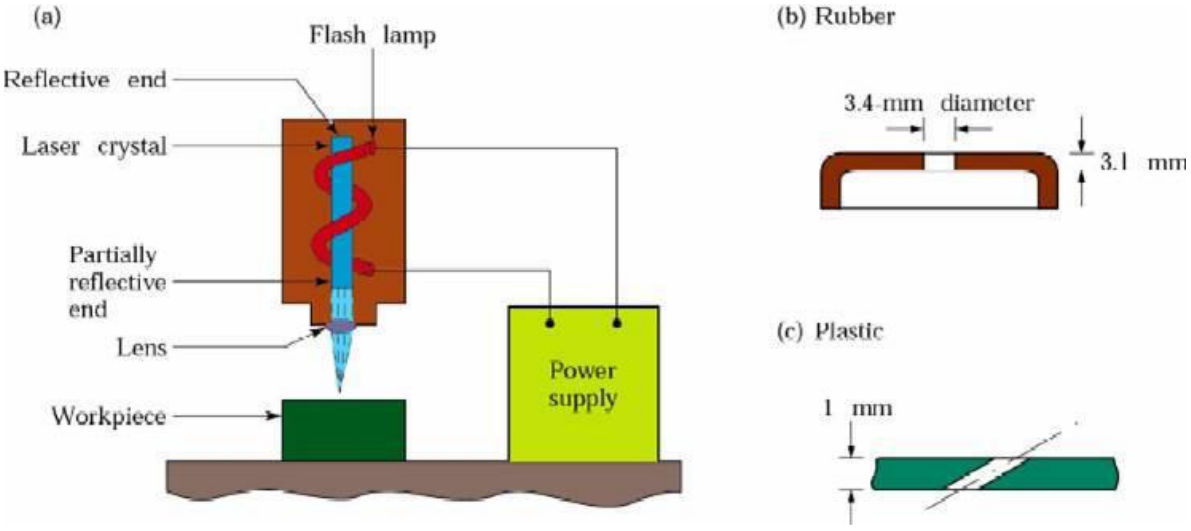
then in to thermal energy. In a typical system, charged capacitors are discharged through a gas filled flash lamp with a power source of 250 w – 1000 w in order to produce and intense flash of white light. Radiation from the lamp is directed into the laser, where the light is amplified and emitted as a coherent, highly collimated beam of single wave length. This narrow beam is focused by an optical lens to produce a small intense spot of light on the work surface. Optical energy is converted into heat energy upon impact and temperatures generated can be made sufficient to melt and vaporize every known material.

Although laser is used as light amplifier in many applications, their main use is as optical oscillators or transducers for converting energy into highly collimated, and high focused (i.e a very small divergent of less than 0.001 radian) beams of optical radiation (light). Light energy emitted by laser is very monochromatic and highly collimated and had high focused power density. Light radiated by excited electrons is in phase with the beam which initiates the radiation. As the intense light continues to travel back and forth through the laser material more and more electrons are stimulated to release their energy all in phase. As the light is reflected and moves back in the tube, it soon becomes so powerful that a ray burst from the partially reflecting end.

Many types of laser exist which produce highly directive beams of optical infra red radiation. They can be classified as solid state, gas or liquid.

Solid state units have laser rods made of any one of a number of solid materials including Ruby, Neodymium – doped glass and neodymium – doped Yttrium – Aluminium – Garnet (Called YAG), gas units has glass tubes filled with CO2, (usually a mixture of CO2, helium and nitrogen) but called CO2 Laser, Helium – Neon, Cadmium gas or Argon.

The Laser rod or tube is pumped by an energy source (Krypton, Tungsten-halogen, or Xeon – filled flash lamps) and radiant energy known as "Laser – light" is emitted from one end of the Rod or tube, laser beams may operate continuously or be pulsed, with pulse durations as short as a few billionth of a second.



ADVANTAGES

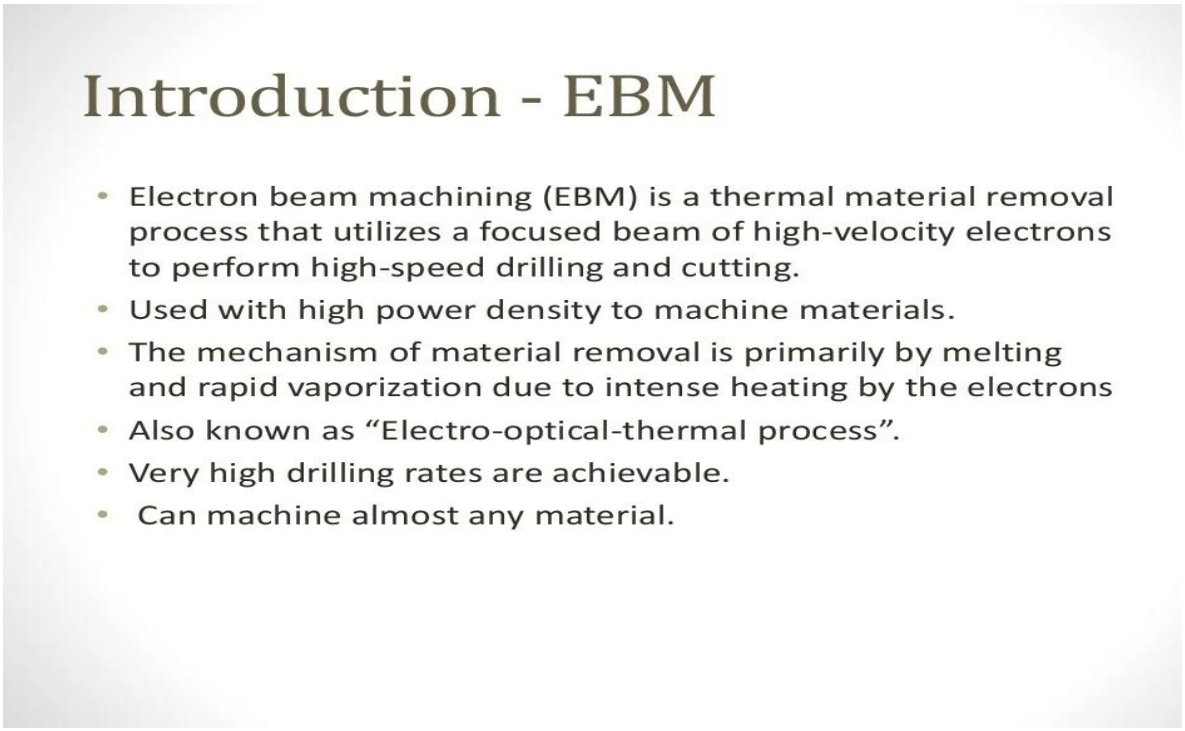
1. Any solid metal w/o decomposition can be cut
2. No contact of tool with work.
3. The Beam can be projected through a transparent window
4. Large mechanical forces are not exerted to work PC

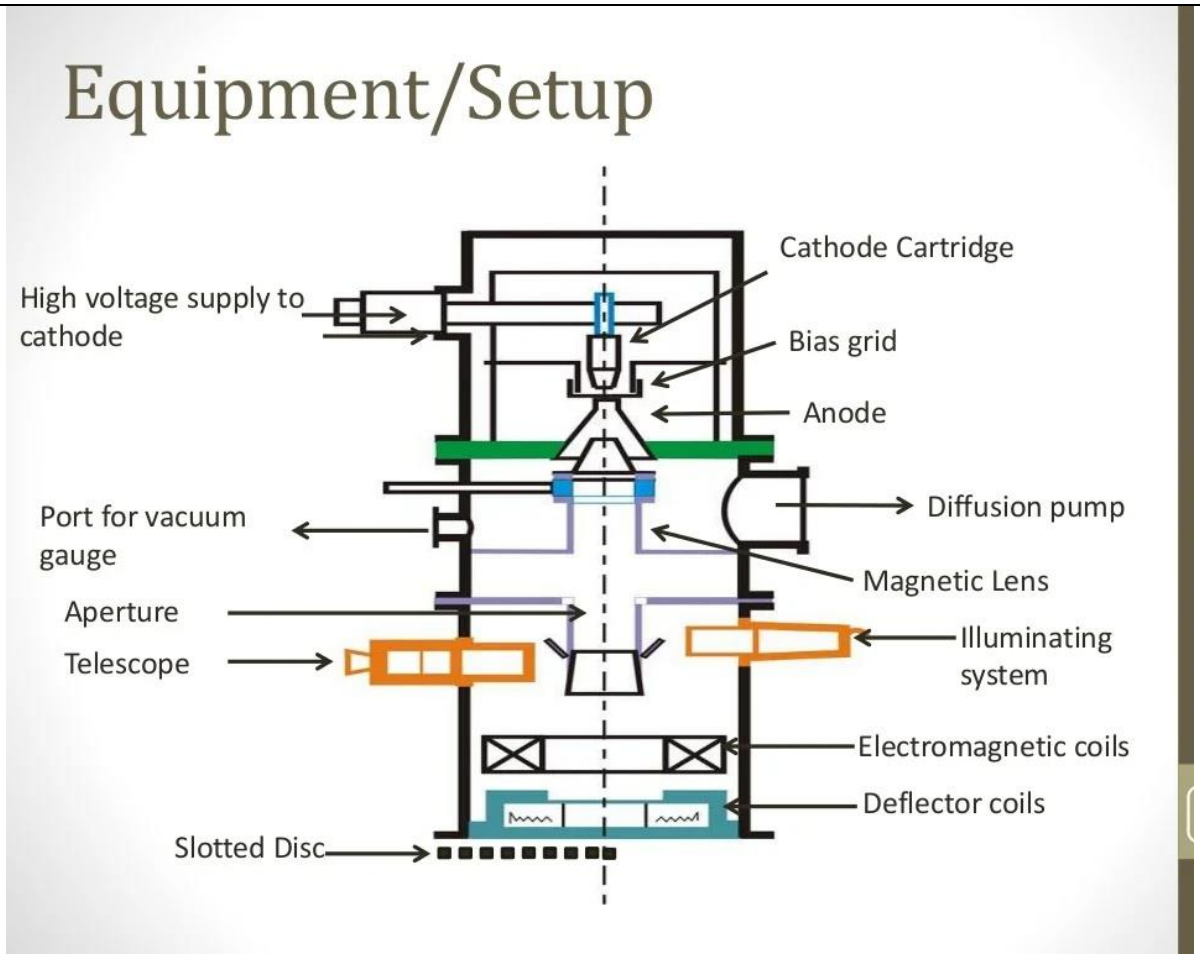
LIMITATION

- Materials with high conductivity and or reflectivity cannot be cut.
- So, Al, Cu and their alloys cannot be cut satisfactorily.
- Out put of energy of laser is different to control
- The laser system is quite inefficient.
- The least diameter which can be cut depends mainly on laser divergence.

9. Explain in detail the metal removal mechanism , process parameters , surface finish in EBM process?

(Fig 3M)





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Mechanism of material removal

- As high voltage is applied across the Cathode filament , thermo-ionic emission of electrons takes place.
- These Thermo-ionic electrons are replied by the cathode and attracted by anode through the bias grid, electrons are accelerated to the half of the velocity of the light.
- These electron/beam of electron is shaped and focused with the help of series of magnetic and electromagnetic lenses.
- Finally the electron beam impinges the workpiece.
- Upon impingement the kinetic energy of the electron is absorbed by the workpiece which will result into heating, melting and vaporization – drilling.
- Spot size – 10 to 100 microns – high energy density

Process Parameters

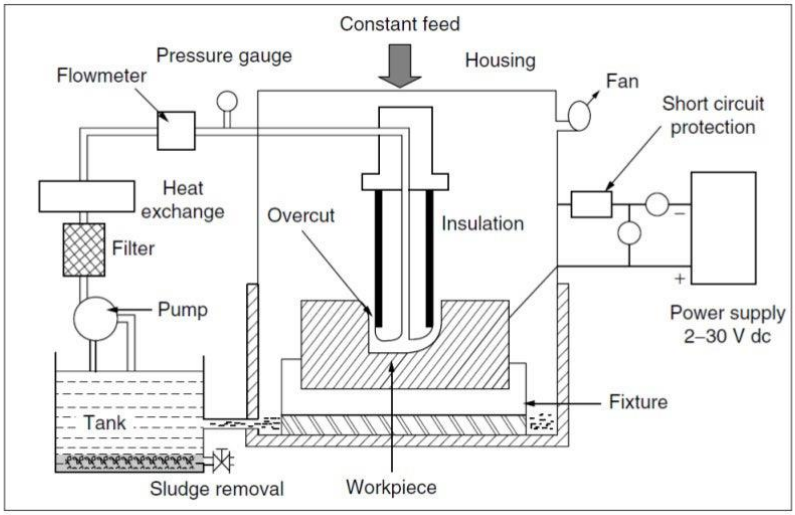
- Accelerating Voltage (V_a)– 100 KV
- Beam current (I_b)– 250 µA to 1 A
- Pulse duration (t_{on}) – 50 µs to 50 ms
- Energy per pulse – 100 J/Pulse
- Spot size - 10 µm to 500 µm
- Power Density

$$P_d = \frac{\frac{1}{2} m_e v_e^2}{\frac{\pi}{4} d_s^2} = \frac{V_a I_b t_{on}}{\frac{\pi}{4} d_s^2}$$

10 a) with the help of a neat sketch explain the construction of shaped electrolyte machining?
(Fig 2M)

Introduction

- Shaped tube electrolytic machining (STEM) is based on the dissolution process when an electric potential difference is imposed between the anodic work piece and a cathodic tool.
- Because of the presence of this electric field the electrolyte, often a sulphuric acid, causes the anode surface to be removed.
- After the metal ions are dissolved in the solution, they are removed by the electrolyte flow the tool is a conducting cylinder with an insulating coating on the outside and is moved toward the work piece at a certain feed rate while a voltage is applied across the machining gap. In this way a cylindrically shaped hole is obtained.



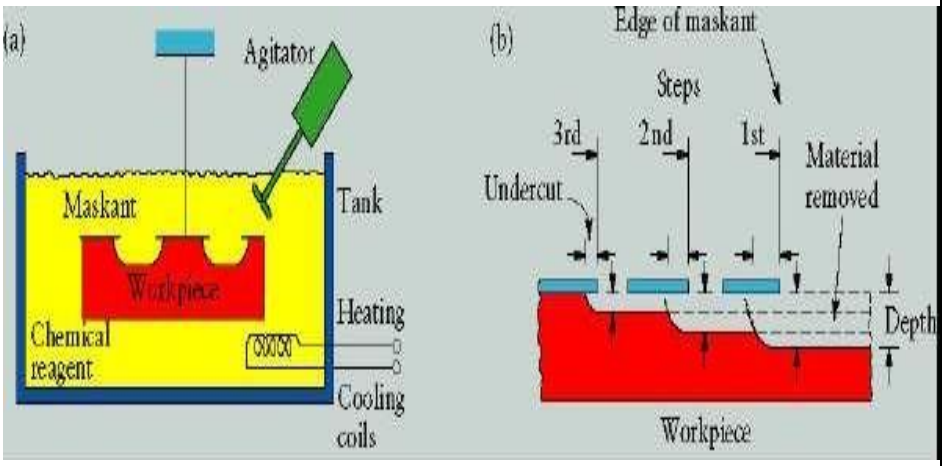
- STEM is, therefore, a modified variation of the ECM that uses acidic electrolytes.
- The process is capable of producing small holes with diameters of 0.76 to 1.62 mm and a depth-to-diameter ratio of 180:1 in electrically conductive materials.
- It is difficult to machine such small holes using normal ECM as the insoluble precipitates produced obstructs the flow path of the electrolyte.

B)Explain the principle and working of CHM . Mention any four advantages ,limitations and applications of CHM.

(Fig 2M)

CHEMICAL MACHINING

Chemical machining (CM) is the controlled dissolution of work piece material (etching) by means of a strong chemical reagent (etchant). In CM material is removed from selected areas of work piece by immersing it in a chemical reagents or etchants; such as acids and alkaline solutions.Material is removed by microscopic electrochemical cell action, as occurs in corrosion or chemical dissolution of a metal. This controlled chemical dissolution will simultaneously etch all exposed surfaces even though the penetration rates of the material removal may be only 0.0025–0.1 mm/min. The basic process takes many forms: chemical milling of pockets, contours, overall metalremoval, chemical blanking for etching through thin sheets; photochemical machining (pcm) for etching by using of photosensitive resists in microelectronics; chemical or electrochemical polishing where weak chemical reagents are used (sometimes with remote electric assist) for polishing or



deburring and chemical jet machining where a single chemically active jet is used. A schematic of chemical machining process is shown in Figure.

11. With the help of a neat sketch explain the process of metal removal inplasma machining and state its applications and limitations?
(Fig 3M)

PLASMA

When heated to elevazted temperatures, gases turn into distinctly different types of matter which is plasma. The changes that take place in the gas when heated to few thousand degrees arc

- Some of electrons are removes from outer boundary of atoms thus they become ionized.
- The released electron strikes to atoms to further heat them to increase the kinetic energy.
- Getting highly excited the atoms give out de-excitation light.
- This effect produces more electrons and ions.
- So there new maters generated can conduct electricity due to available of free charges.
- At high charge densities these matter becomes bright due to emission from atoms.

The principle of plasma generation is that the high velocity electron of

the arc collides with gas molecules and produce dissociation of diatomic molecules followed by ionization of the beam. The plasma forming gas is forced through the nozzle duct in such a manner as to stabilize the arc. Much of the heating of the gas takes place in the constricted region of the nozzle duct, resulting in the relatively high exit of gas velocity and very high core temperature upto 16000º C

MECHANISM OF METAL REMOVAL

Metal removal in PAM is necessarily due to high temperature produced. Work Piece is heated due to Anode Heating, due to direct electron bombardment plus the convection heating from the high temperature plasma that accompanies the arc. The heat produced is sufficient to raise the work piece temperature above its melting point and the high velocity gas stream effectively blows the molten metal away. Under optimum conditions upto approx 45% of the electrical power delivered to the torch is used to remove metal from work piece.

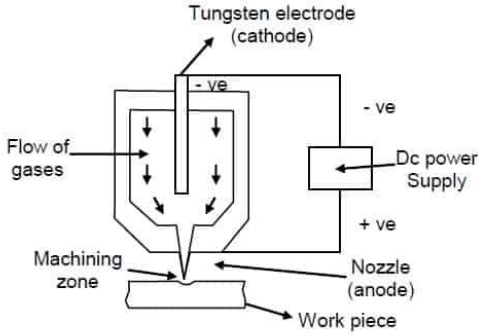


Figure Working Principle and Process Details of PAM

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