UNIT V

THERMAL ENERGY BASED PROCESSES

LASER BEAM MACHINING AND DRILLING (LBM) :

Laser Beam Machining or more broadly laser material processing deals with machining and material processing like heat treatment, alloying, cladding, sheet metal bending etc. Such processing is carried out utilizing the energy of coherent photons or laser beam, which is mostly converted into thermal energy upon interaction with most of the materials. Nowadays, laser is also finding application in regenerative machining or rapid prototyping as in processes like stereo-lithography, selective laser sintering etc.Laser stands for light amplification by stimulated emission of radiation. The underline working principle of laser was first put forward by Albert Einstein in 1917 though the first industrial laser for experimentation was developed around 1960s.Laser beam can very easily be focused using optical lenses as their wavelength ranges from half micron to around 70 microns. Focussed laser beam as indicated earlier can have power density in excess of 1 MW/mm^2. As laser interacts with the material, the energy of the photon is absorbed by the work material leading to rapid substantial rise in local temperature. This in turn results in melting and vaporisation of the work material and finally material removal.

PRINCIPLES :

LBM uses the light energy of a laser beam to remove material by vaporization and ablation.In this process the energy of coherent light beam is focused optically for predecided longer period of time. The beam is pulsed so that the released energy results in an impulse against the work surface that does melting and evaporation. Here the way of metal removing is same as that of EDM process but method of generation of heat is different. The application of heat is very finely focused in case of LBM as compared to EDM.

EQUIPMENT :

Laser Tube and Lamp Assembly

This is the main part of LBM setup. It consists of a laser tube, a pair of reflectors, one at each end of the tube, a flash tube or lamp, an amplification source, a power supply unit and a cooling system. This whole setup is fitted inside a enclosure, which carries good quality reflecting surfaces inside. In this setup the flash lamp goes to laser tube, that excites

the atoms of the inside media, which absorb the radiation of incoming light energy. This enables the light to travel to and fro between two reflecting mirrors. The partial reflecting mirror does not reflect the total light back and apart of it goes out in the form of a coherent stream of monochromatic light. This highly amplified stream of light is focused on the workpiece with the help of converging lense. The converging lense is also the part of this assembly.

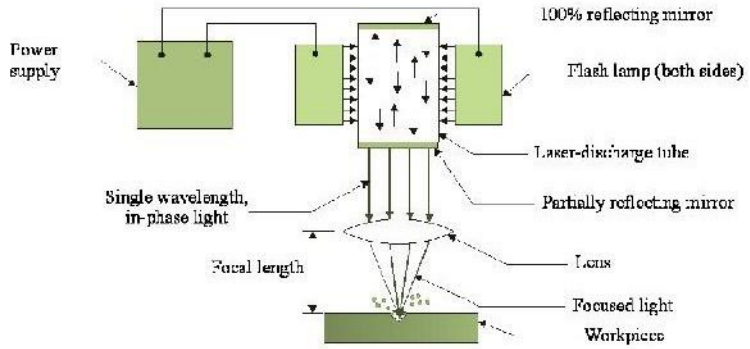

Fig : Laser Beam machining and drilling (LBM)

Work piece

The range of workpiece material that can be machined by LBM includes high hardness and strength materials like ceramics, glass to softer materials like plastics, rubber wood, etc. A good workpiece material high light energy absorption power, poor reflectivity, poor thermal conductivity, low specific heat, low melting point and low lotent heat.

Cooling Mechanism

A cooling mechanism circulates coolant in the laser tube assembly to avoid its over heating in long continuous operation.

Tool Feed Mechanism

There is no tool used in the LBM process. Focusing laser beam at a pre-decided point in the workpiece serve the purpose of tool. As the requirement of being focused shifts during the operation, its focus point can also be shifted gradually and accordingly by

moving the converging lense in a controlled manner. This movement of the converging lense is the tool feed mechanism in LBM process.

TYPES :

Many materials can be used as the heart of the laser. Depending on the lasing medium lasers are classified as solid state and gas laser. Solid-state lasers are commonly of the following type

- Ruby which is a chromium – alumina alloy having a wavelength of 0.7 μm
- Nd-glass lasers having a wavelength of 1.64 μm
- Nd-YAG laser having a wavelength of 1.06 μm

These solid-state lasers are generally used in material processing.The generally used gas lasers are

- Helium – Neon
- Argon
- CO_2 etc.

Lasers can be operated in continuous mode or pulsed mode. Typically CO_2 gas laser is operated in continuous mode and Nd – YAG laser is operated in pulsed mode.

APPLICATIONS :

Laser can be used in wide range of manufacturing applications

- Material removal – drilling, cutting and tre-panning
- Welding
- Cladding
- Alloying

Drilling micro-sized holes using laser in difficult – to – machine materials is the most dominant application in industry. In laser drilling the laser beam is focused over the desired spot size. For thin sheets pulse laser can be used. For thicker ones continuous laser may be used.

PLASMA ARC MACHINING (PAM) :

The plasma welding process was introduced to the welding industry in 1964 as a method of bringing better control to the arc welding process in lower current ranges. Today,

plasma retains the original advantages it brought to industry by providing an advanced level of control and accuracy to produce high quality welds in miniature or precision applications and to provide long electrode life for high production requirements. The plasma process is equally suited to manual and automatic applications. It has been used in a variety of operations ranging from high volume welding of strip metal, to precision welding of surgical instruments, to automatic repair of jet engine blades, to the manual welding of kitchen equipment for the food and dairy industry.

PRINCIPLES- EQUIPMENT :

The plasma arc welding process is normally compared to the gas tungsten arc process. But in the TIG-process, the arc is burning free and unhandled, whereas in the plasma-arc system, the arc is necked by an additional water-cooled plasma-nozzle. A plasma gas – almost always 100 % argon –flows between the tungsten electrode and the plasma nozzle. The welding process involves heating a gas called plasma to an extremely high temperature and then ionizing it such that it becomes electrically conductive. The plasma is used to transfer an electric arc called pilot arc to a work piece which burns between the tungsten electrode and the plasma nozzle. By forcing the plasma gas and arc through a constricted orifice the metal, which is to be welded is melted by the extreme heat of the arc. The weld pool is protected by the shielding gas, flowing between the outer shielding gas nozzle and the plasma nozzle. As shielding gas pure argon-rich gas-mixtures with hydrogen or helium are used. The high temperature of the plasma or constricted arc and the high velocity plasma jet provide an increased heat transfer rate over gas tungsten arc welding when using the same current. This results in faster welding speeds and deeper weld penetration. This method of operation is used for welding extremely thin material and for welding multi pass groove and welds and fillet welds. Plasma-arc machining (PAM) employs a high-velocity jet of high-temperature gas to melt and displace material in its path called PAM, this is a method of cutting metal with a plasma-arc, or tungsten inert-gas-arc, torch. The torch produces a high velocity jet of high-temperature ionized gas called plasma that cuts by melting and removing material from the work piece. Temperatures in the plasma zone range from 20,000° to 50,000° F (11,000° to 28,000° C).It is used as an alternative to ox fuel-gas cutting, employing an electric arc at very high temperatures to melt and vaporize the metal.

A plasma arc cutting torch has four components:

1. The electrode carries the negative charge from the power supply.
2. The swirl ring spins the plasma gas to create a swirling flow pattern.
3. The nozzle constricts the gas flow and increases the arc energy density.
4. The shield channels the flow of shielding gas and protects the nozzle from metal spatter.

APPLICATIONS :

The materials cut by PAM are generally those that are difficult to cut by any other means,such as stainless steels and aluminum alloys. It has an accuracy of about 0.008".

ELECTRON BEAM MACHINING (EBM) :

Electron beam is generated in an electron beam gun. The construction and working principle of the electron beam gun would be discussed in the next section. Electron beam gun provides high velocity electrons over a very small spot size. Electron Beam Machining is required to be carried out in vacuum. Otherwise the electrons would interact with the air molecules, thus they would loose their energy and cutting ability. Thus the workpiece to be machined is located under the electron beam and is kept under vacuum. The high-energy focused electron beam is made to impinge on the workpiece with a spot size of 10 – 100 μm. The kinetic energy of the high velocity electrons is converted to heat energy as the electrons strike the work material. Due to high power density instant melting and vaporisation starts and "melt – vaporisation" front gradually progresses, as shown in Fig. 9.6.2. Finally the molten material, if any at the top of the front, is expelled from the cutting zone by the high vapour pressure at the lower part. Unlike in Electron Beam Welding, the gun in EBM is used in pulsed mode. Holes can be drilled in thin sheets using a single pulse. For thicker plates, multiple pulses would be required. Electron beam can also be manoeuvred using the electromagnetic deflection coils for drilling holes of any shape.

PRINCIPLES- EQUIPMENT :

An electron beam gun is the heart of any electron beam machining facility. The basic functions of any electron beam gun are to generate free electrons at the cathode, accelerate them to a sufficiently high velocity and to focus them over a small spot size. Further, the beam needs to be manoeuvred if required by the gun.Tungsten or tantalum cathode filaments are heated, often inductively, to a temperature of around 2500^{0} C. Such heating leads to thermo-ionic emission of electrons, which is further enhanced by maintaining very low vacuum within the chamber of the electron beam gun. Moreover, this cathode cartridge is highly negatively biased so that the thermo-ionic electrons are strongly repelled away form the cathode. This cathode is often in the form of a cartridge so that it can be changed very quickly to reduce down time in case of failure.Just after the cathode, there is an annular bias grid. A high negative bias is applied to this grid so that the electrons generated by this cathode do not diverge and approach the next element, the annular anode, in the form of a beam. The annular anode now attracts the electron beam and gradually gets accelerated. As they leave the anode section, the electrons may achieve a velocity as high as half the velocity of light.

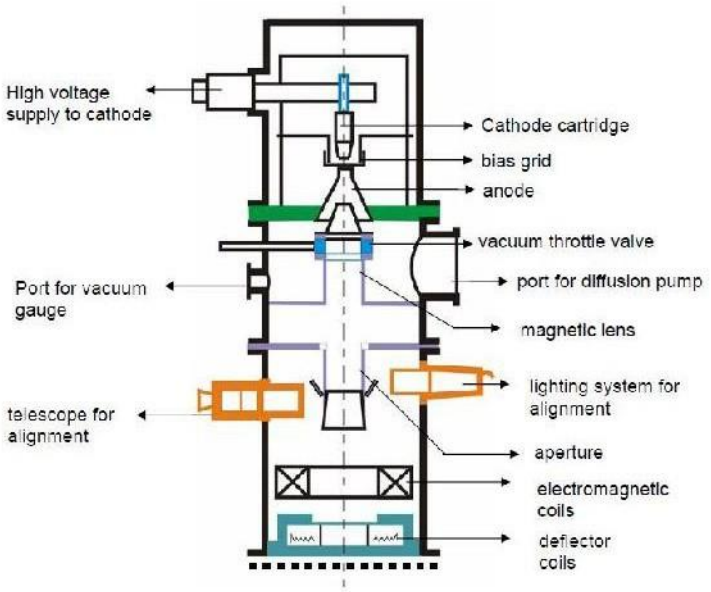

Fig : Electron Beam Machining (EBM)

The nature of biasing just after the cathode controls the flow of electrons and the biased grid is used as a switch to operate the electron beam gun in pulsed mode.After the anode, the electron beam passes through a series of magnetic lenses and apertures. The magnetic lenses shape the beam and try to reduce the divergence. Apertures on the other hand allow only the convergent electrons to pass and capture the divergent low energy electrons from the fringes. This way, the aperture and the magnetic lenses improve the quality of the electron beam. Then the electron beam passes through the final section of the electromagnetic lens and deflection coil. The electromagnetic lens focuses the electron beam to a desired spot. The deflection coil can maneuver the electron beam, though by small amount, to improve shape of the machined holes. Generally in between the electron beam gun and the workpiece, which is also under vacuum, there would be a series of slotted rotating discs. Such discs allow the electron beam to pass and machine materials but helpfully prevent metal fumes and vapour generated during machining to reach the gun. Thus it is essential to synchronize the motion of the rotating disc and pulsing of the electron beam gun.

Electron beam guns are also provided with illumination facility and a telescope for alignment of the beam with the work piece. Work piece is mounted on a CNC table so that holes of any shape can be machined using the CNC control and beam deflection in-built in the gun. One of the major requirements of EBM operation of electron beam gun is maintenance of desired vacuum. Level of vacuum within the gun is in the order of 10^{-4} to 10^{-6} Torr. *{1 Torr = 1mm of Hg}* Maintenance of suitable vacuum is essential so that electrons do not loose their energy and a significant life of the cathode cartridge is obtained. Such vacuum is achieved and maintained using a combination of rotary pump and diffusion pump. Diffusion pump is essentially an oil heater. As the oil is heated the oil vapour rushes upward where gradually converging structure as shown in Fig. 9.6.4 is present. The nozzles

change the direction of motion of the oil vapour and the oil vapour starts moving downward at a high velocity as jet. Such high velocity jets of oil vapour entrain any air molecules present within the gun. This oil is evacuated by a rotary pump via the backing line. The oil vapour condenses due to presence of cooling water jacket around the diffusion pump.

APPLICATIONS :

It can be used in wide range of manufacturing applications,

- Material removal – drilling, cutting and tre-panning
- Welding
- Cladding

Unconventional Machining Process (2 mark Q&A)

ULTRA SONIC MACHINING

1. What is ultrasonic machining?

USM is a mechanical material removal process in which the material is removed by repetitive impact of abrasive particles carried in liquid medium on to the work surface, by a shaped tool, Vibrating at ultrasonic frequency.

2. What are the advantages of USM ?

Advantages

1. High accuracy and good surface finish
2. No heat generation during machining
3. Capability of drilling circular and non-circular holes in very hard materials.
4. No thermal effects on mechanical work piece.
5. Non-conductive materials can be machined.

3. What are the Disadvantages of USM?

(1) Tool wear

(2) Frequent turning is required

(3) Low material removal rate.

(4) Not economical for soft materials.

(5) Not suitable for heavy stock removal.

4. What are the applications of USM?

(1) Almost all the material can be machined except some soft materials.

(2) Diamond, Tungsten, Tungsten carbide, and synthetic ruby can be successfully machined.

(3) USM can be used for drilling, grinding, profiling, coining, threading and even for welding.

(4) For preparing wire drawing dies and tool room items.

(5) Used in jewellery for shaping jewels

(6) Drilling of screw threads and curved holes in brittle materials.

5. What are the components of USM?

(1) Ultrasonic transducer

(2) Concentrator

(3) Tool

(4) Abrasive slurry

(5) Abrasive feed mechanism

(6) Tool feed mechanism

6. What is ultrasonic transducer?

The device used for converting any type of energy into ultrasonic wavers or vibration is called ultrasonic transducer.

7. Write short noted on piezoelectric crystals?

Piezoelectric crystals are used foe inducing ultrasonic vibrations since they posses the capability of changing their dimensions to the given electrical energy or in other sense they have the capability converting electrical energy into mechanical vibrations.

8. What is magnetostrictive effect?

It is the one in which the material changes its dimension is in response to a magnetic field.

9. What are the magnetostrivtive materials employed in USM?

Nickel, Iron – cobalt called as permendum , iron – aluminum called as alter.

10.What is the purpose of concentrator used in USM?

The main purpose of the concentrator is to increase the amplitude of the vibration obtained from the transducer.

11. What is abrasive Slurry?

The abrasive slurry is nothing but a mixture of abrasive grains and the carrier fluid, generally water.

12. What are the different types of concentrators?

(1) Conical Type

(2) Exponential type

(3) Stepped type.

13. What are the characteristics of carrier fluid?

(1) Good wetting characteristic

(2) High thermal conductivity

(3) Non-toxic and non-corrosive.

(4) Should have low viscosity.

14. What are the elements of Carrier Fluid?

(1) Act as a coolant.

(2) Act as an acoustic bond between the work piece and the tool.

(3) Helps efficient transfer of energy.

(4) Act as medium to carry the abrasive machined materials and worm abrasives

15. What are the types of feed mechanisms used in USM?

(1) Spring type

(2) Counter – weight type

(3) Motor type

(4) Pneumatic and hydraulic type

16. What are the mechanisms used in USM metal removal?

1. Hammering of abrasive particles in the work surface by the tool
2. Impact of free abrasive particles on the work surface
3. Cavitation erosion
4. Chemical action associated with the fluid employed

17. What are the major variables that controls the metal removal rate in USM?

Tool oscillation, impact force, abrasive size

18. Write the disadvantages of amplifying type concentrators used in USM

1. Higher fabrication cost
2. Poor surface finish quality
3. Need for frequent tuning to maintain resonance

19. What is the purpose of horn used in USM?

The horn should be fixed at a particular nodal point so that it makes the system rigid without loss in the mounting and we get the required amplitude of vibration

20. What are the functions of carrier fluid used in USM?

1. Acts as an acoustic bond between the work piece and the tool
2. Acts as a coolant
3. Helps efficient transfer of energy
4. Acts as medium to carry the abrasive, machined materials and worn abrasives

ABRASIVE JET MACHINING

1.Define AJM?

It is the material removal process where the material is removed or machined by the impact erosion of the high velocity stream of air or gas and abrasive mixtrue, which is focused on to the work piece.

2. How does AJM differ from conventional sand blasting process?

AJM differ from the conventional sand blasting process in the way that the abrasive is much finer and effective control over the process parameters and cutting. Used mainly to cut hard and brittle materials, which are thin and sensitive to heat.

3. What are the advantages of AJM process?

(1) Low capital cost

(2) Less vibration.

(3) Good for difficult to reach area.

(4) No heat is genera6ted in work piece.

(5) Ability to cut intricate holes of any hardness and brittleness in the material.

(6) Ability to cut fragile, brittle hard and heat sensitive material without damage.

4. What are the applications of AJM?

(1) For abrading and frosting glass, it is more economical than acid etching and grinding.

(2) For doing hard suffuses, safe removal of smears and ceramics oxides on metals.

(3) Resistive coating etc from ports to delicate to withstand normal scrapping

(4) Delicate cleaning such as removal of smudges from antique documents.

(5) Machining semiconductors such as germanium etc.

5.Write the Disadvantages of AJM process?

(1) Low metal removal rate.

(2) Due to stay cutting accuracy is affected.

(3) Parivles is imbedding in work piece.

(4) Abrasivc powdcr cannot bc rcuscd.

6. Give the formula for find the material remove rate for brittle metal?

$MRR = 1.04 (MV^{3/2} / \rho^{1/4} H^{3/4})$

7.Give a summary of the abrasive of their application for different operation?

ABRASSIVE APPLICATION

(1) Aluminium Clcaning, Cutting and Dcburrig

(2) Silicon Carbidc. Fastcr clcaning, Cutting.

(3) Glass Heads Matt polishing, cleaning

(4) Crushed glass Peening and cleaning.

8.Write the formula for find the MRR for ductile materials?

$MRR = 0.5 (MV^2 / H)$

9. What are the Process parameters affecting the MRR in AJM?

(1) Gas Pressure.

(2) Vclocity of Particlcs.

(3) Abrasive mass flow rate.

(4) Mixing ratio.

(5) Nozzle Tip Distance.

10. What are the disadvantages of using abrasives again and again?

(1) Cutting ability of the abrasives decreases after the large

(2) Contamination of wears materials clogging the nozzle and the cutting unit orifices.

11. What are the different types of nozzles heads used in AJM?

(1) Right angle head.

(2) Straight head.

12. Why oxygen should not be used in AJM?

Oxygen should not be used because of fire hazard problem.

13. What are the different types abrasives used in AJM?

Aluminium oxides, silicon carbides, Crushed glass, Sodium bicarbonate, Dolomite.

14. Reuse of abrasives is not recommended in AJM. why?

Reuse of abrasives is not recommented since the cutting ability of abrasive decrease after the usage and also the contamination of wear materials clogging the nozzle and the cutting unit orifice.

15. What is Stand Off distance or Nozzle Tip Distance?

It is defined as the distance between the face of the nozzle and the working surface of the work piece material.

LASER BEAM MACHINING

1.What is Laser?

It is acronym of light amplification by stimulated emission of radiation.

2.What is Maser?

Laser can be melt diamond when focused by lens system. The energy density being of two order 100,000 KW/cm2. This energy is due to atoms that have light energy level. When such an atom impinge with electromagnetic waves having resonant frequency.

3.What are the characteristics of Laser beam?

1.Material removal

2.Material shaping

3.Welding

4.Thermo kinetic change.

4.What are the gases commonly used in LASER?

The gases commonly used are: He, Ne, Argon, Co2 etc.

5.What are the advantages of Laser drilling?

No physical contact between work root pair hence there is no possibility if breakage or wear of root. Precision location is ensured by focusing of the beam Large aspect ratio can be achieved.

6.What are the characteristics of Laser used in Laser machining?

1. Can be focused to maximum intensity or to lower intensity as needed.

2. Can be moved rapidly on the work.

3. Remote cutting over long standoff distances.

7.What are the fundamentals of photons used in Laser?

In the Laser the photons are in ground state at 0_oC they are brought to the excited state by means of absorption of energy by temperature change, collision etc.

8.What are the emission lines?

The atoms when this they are bringing down goes to the excited state by stimulated emission and emit photons within 10 nano secs. They have the same wavelength as the excited photons.

9.What is the Maser principle?

The energy density of laser with 100,000Kw/cm_2. The atoms at this state will impinge with electrons waves having resonate frequency. This is known as maser.

10.What is population inversion?

If the atoms in the excited state are greater than that of the ground state then it is known as population inversion.

11.How does Laser melting works?

It melts and vaporizes the unwanted material by means of narrow pulsed laser operating at 2 to 100pilses/sec Because of this high accuracy is not possible to micro sized holes.

12.What is solid state Laser?

Solid state Laser is the Lasers, which consist of a hot nat, which may be crystalline solid/ glass, doped with an active material whose atoms provide the lasing action.

13. Write the properties of laser

monochromatic, coherence, divergence, intensity, mode structure

ELECTRON BEAM MACHINING

1) Define EBM?

It is the thermo-electrical material removal process on which the material is removed by the high velocity electron beam emitted from the tungsten filament made to impinge on the work surface, where kinetic energy of the beam is transferred to the work piece material, producing intense heat, which makes the material to melt or vaporize it locally.

2) What is the characteristic of the electron beam?

(i) High concentrated energy.

(ii) Deep penetration into the metals.

(iii) Low distortion.

(iv) Any material either conductive or non-conductive can be processed.

3) Write the application of electron beam?

- Thin film machining.
- Surface treatment.
- Engraving metals and non-metals.
- Cutting of materials.

4) What are the main elements of the EBM equipment?

(i) Electron Gun.

(ii) Beam focusing and deflecting units.

(iii) Work Table.

(iv) Vacuum chamber

5) What is the function of magnetic lens used in EBM?

It converges the beam into a narrow spot into the work piece.

6) What are the two types of EBM?

(i) Thermal type. (ii) Non-thermal Type.

7) Explain the thermal type EBM?

In this type the electron beam is used to heat the material up to the point where it is selectively vaporized.

8)Explain Non-thermal type EBM?

In this type, the EBM produces a chemical reaction.

9) Write the advantage of EBM?

(i) High accuracy. (ii) Any type of material can be processed. (iii) No mechanical or thermal distortion. (iv) No physical or metallurgical damage results.

10) Write the disadvantages of EBM?

(i) High cost of equipment. (ii) Skilled operator is required for operation. (iii) Limited to 10mm material thickness.

11) Write any four application of EBM?

(i) Micro machining application on materials. (ii) Drilling of apertures for electron microscope. (iii) Drilling of holes in ruby and diamond crystal.

12) Write the Richardson-Dushman Equation?

$J=At_2 e^{-(EW/KT)}$

J = Current Density

A =constant (120 Amphere/cm_2deg_2)

K =Boltzman Constant (1.3x10-23 J/K)

T = Absolute temperature (Kelvin)

W =work function (Volts)

13) Write general formula for focal length of a magnetic lens?

$f/(S + D) = 25V/(NT)^2$

V =Electron accelerating voltage

NT =Ampere turns in the lens winding

S =pole piece separation

D =Bore diameter

F =focal length

14) Why vacuum is needed in EBM?

1) To reduce corrosion

2) To get correct focusing

15)What is the drawback of electron beam machining?

One major diameter of electron beam welding has been the requirement of high degree of vacuum essential or satisfactory operation of this process because of degassing.

ELECTRO CHEMICAL MACHINING

1) Define ECM?

It is the controlled removal of metals by the anodic dissolution in an electrolytic medium, where the work piece (anode) and the tool (cathode) are connected to the electrolytic circuit, which is kept, immersed in the electrolytic medium.

2) Write the Faraday's first law of electrolysis?

The amount of any material dissolved or deposited is proportional to the quantity of electrolyte passed.

3) Write the Faraday's second law of electrolysis?

The amount of different substances dissolved or deposited by the same quantity of electricity are proportional to their chemical equivalent weight.

4) Write Ohm's law?

Current, I = V/R

V = Voltage

R = resistance

5) What are the factors that influence oxidation in ECM?

(i) Nature of work piece. (ii) Type of electrolyte. (iii) Current density.

(iv) Temperature of the electrolyte.

6) What are the materials used to make the tool electrode?

Copper and copper alloys, titanium, aluminum, brass, bronze, carbon, Monel and reinforced plastic.

7) What are the main functions of electrolysis in the ECM?

i) For completing the electric circuit between the tool and the work piece and to allow the reaction to proceed efficiently.

ii) To remove the products of machining from the cutting region.

iii) To carry away the heat generated during the chemical reaction.

iv) To avoid ion concentration at the work piece- tool gap.

8) What are the properties are expected from the electrolysis used in the ECM?

i) High thermal conductivity.

ii) Low viscosity and high specific heat.

iii) Should chemically stable even at high temperature.

iv) Should be non-toxic and non-corrosive.

9) What are the electrolysis commonly used in ECM?

15 -20 % Nacl in water, sodium nitrate, potassium nitrate, sodium sulphate, sodium chromate and potassium chloride.

10) What are the results which is in improper selection of electrolyte in ECM?

(i) Low machining rate. (ii) Over cut and stray cutting.

11) What are the methods generally used to filter the electrolyte?

(i) Running the system until it is contaminated completely and replace it.

(ii) Centrifugal separation.

(iii) Sedimentation.

(iv) Use of clarifiers.

12) What are the characteristics of a good ECM tool?

(i) It should be a good conductor of electricity and heat.

(ii) Easily machinable.

(iii) Resistant to chemical reaction.

(iv) It offers resistance to the high electrolyte pressure.

13) What are the problems that occur while improperly selecting the electrolyte flow?

Cavitations, stagnation and vortex formation.

14) What are the parameters that affect the MRR?

(i) Feed rate. (ii) Voltage. (iii) Concentration of the electrolyte.

(iv) Temperature of the electrolyte. (v) Current density. (vi) Velocity of the electrolyte.

15) How the current density affect the MRR?

Current density is controlled not only by the amount of current but also by the size of the gap between the tool and the work piece. A small gap results in high current density, which in turn produce more material removal.

16) What are the advantages of ECM?

(i) ECM is simple, fast and versatile method.

(ii) Surface finish can be extremely good.

(iii) Fairly good tolerance can be obtained.

17) What are the limitations of ECM?

(i) Large power consumption and the related problems.

(ii) Sharp internal corners cannot be answered.

(iii) Maintenances of higher tolerances require complicated contours.

18) What are the applications of ECM?

ECM is used for sinking, profiling and contouring, multi hole drilling, trepanning, broaching, honing, steel mill applications, surfacing, sawing, contour machining of hand to hand machine materials.

ELECTO CHEMICAL GRINDING

1.Define ECG.

ECG is the material removal process in which the material is removed by the combination of Electro- Chemical decomposition as in ECM process and abrasive due to grinding.

2. Which material is used to make the grinding wheel?

Metal bonded diamond (or) Aluminum oxide.

3.What are the important functions of abrasive particles used in ECG?

It acts as insulator to maintain a small gap between the wheel and work piece. They are electrolysis products from the working area. To cut chips if the wheel should contact the work piece particularly in the event of power failure.

4.What are the advantages of ECG?

i) No thermal damage to work piece.

ii) Wheel wear is negligible.

iii) No distortion of the work piece.

5.What are the disadvantages of ECG?

High capital costs, because of the special wheel tool. Power consumption is quite high. Electrolyte is corrosive.

6.What are the limitations of ECG?

1.The work material must be conductive.

2.Nit suitable for machining soft material.

3.Require dressing tools for preparing the wheels.

7.What is the application of ECG?

1.Precision grinding of hand metals economically.

2.Grinding Carbide cutting tools inserts.

3.To grind end mill cutters more precisely.

PLASMA ARC MACHINING

1. Define plasma

2.

Plasma is defined as the gas, which has been heated to a sufficiently high temperature to become ionized.

2. What are the advantages of plasma arc welding?

a. Exothermic oxidation takes place.

b. DC power supply

3. What are the metals that can't be machined by plasma arc machining?

a. Stainless steel

b. Monel

c. Super alloys

4. What is the basic heating phenomenon that takes place in plasma arc welding?

The basic heating phenomenon that takes place at the work piece is a combination of anode heating due to direct electron bombardment recombination of molecules on the work piece.

5. How does the basic plasma is generated.

The basic plasma is generated by subjecting a stream of gas to the electron bombardment of the electric arc.

6. How the initial ionization is accomplished in plasma arc machining.

A high voltage arc established between electrode and nozzle accomplishes initial ionization.

7. Why does gas formed in plasma do in P.A.M?

This gas stabilizes the arc and prevents it from diverging.

8. How another source of heating achieved in P.A.M

It is desirable to achieve a third source of heating by injecting oxygen into work area to take advantage of exothermic oxidation.

9. Write the principle of P.A.M

Once the material has been raised to molten point the high velocity gas stream blows the material away.

10.Write the circuitry details in PAM.

+ ve terminal connected to work piece and -- ve terminal connected to electrode.

12. Which type of power supply is used in P.A.M

DC power supply is used.

13. Which part is constricted by plasma?

Nozzle duct is constricted by plasma.

WATER JET MACHINING

1. What are the properties of water jet machining about effect cutting action?

High pressure, high velocity jet of water.

2. What are the types of units and its purpose used in water jet cutting system?

a. Pump -- to generate high pressure

b. Machining unit-- to actually cut the material with the jet nozzle.

c. Filtration unit -- to clear the water after use.

3. Why we are using the diamond nozzle.

a. High hardness metal

b. Working life is more compared to other jewel nozzle such as ruby or sapphire.

4. Why do you select proper cutting fluid in WJM?

Cutting fluids mainly depends on the operation requirement, quality of finish, cutting speed and overall cost

5. Does there is any environmental effects while using the water jet machining.

There is no environmental pollution such as dust suspended in the air because the water jet drains any dust simultaneously when cutting.

6. What are the advantages of WJC over conventional cutting methods?

a. Because of point cutting WJC is able to cut materials almost any pattern

b. Material loss due to machining is minimum.

c. WJC will not burn surfaces or produces a heat an affected zone.

d. No environmental pollution.

7. What are the applications of WJM?

*Aero space

*Automobile

*Paper pulp industries

8. What are the commonly used additives in WJM?

1.Crly ccrinc

2.Polyethylene oxide

3.Long chain polymers

9. What is optical tracing system?

It employs an optical scanner that traces a line drawing and produces electronic signals that control the X-rays.

ELECTRICAL DISCHARGE MACHINING

1. Define electrical discharge machining?

EDM is the controlled erosion of electrically conductive materials by the initiation of rapid and repetitive spark discharge between the electrode tool to the cathode and work to anode separated by a small gap kept in the path of dielectric medium. This process also called spark erosion.

2. What are functions of dielectric fluid used in EDM?

1.It acts as an insulating medium

2.It cools the spark region and helps in keeping the tool and work piece cool.

3.It maintains a constant resistance across the gap.

4.It carries away the eroded metal particles.

3. Basic requirement of dielectric fluid used in EDM?

1.Stable Dielectric strength.

2.It should have optimum viscosity.

3.It should have high flash point.

4.It should be chemically stable at high temperature and neutral.

5.It should not emit toxic vapours.

4. What the dielectric fluids commonly used in EDM?

1.Pctrolium bascd hydrocarbon fluids.

2.Parafin, white sprite, transformer oil.

3.Kerosine, mineral oil.

4.Ethylene glycol and water miscible compounds.

5. What are the prime requirements of tool material in EDM?

1.It should be electrically conductive.

2.It should have good mach inability.

3. It should have low erosion rate.

4. It should have low electrical resistance.

6. Name some of the tool material used in EDM?

1.Copper, brass, alloys of Zinc &tin.

2.Hardend plain carbon steel

3.copper tungsten, silver tungsten, tungsten

4.Copper graphite and graphite.

7. What is the process parameter efficiency the MRR?

1.Energy discharge

2.Capacitance.

3.Size of work piece.

4.M/c tool design

8. Writc thc formula for finding thc cnergy dischargc in EDM?

W=(1/2) X EIT

W-discharge energy

I-Current

T-time

E-voltage

9. What is the effect of capacitance in EDM?

Increasing the capacitance causes the discharge to increase and increase both the peak current and discharge time.

10. How do you increase the inductance of the circuit?

A piece of iron or steel be allowed to lodge between the leads it would increase the inductance of the circuit and reduce the M/C rate.

11. Define W/T ratio?

It is the ratio of volume of work removed to the volume of tool removed.

12. What is cycle time?

It is the sum of discharge time and waiting time.

13. Define over cut?

It is the discharge by which the machined hole in the work piece exceeds the electrode size and is determined by both the initiating voltage and the discharge energy.

14. Define Rehardening?

While metal heated to a temperature above the critical and then rapidly cooled by the flowing dielectric fluid the metal is rehardened.

15. What is recast metal?

Metal heated to a temperature above the melting point and which is not displaced by the action of the spark discharge, resoldifies as recast metal.

16. Explain electrode wear?

A crater is produced in the electrode, which is likewise dependent on the electrode material and the energy of the discharge.

17. What are types of power supply circuits used in EDM?

1.R-Ccircuit.

2.Rotary impulse generator.

3.Controlled pulse (vacuum tube).

4.Oscillator controlled pulse.

5.Transister pulsed circuit.

18. What are the design factors to be considered while selecting the machine tool?

1.Number of parts to be produced.

2.Accuracy.

3.Size of work piece.

4.Size of electrode.

5.Depth of cavity.

19. Why the servo controlled system is needed in EDM?

EDM requires that a constant arc gap be maintained between the electrode and the work piece to obtain maximum machining efficiency. Therefore EDM tool in corporate some form of servo control.

20. Define wear ratio?

Wear ratio=Work piece material removed/Loss of electrode material.

Possible Part – B Questions

1. With the neat sketches discuss the working principle of main components of an Ultrasonic drilling machine (Ref. Nonconventional machining – P.K. Mishra page no:22

2. Explain the functions of transducer and horns used in USM. List the tool materials used. (Ref. Nonconventional machining – P.K. Mishra page no:25,37& NTM- Weller page no: 18)

3. Briefly explain the effect of operating parameters on material removal rate. List the applications of USM.(NTMT – John Alexis , page no: 37 – 41)

4. Discuss the Abrasive slurry used in USM (NTMT – John Alexis , page no: 32)

5. Explain the Tool feed mechanism used in USM (NTMT – John Alexis, page no: 32)

6. How the unconventional machining processes are classified? (Ref. NCM – P.K. Mishra, Page no: 6)

7. How do the operating parameters affect the machining process in AJM process? Ref. (NTMT – John Alexis, page no: 7 - 12)

8. With the neat sketches discuss the working principle of main components of an AJM process and write the advantages and disadvantages of AJM. (NTMT – John Alexis, page no: 5 - 7)

9. Explain the Nozzle design and it's effect in AJM. (Ref. NTM- Weller page no: 41)

10. With the neat sketches discuss the working principle of main components of an AJM process and write the advantages and disadvantages of AJM. (NTM – Weller , page no: 144)

11. Discuss the following: i. Lasing process ii. Lasing materials(Ref. NCM – P.K. Mishra, Page no: 147 - 154)

12. Explain the types of Laser used in Laser beam machining. . (Ref. NTM- Weller page no: 141)

13. With the neat sketches discuss the working principle of main components of an AJM process and write the advantages and disadvantages of EBM. (Ref. NCM – P.K. Mishra, Page no: 161)

14. How do the operating parameters affect the machining process in EBM process? (Ref. NTMT – John Alexis, page no: 121 - 123)

15. What is the basic principle of Electro chemical machining process? (Ref. NCM – P.K. Mishra, Page no: 59)

16. Explain the Dynamics of ECM process. (Ref. NCM – P.K. Mishra, Page no: 65 - 71)

17. Discuss the Tool Design in ECM process. (Ref. NCM – P.K. Mishra, Page no: 71- 76)

18. How do the operating parameters affect the machining process in ECM process? (Ref. NTMT – John Alexis, page no: 79 - 81)

19. With the neat sketches discuss the working principle of main components of an ECM

process and write the advantages and disadvantages of ECM. (NTMT – John Alexis, page no: 68 - 73)

20. With the neat sketches discuss the working principle of main components of an ECG process and write the advantages and disadvantages of ECG. (NTMT – John Alexis, page no:

84 - 88)

21. Explain the types of plasma arc torches (Plasmatron) used in PAM. (Ref. NCM – P.K. Mishra, Page no: 170 - 172)

22. How do the operating parameters affect the machining process in PAM process? (Ref. NCM – P.K. Mishra, Page no: 172 - 176)

23. With the neat sketches discuss the working principle of main components of an PAM process and write the advantages and disadvantages of PAM. (NTMT – John Alexis, page no: 126 - 128)

24. With the neat sketches discuss the working principle of main components of an WJM process and write the advantages and disadvantages of WJM. (Ref. NCM – P.K. Mishra, Page no: 45)

25. How do the operating parameters affect the machining process in WJM process? (Ref. NCM – P.K. Mishra, Page no: 47 - 52)

26. What are the metal removal concepts support the EDM process? (Ref. NCM – P.K. Mishra, Page no: 90 - 92)

27. Discuss the electrode tool materials used in EDM process. (Ref. NCM – P.K. Mishra, Page no: 94 - 102)

28. Discuss the power generators used in EDM process. (Ref. NCM – P.K. Mishra, Page no: 107 - 121)

29. Explain the flushing techniques used in EDM process. Discuss the electrode tool materials used in EDM process. (Ref. NCM – P.K. Mishra, Page no: 141 - 145)

30. How do the operating parameters affect the machining process in EDM process? (NTMT – John Alexis, page no: 99 - 100)

31. With the neat sketches discuss the working principle of main components of an EDM process (Ref. NTM – Weller, Page no: 163)

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