CHAPTER-01 (1.0)

Advanced Manufacturing process.

Introduction:

Unconventional machining process is defined as a group of processes that remove excess material by various techniques involving mechanical, thermal, electrical or chemical energy or combinations of these energies but do not use a sharp cutting tools as it needs to be used for traditional / conventional machining process.

NB

-> Extremely hard & brittle materials are difficult to machine by traditional machining process such as turning, shaping & milling

-> NTM also called as Advanced manufacturing process & these are employed where traditional machining processes are not feasible, satisfactory or economical due to special reasons

Needs or NTM Needs or NTM

Q. 2 marks

(1) Very hard brittle materials difficult to clamp for traditional machining.

(2) When the shape of the part is too complex

(3) When the W/P is too flexible or slender to support the cutting or grinding forces.

Classification of Advanced Machining / Metal Removal Process

(1) Based on use of Electrochemical energy.

(1) ECM (Electro chemical Machining)

(2) ECG (Electrochemical Grinding)

(2) Based on the use of Thermal Energy

(1) EDM (Electric discharge machining)

(2) WEDM (Wire-cut Electric discharge machining)

(3) LBM (Laser Beam Machining)

(4) EBM (Electron Beam Machining)

Differences between conventional & Non-conventional Machining process.

Conventional process	Non conventional process
→ The cutting tool & w/p are always in physical contact.	→ There is no physical contact b/w tool & w/p
→ conventional process mostly uses mechanical Energy	→ Most NTM uses energy in direct form. For ex – Laser, Electron beam in its direct forms are used in LBM & EBM respectively
→ Machining of small cavities, slits, blind holes or through holes are difficult	→ Machining of small cavities, slits and production of ~~small~~ non-circular, micro sized, holes are easy by using NTM
→ Materials are removed in the form of tiny sharp chips	→ chips are not produced here. material is removed in various forms such as- ions, vapour etc.

→ Here cutting tool is used for removal of material.	→ So called cutter tool does not exist here.
→ Labor cost is Low as compared to NTM	→ Labor cost is high because less number of skilled labors are available in this field.
→ ~~Provide less surface finish~~ Surface finish is not good as compared to NTM	→ Good surface finish as compared to TM
Ex: Turning, facing, Grooving, Drilling etc.	→ Ex- AJM, EBM, PAM, ECM, etc.

AJM

Abrasive Jet Machining:

Abrasive: These are the materials used to shape or finish a w/p through rubbing (10-50 microns) size.

→ These Abrasive grains are very hard, & sharp materials

→ Silicon carbide, Aluminium oxide, Glass porcelen

Working principle: use of high-speed stream of abrasive particles carried by a high pressure gas or air on the work surface through a nozzle, & the work material is removed by erosion caused by the abrasive particles impacting the work surface at high speed

Parts of AJM:

→ Gas supply

→ Nozzle

→ Abrasive

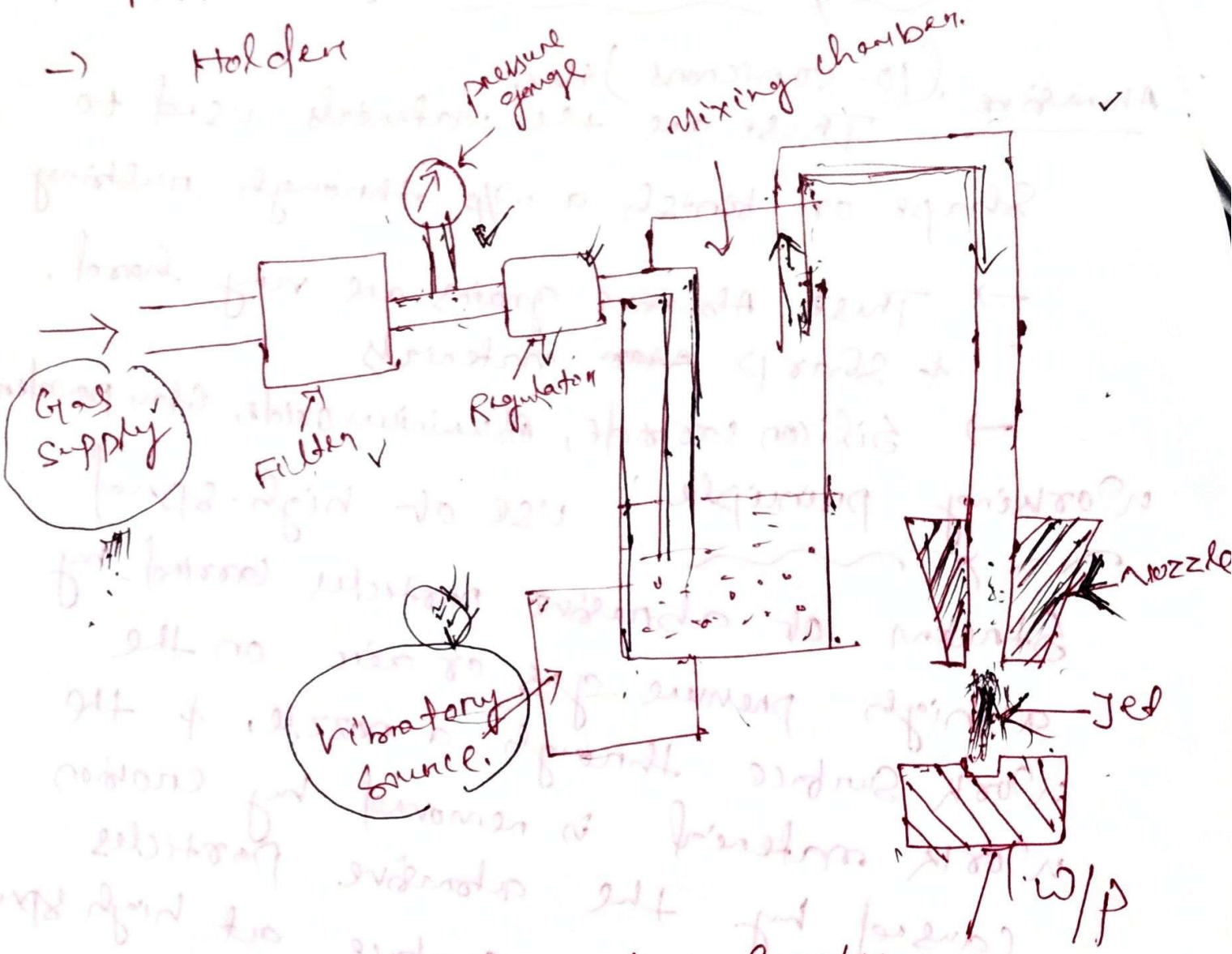
→ w/p

→ pressure Regulator.

→ Filters

→ Fast control valve

→ Holder



① Gas Supply → For Gas Supply Gas cylinder is used. ~~in which~~ !

→ Dry air, Nitrogen, CO_2, used.

→ These gases are called as carrier gas which are mixed with the abrasive particles

Filters: This is used for the removal of any unwanted ~~pa~~ particles (moisture) from the compressed gases which comes through pipe.

-> 1

③ Pressure gauge / ~~Regulator~~: This is used to measure/ ~~Regulate~~ the pressure of the carrier gases.

④ Pressure Regulator -> This is used to Regulate the pressure of the carrier gas.

⑤ Mixing chamber: It is a closed chamber in which both carrier gas & Abrasive particles are mixed.

Abrasives - Al_2O_3, SiC,

Advantages:

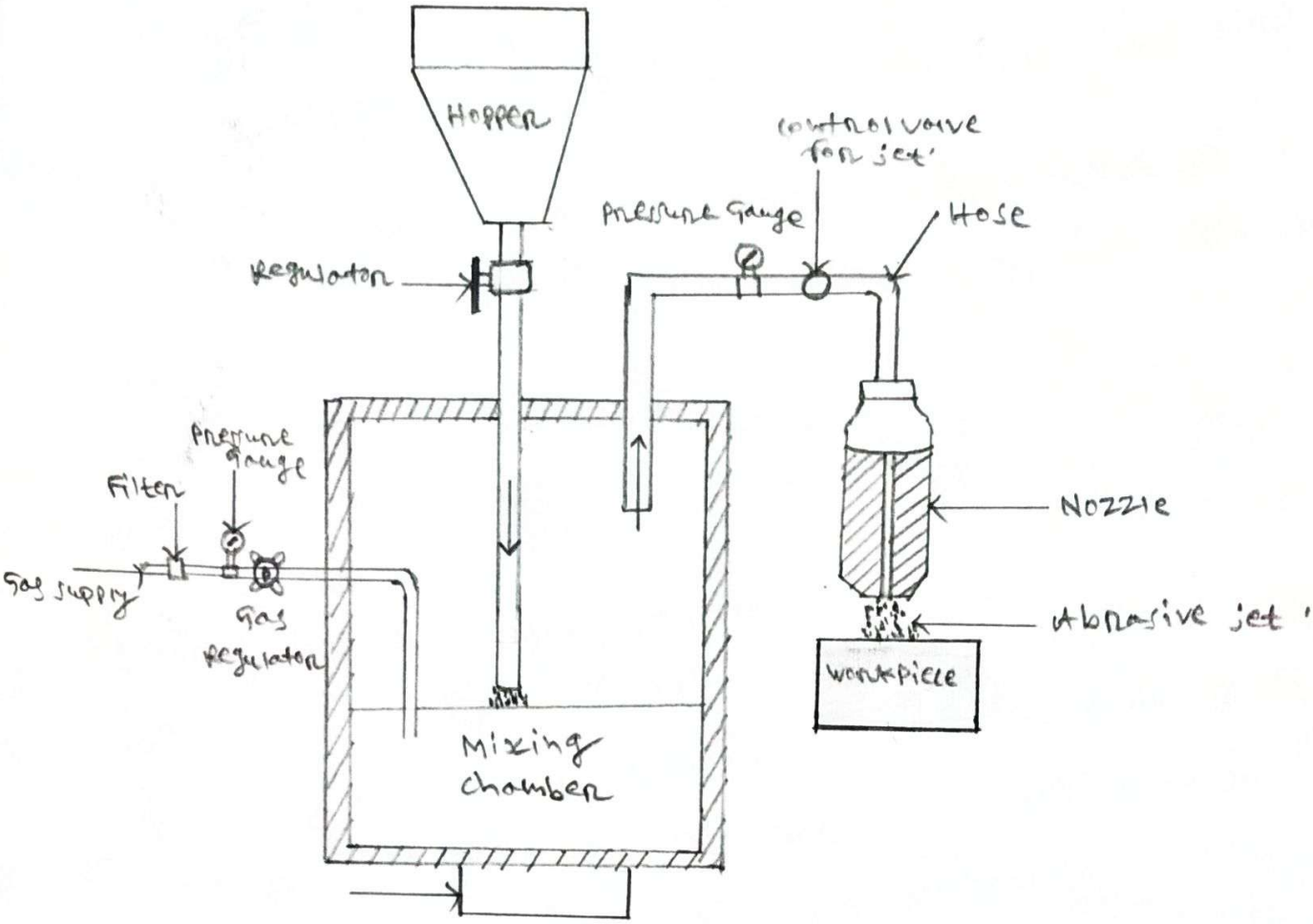
- No tool changes are required
- It is not reactive with any w/p material
- Intricate parts or sharp corners can be machined.
- It can machine thin materials
- Low capital cost

Disadvantages:

- The removal rate is slow
- It requires some kind of dust collection system
- Machining accuracy poor.
- Nozzle wear rate is high
- Abrasive powder can not be reused.
- Nozzle life is limited

Applications:

- Drilling holes, cutting slots, cleaning hard surfaces, polishing. etc.
- For machining brittle materials
- Micro machining of brittle materials



Principle of Abrasive jet machining.

AJM

ULTRASONIC MACHINING PROCESS (USM)

Introduction

It is a mechanical material removal process, used to erode material in the form of fine holes & cavities in hard & brittle w/ps.

→ It uses formed tools, vibrations of high frequency & a suitable abrasive slurry mix

→ It is a NTM process

Principle of USM process:

USM is a NTM process in which abrasives hits on the w/p to remove the material (hammering of abrasives against the w/p with the tool)

Equipments

1. power source (AC)
2. cutting tool
3. Abrasive slurry
4. w/p
5. Fixture
6. Horn (Amplifier)
7. Tool Holder
8. Nozzle
9. Transducer
10. Booster

① Power source → To starts, the machining process power is required. This is essen.

② Tool – made up of tough, strong & ductile materials like Steel, HSS, MS etc.

③ Abrasive Slurry – Abrasive grains + any medium (may be water, oil)
Boron carbide, Aluminium oxide, Silicon carbide,

④ W/P → on which machining process occurs

5. Fixture – on which W/P is placed.

6. Horn → used to amplify the amplitude of vibrations

7. Tool holder or Horn: This unit connects the tool to the transducer. It transfers amplified vibrations from booster to the Tool.

8. Nozzle – ~~used to~~ through which Abrasive slurry are supplied to the system.

9. Transducer (Magnetostrictive transducer)
→ Transducer is a device which converts electric signal in to mechanical vibration

→ In USM magnetostrictive type transducer is used to generate mechanical vibrations

10) <u>Booster</u>: The mechanical vibration generated by transducer is passes through booster which amplify it & supply it to the Horn.

<u>Working</u>:

→ When an AC supply is given to the high-frequency generator. It amplifies the frequency of the input supply up to 20 - 40 KHZ

→ This High frequency input supply is fed to the electromechanical transducer which converts this energy into an ultrasonic vibration thus making the tool to vibrate in the ~~lon~~ longitudinal direc.

→ Horn is the intermediary b/w the transducer & the tool holder. it is used to amplify the ~~amplitude~~ amplitude of

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Abrasives - Aluminium oxide (Light)
Silicon carbide
Boron carbide
Diamond Dust (hardest)

vibrations generated by the transducer & then (3)
quickly & focuses these vibrations on to the tool.

-) Tool holder grips the tool as it vibrates
As the tool vibrates the abrasive slurry is fed with the help of a pump at a const rate b/w the tool & the w/p surface

-) Then the tool is pressed on the w/p.

-) As the vibrating tool is pressed over the w/p, the K.E of the vibration is transmitted to these abrasive particles which impinge on the w/p surface & due to abrasion at microscopic level the material removed from w/p.

-) The shape generated in the w/p is same as the shape of tool.

Advantages

→ very hard & brittle material material can be machined

→ operation is noiseless

→ Low cost

→ Good surface finish & accurate profiles can be generated

→ No heat is generated in the process & hence mechanical properties of the workpiece can be maintained.

Disadvantages:

→ Metal removal rate is slow

→ High initial investment

→ Tool cost is very high

→ More chances of tool wear

→ Abrasive slurry must be replaced periodically

→ Difficult to machine softer material

Applications:

→ This machining is used to machine hard & brittle material like carbide, ceramic, glass etc.

→ used to cut diamond in desire shape

→ profiling of holes, drilling of holes,

ECM: Electro chemical Machining

~~principle~~ Introduction:

ECM is a Non-traditional Machining process belonging to Electrochemical category.

Working principle of ECM:

ECM removes material of electrically conductive w/p. Here the w/p is made anode in the setup & material is removed [(-) w/p — Anode (+ve)] by anodic dissolution.

→ Tool is made cathode (-ve) & kept in close proximity to the w/p & current is passed through the ckt.

→ Both electrodes are immersed in to the electrolyte solution.

→ Works on the basis of Faraday's law of Electrolysis.

→ The cavity machined is the mirror image of the tool.

Equipments

→ W/P (Anode)

→ Tool (cathode)

→ power supply (DC supply) (3-4V)

→ Electrolyte (NaCl, $NaNO_3$,)

→ Tool feed mechanism.

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Function of Electrolyte

NaCl, HCL, $NaNO_3$

It is salt solu^n in which the W/P & tool are kept during the process of M/cing.
→ act as current carrying medium b/w the W/P & tool.

→ It carries the current b/w tool & W/P

→ It removes the product of the reaction from the cutting region.

→ It removes the heat produced by the current flow in the operation.

Power supply: The power supply is given to the machine to work properly.

i.e. (+ve supply → w/p (Anode) & the -ve → tool (cathode)

Feed unit: It gives the feed to the tool.

→ Servomotor is used to give the necessary amount of feed to the tool.

Pump :- It pumps the electrolyte from the sump. to the all parts of the system.

Filter :- It removes the impurities present in the electrolyte.

Pressure gauge: Used to check the pressure of the electrolyte which is being pumped to the system or work region.

Flow meter: Used to measure the discharge or mass flow rate of the fluid (electrolyte)

Disadvantages:

- Non conducting material cannot be machined.
- High electrical power is consumed during the process.
- Higher cost & frequent maintenance of equipment.
- Space & floor requirements are higher than conventional

Work piece: It is the material on which machining is carried out to remove the material from the surface of w/p. (4)

Tool: With the help of the tool, ~~Metal~~ Material removal takes place in the w/p.
→ Act as cathode.

Electrolyte: It as as a medium for the flow of ions & leads to the removal of material from the surface of w/p

Pump:

Example → copper - Anode
Cathode - Cathode

Solute - $CuSO_4$ copper Sulphate.

copper atom dissolved & travel through electrolyte to the cathode where it is subsequently deposited.

→ copper ion moves through solu^n

1st diffusion → it is the movement of ions within a solu^n. (higher concentration to lower concentration

4 9 15

+ve cu ion attract → -ve,

At
Anode - $Cu \rightarrow Cu^{2+} + 2e^-$
Cathode - $Cu^{2+} + 2e^- \rightarrow Cu$

$NaCl - Na^+ + Cl^-$
$H_2O \rightarrow H^+ + OH^-$

Anode & Cl
+ve ions → Cl.
& -ve → w/p

So Hydrogen takes place

Working of ECM:

In actual process of ECM, the cathode is tool shaped (Mirror image of w/p) and Anode is the w/p.

→ A gap of 0.05 to 0.7mm is provided b/w the tool & w/p & Electrolyte flows through the gap at a velocity of 30 to 60 m/s & it completes the electrical circuit.

→ Electrolyte is pumped at high pressure (1.96 Mpa) through the gap. to the work region by the pump via a filter, pressure gauge, flowmeter ~~& final~~.

→ When the power supply is given, a optimum gap is maintained b/w the tool & w/p & the ions are started displacing from the w/p & trying to deposit over the tool.

-> Before the ions are depositing on the tool, the electrolyte present b/w tool & w/p is pumped out. Then, the ions also moving along with electrolyte without depositing on the tool.

-> Mechanism of material removal is Ion displacement

Advantages:

-> very good surface finish

-> complex components can be produced easily.

-> Because of no tool wear, the same tool can be reused.

-> High accuracy

-> No physical contact b/w tool & w/p

-> ECM process can be easily automated

Advantages:

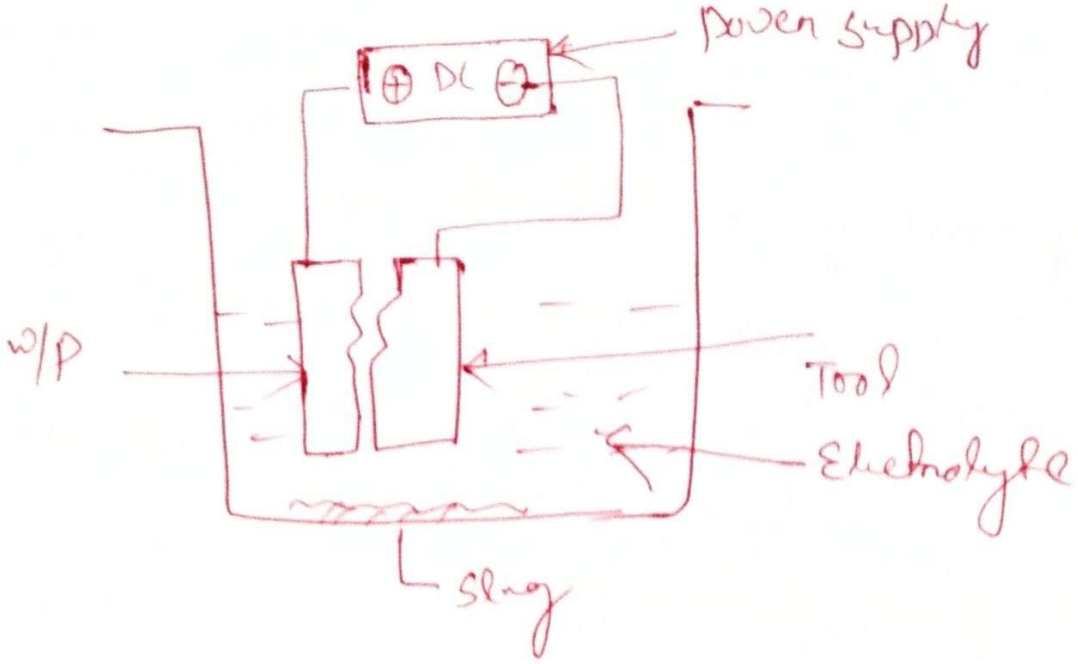
- → heavy machining of hard materials
- → high accuracy & surface finish
- → used for micro machining
- → used for production of very small gear systems
- → machining of turbine blades

Disadvantages

- → High initial cost
- → Non-conductive material can not be machined
- →

NB Faraday's law of electrolysis:

It states that when two electrodes Anode (+ve) & cathode (-ve) are placed in an electrolyte the mass of the metal deposited on the cathode coming from the anode is directly proportional to the potential difference applied across the electrodes.



As potential difference is applied b/w Anode & Cathode the ions start moving from anode & cathode

The -ve ions get attracted towards the W/P which is placed at the +ve potential & +ve ions are attracted towards the tool which is placed at the -ve potential.

$2H^+ + 2e^- = H_2$

Hydrogen ions gain electrons & get converted into Hydrogen gas at cathode

$Fe = Fe^{++} + 2e^-$ (Fe atom releases its 2 electrons & gets converted into iron ions at anode)

$Na^+ + OH^- = NaOH$ (Hydroxyde)

$Fe^{2+} + 2Cl^- = FeCl_2$ (Iron chloride) slug

EDM: / Spark machining

Introduction:

EDM is an electro-thermal NTM process. Where electrical energy is used to generate electrical spark & material removal mainly occurs due to thermal energy of the spark.

Equipments:

1. Tool (cathode)
2. power supply
3. W/P (Anode)
4. Dielectric fluid (kerosene, deionized water) paraffin etc.)
5. Fixture
6. Servomechanism (used to give feed to the tool)
7. pump (used to circulate the dielectric fluid)
8. Filter (used to remove impurities from dielectric solution)

Tool:

→ Tool is given (-ve) polarity

→ It is made of electrically conducting material (brass, copper or tungsten)

Power supply → A DC supply is given to the system (50V – 450V)

→ Due to ionization of dielectric solution an electrical breakdown occurs.

W/P (Anode)

→ It is gives +ve polarity

Dielectric fluid:

→ Its function is to drive away the chips & prevents their sticking to W/P & the tool.

Working:

When DC power is supplied, the fluid in the gap ionized & produces a spark b/w the tool & W/P, which causes rise in temperature about 1000°c which melt the metals in a small area of the W/P. & vaporizes.

Advantages:

-) very hard material can be machined

-) complicated geometries can be produced.

-) Fine holes can be drilled easily & accurately.

-) High MRR (metal removal rate) as compared to others.

-) machining time is less than the conventional machining process.

-) Higher tool life due to proper lubrication & cooling

Disadvantages.

-) Electrically non-conducting materials can'not be machined.

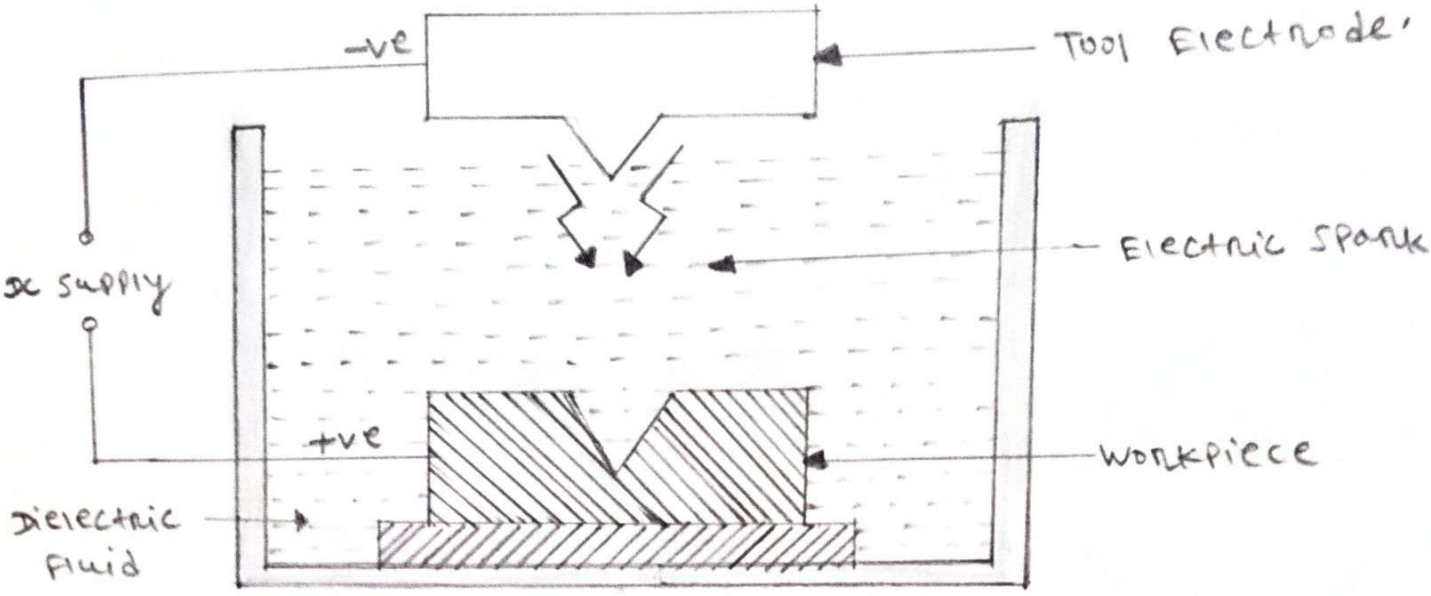
-) This EDM process is not able to produce sharp corners.

-) High power consumption

-) ~~Slow~~

Applications:

Drilling of holes, thread cutting, Helical profile cutting,


-ve
Tool Electrode
Electric Spark
DC supply
+ve
Workpiece
Dielectric fluid

EBM ELECTRON BEAM MACHINING

Introduction:

→ EBM is a metal removal process by a high velocity focused stream of electrons. As the electrons strike the w/p with high velocity, their K.E is transformed in to thermal energy which melts & vaporize the material.

Equipments:

1. Electron gun (used to generate the free electrons (tungsten filament))
2. Grid cup / Bias grid (used to ctrl the flow of electrons generated by electron gun)
3. Anode (used to accelerate the electrons at very higher velocity)
4. Magnetic Lens (To focus the electrons beam on w/p)
5. optical viewing system (~~to carry~~ used by the operator ~~to~~)
6. vacum chamber (To avoid the colliding of electrons with ~~at~~ air molecules)

Electron beam gun: The basic functions of an e gun are to generate electrons from the high voltage supply attached at the cathode, accelerate them to a sufficiently high velocity & direct the beam to the o/p through a small spot.

→ parts of Electron beam gun are divided in to two categories.

(1) The elements necessary for generating free electrons, or cathode elements.

(2) The field shaping elements necessary for the production of useful beam,

This high velocity electron beam, after leaving the anode, passes through the tungsten diaphragm & then then through the electromagnetic focusing lens.

-) Focusing lens are used to focus the electron beam on the desired spot of the w/p

-) When the electron beam impacts on the w/p surface, the K.E of electrons is converted into heat energy. This heat energy melts & vaporizes the work material at the spot of w/p.

-) optical viewing system / device used in this machine so, it becomes easy for the operator to observe the machining process / operation.

Advantages:

-) No mechanical contact b/w tool & w/p

-) very small holes can be machined in every type of material with high accuracy

-) good surface finish

-) Machining any material irrespective of its hardness & other mechanical properties

Dis advantages:

-) cost of equipment is high

-) MRR (metal removal rate) is low as compare to other.

-) vacuum requirements limits the size of w/p

-) High skill operator required

-) It is difficult to produce perfect vacuum.

Applications

-) Drilling of holes.

-) used in aerospace industries for producing turbine blade for supersonic engines & in nuclear reactor

Working of EBM:

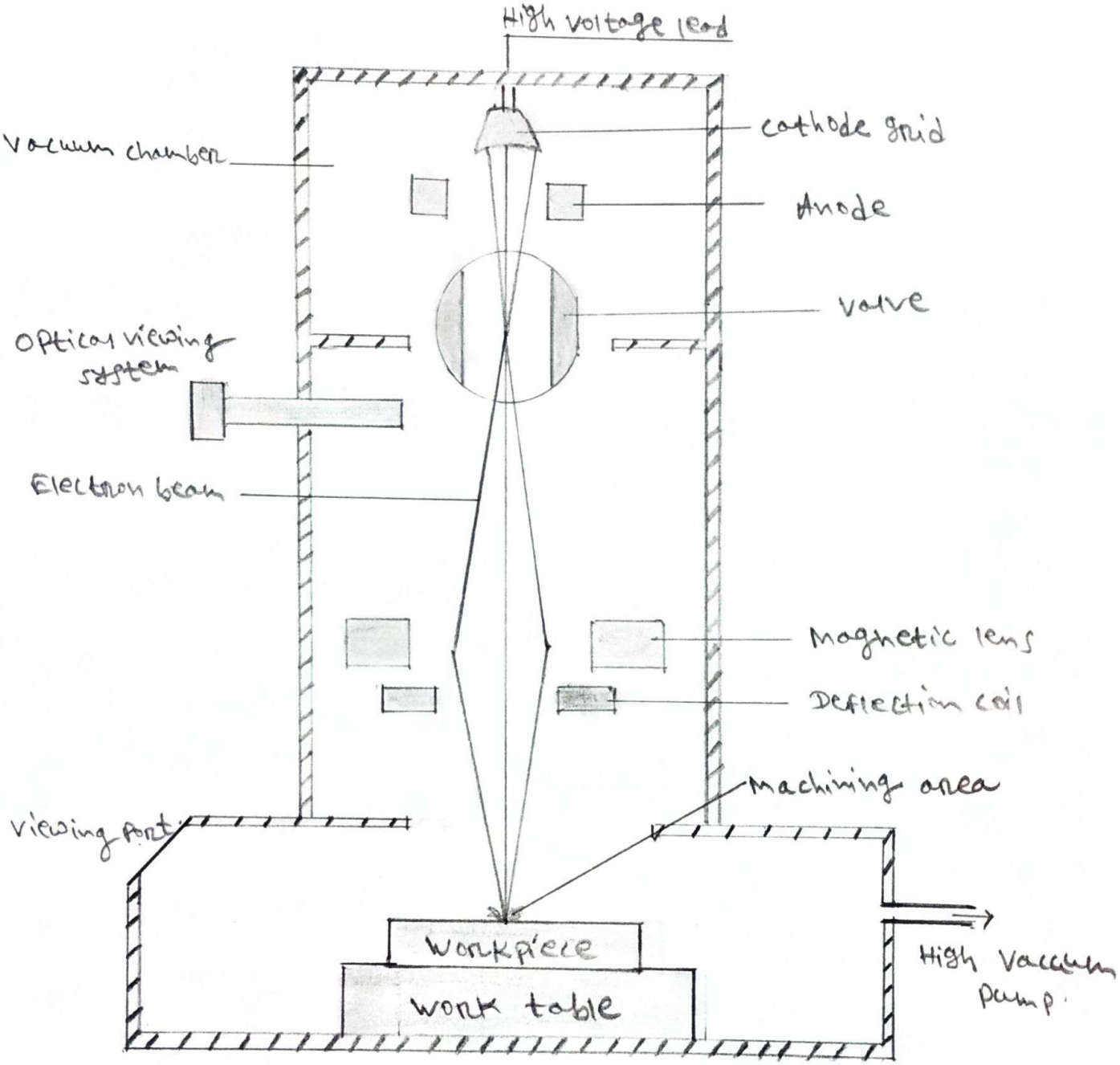
-) When the high voltage DC source is given to the electron gun, tugsten filament wire gets heated & the temp raises up to 2500°C.

-) Due to this high temperature, electrons are emitted from tungsten filament. These electrons are directed by a grid cap to travel ~~towards~~ downwards & they are attracted by the Anode.

-) The electrons passing through the anode are accelerated to achieve high velocity (half of velocity of light)

-) This high velocity of these electrons are maintained until they strike the w/p. It becomes possible because the electrons travel through the vacuum.

The cathode is generally made of tungsten filament, which can tolerate the temp. 2500 – 3000°C.


High voltage lead
cathode grid
Vacuum chamber
Anode
valve
Optical viewing system
Electron beam
Magnetic lens
Deflection coil
machining area
viewing port
workpiece
work table
High Vacuum pump.

LBM

PLASMA ARC MACHENING

Introduction:

- PAM employs a high-velocity jet of high temperature gas to melt & displace the material in its path.

→ plasma arc or tungsten inert gas-arc is used

→ Torch → It produces high velocity jet of high temp. ionized gas (plasma)

PAM: It is a NTM process in which the material is removed by directing a high temp. (11000 – 30000°C) ionized gas on the w/p.

Plasma — Mixture of free electrons, +vely charged ions & neutral atoms.

→ It can be obtained by heating a gas at a very high temp. so that it is partially ionized.

Working principle of PAM

→ Gases are heated & charged to plasma state

→ plasma state is the super heated & electrically ionized gases.

→ These gases are directed on the W/P in the form of high velocity stream

(1) plasma Gun

(2) power supply (DC)

(3) cooling mechanism

(4) Tool (plasma state of gases acts as cutting tool)

(5) W/P (Al, magnesium, stainless steel, & carbon & alloy steels)

2023/1/21

Plasma Gun:

Gases are used to create plasma like, Nitrogen, argon, hydrogen or mixture of these gases.

→ The plasma gun consists of a tungsten electrode fitted in the chamber.

→ The electrode (Tungsten) is connected to the (-ve) terminal of the DC supply. nozzle (copper) of the gun is made Anode (i.e. it is connected to the +ve terminal of DC supply.

→ Then a strong Arc is established b/w two terminals Anode & cathode. due to Heavy potential difference applied.

→ There is a collision b/w molecules of gas & electrons of the established arc.

→ Gas molecules get ionized & plasma state is formed.

→ plasma is directed to the w/p with high velocity

Advantages:

→ It gives faster production rate

→ very hard & brittle metals can be machined.

→ Small cavities can be machined with good dimensional accuracy.

Disadvantages:

→ Its initial cost is very high

→ Inert gas consumption is high

→ It is uneconomical for bigger cavities to be machined.

Applications DAM

→ welding

Cooling mechanism.

→ Hot gases continuously comes out of nozzle, so there are chances of over heating.

→ A water jacket is used to surround the nozzle to avoid its overheating.

Work piece:

Work piece of different materials can be processed by PAM.

Ex: Aluminium, magnesium, stainless steels, & carbon & alloy steels.

Tool:

Plasma state of gases are used as cutting tool.

Power supply

DC power supply is given to ~~the~~ the two terminals of electrode.

* imp primary gases:

Gases that are used to create the plasma arc are

Nitrogen, argon, hydrogen, etc.

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LBM (LASER BEAM MACHINING)

(1)

Electric energy – light energy → Heat energy

Introduction:

Laser beam machining is NTM process which is a thermal machining process that uses ~~LB~~ Laser beam to produce Heat.

→ This Heat energy is used to ~~produce~~ remove the metal from W/P. due to vaporization.

Working:

LASER :- Light amplification by stimulated Emission of Radiation.

→ In LBM Metal melts, & vaporises by Laser beam.

Working principle.

→ The principle is that under proper conditions light energy of a particular frequency is utilised to stimulate the electrons in an atom to emit additional light with exactly the same characteristics of the original light source.

Equipments

① Power Supply → It provides the energy for excitation of electrons from lower energy level to higher energy level.

→ ~~power~~ It is connected to the flash lamp.

→ The laser material is exposed to light which keeps strong light energy

② Laser Discharge tube: The laser material is filled inside the laser discharge tube.

→ Its one side is partialy transparent & other side is 100 % Reflected.

Laser material CO_2, Ruby,

(3)

-> It emits light & produce Laser beam.

1) Focusing Lens : A focusing lens is used in Laser beam machining operation (Convex) function is to focus the Laser beam at one pt.

Working:

-> Laser material is filled in Laser discharge tube

-> Switch on the power supply which is connected to the flash lamps.

-> This flash lamp produces light energy. which excites the electrons. of Laser materials.

-> So the atoms become unstable at high energy level.

-> These Laser lights are collected by the focus lens & directed towards the w/p vapourization takes place on the surface of the w/p & machining takes place.

0.05 %. Chromium (ruby) crystal / glass material

Laser rod 10mm dia & Length - 100mm

No. of cycles of light that pass a given pt in one second.

wavelength - distance b/w corresponding pts in two adjacent light cycles.

Electromagnetic radiation that can be detected by the human eye

antages:

-) No direct contact b/w tool & w/p
-) It can cut any material irrespective of Hardness
-) High surface finish
-) High accuracy
-) Micro holes can be drilled Accurately
-) can produce complex shapes
-) ~~very~~

Disadvantages:

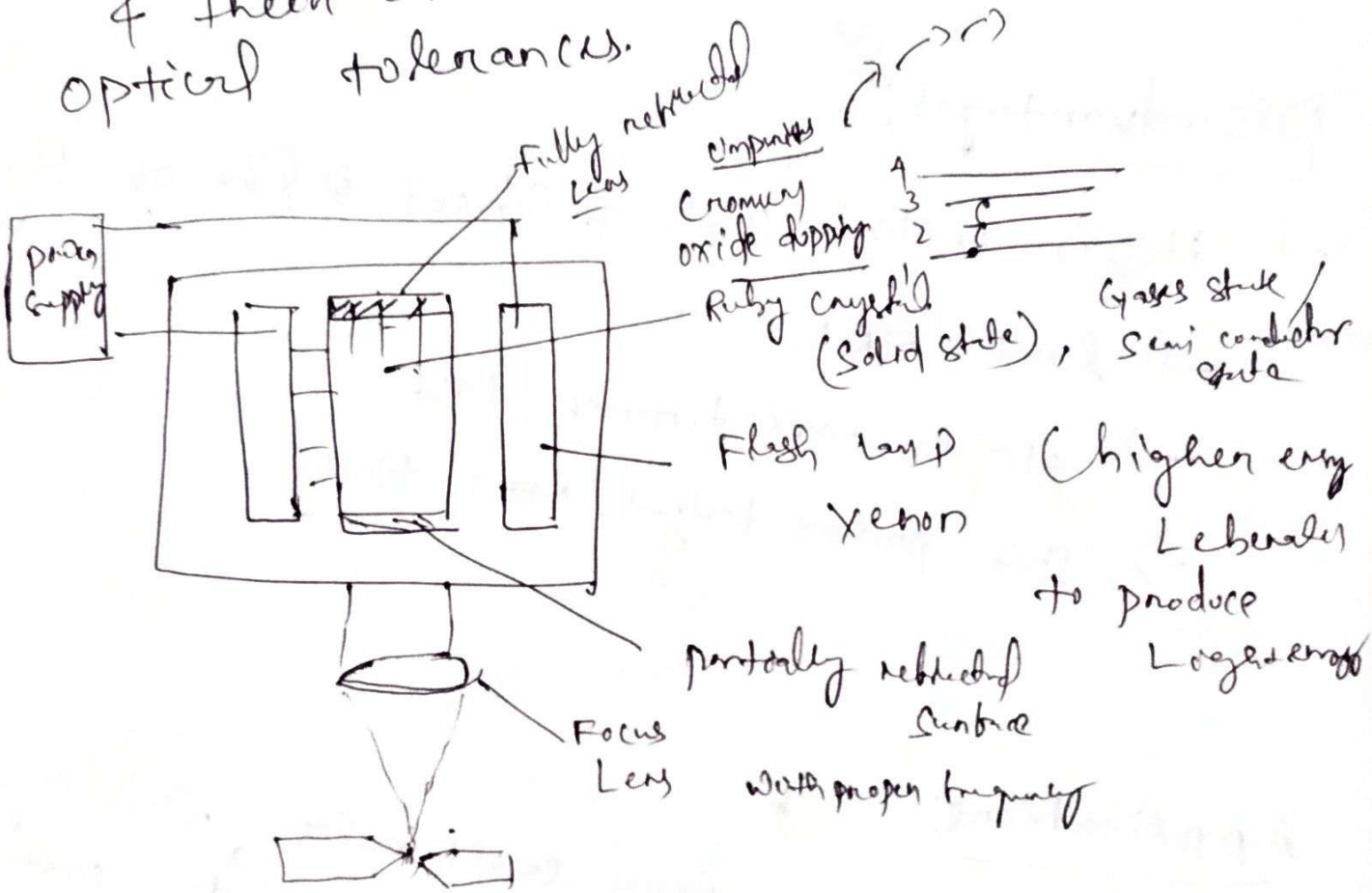
-) High initial cost & short life of flash lamp.
-) low MRR
-) High maintenance cost
-) This process takes more time

Applications:

Used for making very small holes, welding of Non conductive materials, cutting complex profiles in thin & hard materials
-) Used for Mass micro machining production
-) Useful for producing very fine & minute holes etc.

→ There are several types of Lasers used in manufacturing operations, e.g. solid state, gas, Liquid

→ The most commonly used solid state Laser is the ruby Laser. These Lasers are fabricated into rods, about 150 mm long & their ends are furnished to close optical tolerances.



→ monochromatic high intense light

→ It is a device for producing a narrow beam of light, capable of travelling over vast distances without dispersion & one dir. Co-herent frequency & wavelength

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CHAPTER-02

PLASTIC PROCESSING

Defination: plastic processing can be defined as the process of converting the plastic raw material in to semi-finished products.

Ex: Buckets, Automobile parts, pipes, Tanks, Bottles etc

Classification of processing methods:

1. primary processing methods: Injection, Extusion, Blow, compression & transfer moulding

2. Secondary processing methods:- Roto, Thermoforming, coating, casting, Fabrication & calendaring etc.

3. Tertiary processing methods- cutting, Drilling, welding & Bending etc.

good strength
Low cost
good mechanical properties

TYPES:

Thermo plastic

* Tajya - dimension
=> thaka —
-> Rod -
* Room -> thala dimensions

-> Rule ✓

* Dimension -> 18 inch ✓
-> Down side - ✓
-> Rules -> bonesing
->

Types of plastics:

There are mainly 2 types of plastics.

1) Thermo plastics
2) Thermo setting

(1) Thermo plastics:

A plastic which can be softened repeatedly by heating & can be moulded in to different shapes, again & again, is called thermoplastics.

→ Also known as **thermosoftening plastics**

Ex: polythene, & PVC (polyvinyle chloride)

(2) Thermo setting plastic

→ Also called as "thermosets"

→ In thermosetting, the long polymer chains cross-linked with one another. This cross-linking prevents the displacement or sliding of individual polymer chains on heating

Plastics are a wide range of synthetic or semi synthetic materials that use polymers as a main ingredient.

$(C_2H_4)_n$ - polyethylene.

→ The raw materials used - cellulose, coal, Natural gas, salt & crude oil through a polymerisation or polycondensation process.

Types → Thermo plastics (which soften on heating & they harden again on cooling

Thermosets (which never soften once they have been moulded.

Examples

Epoxy Resin, phenolic (Bakelite)
Cyanate Ester, poly ester

→ heating the polymer, if it turns hard, then it is called as thermosettting plastic materials

At room temp - available in the form of liquid

Due to this, thermosettering plastics do not (3) become soft on heating once they have been set in to a particular shape

Ex: Bakelite & Melamine.

NB Bakelite - poor conductor of electricity, It is used for making electrical switches,

Properties of plastics:

1) They are chemically inactive
2) plastics are resistent to corrosion.
3) poor conductor of heat
4) Bad conductor of electricity
5) Light & cheap
6) can be moulded in to different shapes like Bucket, mugs, furniture items, Bags, Toys.

INJECTION MOLDING

Most of the plastic products are produced by injection molding method.

→ Thermoplastic is used as raw material

Working principle

In this process the thermoplastic polymer is heated to a plastic state. Then the hot plastic in a plastic state is forced to flow under high pressure into a prepared mold cavity, where it is allowed to solidify. This solidified plastic is the final product which is removed from the mold cavity.

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→ The process of injection molding is very fast.

→ The product cycle time is very short.

Equipments for injection molding:

Injection molding machine mainly consists of two principal parts

high intensity producing molding

(1) Molten plastic injection unit

(2) Mold clamping unit.

Molten plastic injection unit!

Molten plastic injection unit consists of a barrel having a feed hopper at its one end.

→ The hopper supplies the plastic raw materials.

→ Inside the barrel, there is a Screw like extruder screw.

→ This screw can be rotated to mix the prepared material in the barrel & also act as a ram used to inject molten plastic into the mold.

→ Reciprocating screw is used

Functions of Injection unit!

→ Melts the plastic (polymer)

→ properly injects the plastics to the mold cavity.

(2) Mold clamping unit:

The clamping unit consists of two parts, one is fixed part & another is movable part along with a mechanism for translating the latter.

→ The mechanism is operated with the help of hydraulically operated power press, which is capable to apply a clamping force of several thousand tons.

IMP Functions of Mold clamping unit:

→ It holds the two halves of the mold in proper alignment w.r.t each other.

→ It keeps the mold closed during the process of injection by applying clamping force.

→ It opens & closes the mold at the appropriate timing in the molding cycle.

high in... production handling ... bright brilliant

Working of Injection Moulding:

Raw material, plastic or polymer is bag through hopper to the barrel, which is heated & brought to right temp.. Then it is injected in to the mould cavity through the nozzle, when the screw moves towards the mould cavity.

-) The injected plastic begins to solidify when it comes ~~to~~ in contact with the cold surface of the mould cavity.

-) After solidifying mould is open & product is taken out of the mould.

Advantages:

-) Fast production

-) possible to design complex part.

-) More flexibility.

-) Low Labor cost

Compression Molding process

Compression molding is used for molding process of thermosetting plastics.

-) The raw material used for compression molding can be in any form like. powder, pallets, liquid etc.

Principle of compression molding:

parts are

-) ① upper half of mold

② Lower half of mold

(3) charge (raw material / plastic)

-) 1st Loading of the charge (raw material / plastic) into the lower half of mold.

As we know that mold of compression molding is designed into two parts.

-) The Lower half of the mold is 1st heated to maintain the temperature of charge to a particular point during the process of molding.

→ Then the lower half mold is compre
by bringing both halves of the mo
close together.

→ This pressing or charge is done under pressure which enable the charge to to flow & acquire the shape of the mold cavity with precision & dimensional accuracy.

→ Then after cooling the final product of plastic is to be ejected by pressing the knockout pin towards inside. after opening of molding halves.

NB The operation of applying pressure is possible by two types of actuations

(1) upstroke of bottom part

(2) down stroke of top part.

Advantages:

- Less expensive
- Low maintenance cost
- Negligible scrap

3 Transfer Moulding:

Transfer molding process is a manufacturing process in which casting material is forced into a mold.

- combination of injection & compression molding process.
- Transfer Molding is a process in which polymers are preheated in a separate chamber called (transfer pot) & then forced/transfered in to a preheated

mold through a sprue. then taking a shape of the mold cavity & performing curing due to heat & pressure applied to the material.

→ This method is ~~used for~~ primarily used for molding of Thermosetting polymers.

parts of Transfer molding:

1. plunger
2. Transfer pot
3. Charge / Raw material
4. Mold cavity
5. Ejector pin
6. Heater.

Working process:

→ 1st A pre-weighed amount of polymer mixed with additives & fillers (charge/Raw material) is placed into the transfer pot.

(The charge may be in the form of powders, pellets, etc.

→ Then the plunger, mounted on the top plate, moves downwards, pressing on the polymer charge & forcing it to fill the mold cavity through the sprue.

→ The mold is opened & the part is removed from it by means of the ejector pin.

Advantages:

→ capable to produce more complicated shapes than compression molding.

→ Molding cycle time is shorter than compression molding.

→ ~~Suitable for~~

Transfer Moulding:

Transfer moulding may be defined as a combination of injection & compression moulding in which the plastic is first melted in a heated cylinder or pot and then transferred to a cavity / mould & compressed in to the desired shape.

→ In case of compression moulding the material melts in the cavity itself.

EXTRUSION PROCESS:

→ One of the most common process for creating plastic.

→ Extrusion is a process where a material is pushed through a tool with a specialized shape called a die, producing continuous objects of a fixed cross section profile.

Parts:

→ Hopper
→ die
→ Rotating screw
→ Heater / thermocouples,
→ motor

Working: The plastic extrusion process starts with filling the hopper with raw material. Then it goes to the barrel. Once the material enters in to the barrel, it begins to be heated by thermocouples & the material is simultaneously pushed towards the ~~die~~ die end of barrel when the screw rotates. which is driven by a motor.

Then the molten plastics exits the barrel & pushed through a die open tool. This forces the material into a tube shape based on the specific shape on the die. The material forming a solid tube shape after cooling. Then this product is to be cut into required size

Ex -! pipes, tubing, sheets,

Advantages!

-> Shaping hard & brittle material

-) Favorable for the creation of a typical cross-sections.

-> more flexibility.

CASTING PROCESS

-) This process is used for both thermosetting & thermoplastic materials.

-) Basically casting places plastic in a mold then hardens it into a rigid article or form.

-) defined as plastic part manufacturing process which involves the introduction of a liquified plastic material allowing its solidification in a mold

Advantages:

-) Low equipment cost.
-) This process is not complex.
-) No internal stress.

Disadvantages:

-) output rate is slow & has long cycle time.
-) Dimensional tolerances are not very good.

Steps involved in plastic casting process.

① Patterns making

-) which involves designing of a physical model.

-) pattern making can use computer assisted systems to design the geometry & dimensions of the model.

② core making:

-) which involves placing of solid materials inside the mold cavity as for creating interior surface of a casting

③ Molding:

It also allows you as the manufacturer to create the casting model.

The plastic material fills the casting mold model which is subsequently allowed to harden to a pt of removing it from the cavity & beginning of casting or component

(4) Melting & pouring:

→ you must ensure that you meld the plastic material properly before placing it in the mold.

→ once you melted it accordingly depending on various properties of the plastic, you then pour the molten plastic in the casting mold to allow it to cool & also harden.

(5) Finishing:

After hardening you can use different ways of finishing techniques.

Blow molding

by which hollow plastic parts are branch

Melt plastic - parison -

Blow pin -

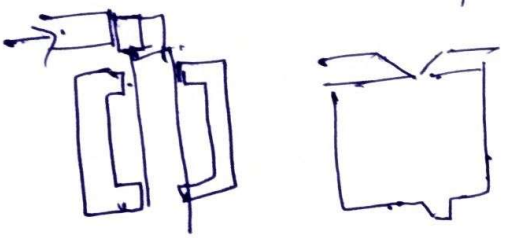
Dies with mold

Blow molding

Air Shape (by using air pressure.)

parison - Heated tube

Step-1



Die mold

Blow pin - small pin (Allows air through pin pin

in which we make hollow product.

parison - Pre form (injection -) preform

↓ Continuous tube (molten shape) heated

↓ Air blow bottle - pre form Pre hot

① injection
② extrusion
③ injection
④ Stretch (pre form
⑤ multilayer blow molding

CALENDERING

It is a finishing process applied to plastic

-) During calendering rolls of the material are passed b/w several pairs of heated rollers, to give a shiny surface.

-) Calendering is a final process in which heat & pressure are applied to a fabric by passing it between heated rollers, imparting a flat, glossy, smooth surface.

Ex:

Kitchen - 2

Drawing -

FABRICATION METHODS

Plastic fabrication is the design, manufacture or assembly of plastic products through one or number of methods.

* **BLOW MOLDING** (injection / Extrusion)

Blow molding is a manufacturing technique used to create hollow plastic parts by inflating a heated plastic tube inside a mold until it forms into the desired shape.

3.0 CHAPTER-03

ADDITIVE MANUFACTURIN PROCESS

3.1 Introduction:

Additive Manufacturing (AM) or additive layer manufacturing (ALM) is a computer controlled process that creates three dimensional objects by depositing materials, usually in layers.

How does Additive Manufacturing work?

Using computer aided design (CAD) or 3D object scanners, AM (additive manufacturing) allows for the creation of objects with precise geometric shapes.

Need

→ create parts with greater complexity

→ Minimal material waste

→ Simplified assembly

→ cost- effective customisation

→ Reduce the production steps

Materials used in AM

- Polymers
- Metals & Alloys → Aluminium, Mild steel
- Composites
- Ceramics

Metals:- Most of the metals like Aluminium, Mild steel ~~are used~~ & Structural materials can be manufactured using layer by layer process.

→ This manufacturing process occurs by partially melting or bringing the metal powders to a phase transition from solid to liquid & then solidification using lasers or electron beams

Hence, the materials are expected to in powder or in the form of wires in geometry for easy handling & processing.

→ Aerospace } Industry
Automobiles

Applications of AM process:

→ Aerospace — ✓

→ Healthcare — ✓

→ Turbine blades ✓

→ Tooling process for injection moulding ✓

Imp

Advantages of Additive Manufacturing ⑤

-> Reduces material wastage as compared to traditional process.

-> Reduces the the number of operations as compared to traditional manufacturing process.

-> Reduces the cost of cost of raw materials

Limitations:

-> Minimal wall thickness is 0.4 mm for DMLS ✓
0.3 - 0.5mm for SLM, 0.6 - 1mm for EBM

-> Limited amount of material powder is available.

-> Price of the material is high due to powder manufacturing process cost

-> Residual stresses.

-> Building volume is limited according to M/c.

Principle: Fundamental

The principle of Layer based technology is to compose a 3-dimensional physical object called "part" from many layers of equal thickness.

→ Each Layer is contoured according to the corresponding 3-dimensional data set & put on the top of the preceding one. Layers are called slices

{Additive Manufacturing process:}

Step-1 → CAD
" -2 → conversion to STL (standard Tessellation Lithography Language)
3 → Transfer to AM machine & STL file manipulation
4 → Machine setup
5 → Build
6 → Removal
7 → post processing

~~Common~~

8 → Application

(7) Step-3

The

Step-1 CAD

All ~~Any~~ parts must start from a software model that fully describes the external geometry.

→ This can involve the use of almost any professional CAD solid modeling software, but the output must be a 3D solid or surface representation

Step-2 : conversion to STL

Every CAD system ~~can output~~ ~~such~~ a have STL file format which describes the external closed surfaces of the original CAD model & forms the basis for calculation of the slices.

Step-3

The STL file describing the part must be transferred to the AM machine.

correct size, position, & orientation etc

Step-4

The AM machine must be properly setup prior to the build process. such as power sources, thickness of layer, timing materials used.

Step-5 Build

Building the part is mainly an automated process & the M/C can largely carry on without supervision.

Step-6 Removal:

once the AM machine has completed the build, the parts must be removed.

This may requires machine,

Step-7 post processing.

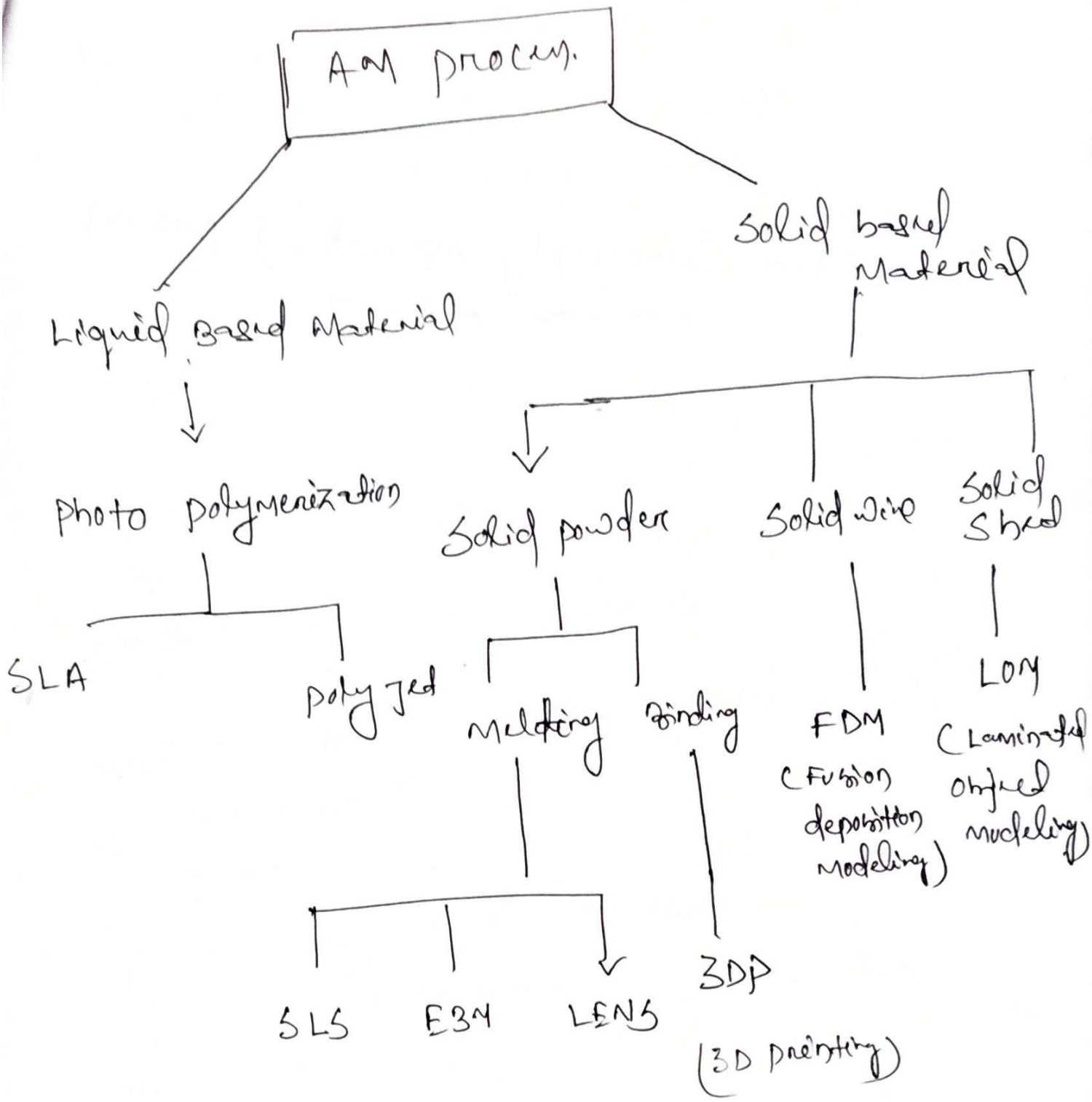
once removed from the machine, parts may require an amount of additional cleaning up before they are ready for use.

Step-8 Application:

parts may now be ready to be used.

for example-

Types of AM (Additive Manufacturing process)



SLS - Selective Laser Sintering

EBM — Electron Beam Melting

LENS — Laser Engr. Net Shaping

traditional machinery

Distinction Between AM & CNC Machining

CNC - (Computer Numerical Control).

CNC Machining is a Subtractive Manufacturing process controlled by computers & Remove Material from work piece. Automatically.

CNC	AM
→ computer based technology used to manufacture products	→ computer based technology used to manufacture products
→ Subtractive process i.e. (Removal of Material	→ Additive process i.e. deposition of material
→ CNC machines requires considerable setup & process planning.	→ AM technology can be used to produced a part in a single stage.
→ Takes more time to to manufacture the product	→ Take less time to manufacture product
→ older process of manufacturing	→ New technology used in manufacturing industry

AM	CNC
→ More efficient	→ less efficient
→ preferred for a few prototype parts or parts with complex design. & this process is slower than CNC	→ good for large scale production of parts, & faster & more economical than AM process.
→ less strength of product	→ product strength is high
→ Reducing the waste	→ More Generation of waste
→ AM works with plastic & metal ~~but~~ ~~which~~ ~~is~~ with their powder form, liquid form.	→ Substractive Manufacturing work with plastics & metal in their stock form.
→ complex operation	→ Easy operation
→ More accuracy	→ comparatively less.

LASER BEAM MELTING (SLM)

In the Laser beam melting process, a powder layer is first applied on a building platform with a re coater (blade or roller) & a Laser beam selectively melts the layer of powder.

→ Then the platform is lowered by 20 up to 100 μm & a new powder layer is applied. The Laser beam melting operation is repeated. After a few thousand cycles (depending on height of the part), the built part is removed from the powder bed.

→ During LBM (Laser beam melting) the Laser beam with diameter such as 100 μm, will locally melt the upper powder layer on the powder bed

→ The laser will be partially absorbed by metal powder particles, creating a melt pool which solidifies rapidly

→ Laser power varies from 200W – 1000W

Processable materials:

1. Steel alloys
2. Nickel based alloys
3. Aluminium alloys
4. Titanium alloys

Advantages:

→ good Accuracy

→ Alloys of Titanium, cobalt chrome can be fabricated

→ completely melt the powder

Advantages of SLA

→ Fast & effective

→ Applied to every Industry including oil Refining, petrochemical, Marine etc

→ Stereo lithography saves time, money, & it improves designs

Applications!

EBM (ELECTRON BEAM MELTING)

→ The EBM process is based on high power electron beam that generates the energy needed for high melting capacity & high productivity

→ The EBM process takes place in vacuum. & at high temperature, resulting in stress relieved components

→ For each layer in the build the electron beam heats the entire powder bed to an optimal ambient temp, specific for material used. As a result the parts produced with the EBM process are almost free from residual stresses

Advantages

-) EBM can produce high-quality metal parts as compared to Traditional methods.

-) EBM offers minimal waste (unused powder can be reused)

→ EBM process uses a beam several times more powerful than a laser.

Disadvantages!

→ Lower level of accuracy as compared to SLM (Selective Laser melting)

→ The choice of materials that can be used in the EBM process is rather limited.

→ Equipment cost is very high.

→ Material must be conductive

Metals — Steel powders, Nickel alloy titanium alloys

Applications (1) Medical, & Aerospace Ind

Advantages FMS

- Reduced Manufacturing cost
- Improved quality
- ~~Large~~ Large variety of ~~so~~ products
- Low labour cost
- Speedy production
- Flexible system
- Works with CAD/CAM
- ^

Disadvantages of FMS

- FMS is a complex system
- Requires Highly Skilled Technicians
- Needs High level of planning
- High Initial investment

CHAPTER-04

4.0 SPECIAL PURPOSE MACHINE

SPM

Defination : Special purpose Machines are designed & Manufactured for specific jobs and are never produced in bulk.

→ used for specific purpose (Manufacture of special type of product)

→ Also called **Bespoke Machines**

Ex: Hexagonal nuts, springs, (products)

Need of special purpose Machine

→ It gives very high productivity

→ less wastage of Material

→ Lower power consumption

→ Less amount of investment in the long term

→ Saves time due to use of SPM tools.

→ ~~[illegible]~~

→ Minimize ~~the~~ possibility of Human error

→ used ~~in~~ for Mass production

Example: — Gear cutting & gear grinding
or SPM Machines, Broaching Machines,
boring Machines, Lathe Machine.

SPM for metal cutting
Special purpose CNC Machine
SPM for vertical turning Machine
SPM for multi & simultaneous
operations such as drilling, milling
boring etc.

GPM (GPM =)	SPM
→ Flexible M/Cs that perform operations of different types	→ SPM perform operations of same type only
→ Initial investment is less.	→ Initial investment is high
→ They are slow in operation	→ They are fast in operation
→ They are suitable for batch production	→ Suitable for mass production
→ Manually operated	→ Automatic or semiautomatic

Designing of SPM includes the selection of necessary SPM elements & it is important that this selection process is automated to reduce the design time.

Principles of SPMs

good for high production quantities with low variety

→ SPMs are considered to be a new series of machine tools that produce high rate of produced parts.

→ SPMs have superior efficiency in increasing the quality & quantity of production lines

→ Engineers knowledge & experience are important in the SPM design process & apply this technology

The concept of SPMs

The basic units of SPMs

- Machining units
- Sliding units

Sliding units: Sliding units are used to carry the machining units, & they also supply the required feed motion during machining operations.

→ These units provides a flexible mounting of the machining units whether they are mounted perpendicular or parallel to the sliding direction depending on the requirements of the machining operations.

The concept of SPMs

In SPMs, different machining operations such as drilling, tapping, milling, reaming & cutting can be performed at the same time by using multiple machining units from different directions, while in the machining centre (which uses CNC), only one operation can be performed in the same cycle time.

For example - a part whose production involves 20 machining operation including drilling, reaming, milling etc can be machined in 1.6 minutes by SPMs. However, It takes about 20 minutes to perform the same operations for the same part in the traditional machining centre which proves the efficiency of SPMs

SPM design

Designing SPM is same as designing any machines.

1. Theory - Kinematics, Dynamics, Material science, Mathematics

2. Good knowledge of standard machine element : bearing, screws, shafts, etc.

3. Knowledge of machine drawings, how to produce documentation, projections, .. etc.

4. Good skills on CAD software.

Design procedure:

→ power required.
→ Design of spindle unit
→ " " spindle shaft
→ selection of Bearing
→ Design of Gear box
→ Selection of Lubrication

Productivity Improvement

① DFMA (Design for Manufacturing & Assembly) Approach.

This concept reveals the fact that design department should work in co-ordination with production department resulting in economic production process with saving in time & labour enhancing product quality

→ It can also be simply stated ~~that~~ as design for a product with manufacturing & assembly in mind

(i) The design should be done in least time with minimum cost of development

(ii) Smoothen the phases of transition from design to Manufacturing & Assembly

(iii) This helps to meet customer demand & achieve competitive position in market

(4)

1.1 DFA (Design for Assembly)

→ Significant cost of manufacturing is decided at the design stage of assembly.

Ex: components shape, size, etc.

1.2 DFM (Design for Manufacturing)

The designers tried to minimize total number of parts for simplification & cost reduction.

→ Assembly procedure of spindle unit

→ Assembly " for Gear box

→ Inspection after Assembly

S.O (CHAPTER-05)

Maintenance of Machine Tools ✓ [CNC]

M/C Tools!

A M/C tool is a machine for shaping or machining metal or other rigid materials. (cutting, boring, grinding tool) etc.

Need for M/C tool Maintenance!

→ M/C tools are properly maintained so that they remain in working condition at all the times

→ They manufacture the components most economically. for this machine tools are inspected periodically.

→ Wear of slideways, bearing & other components.

→ Dust, heat & humidity.

Causes of Equipment Breakdown!

→ Failure to replace worn out parts.

→ Lack of Lubrication.

-> Neglected cooling system

-> External factors (two low & two high voltage)

-> vibrations, heat

Maintenance approach:

The main objective of the maintenance is to avoid disruption to production & to ensure that the M/C produces at max^m efficiency.

Types of Maintenance:

① Periodic Maintenance – Maintenance performed on a calender basis.

② Planned Maintenance: – Maintenance that is performed purposely & Regularly

order to prevent a M/C from breakdown

(3) Predictive Maintenance:- Maintenance performed based on the known & expected behavior, condition & history of M/C.

(4) Preventive Maintenance: Maintenance performed while a M/C is still in working order to keep it from breaking down. it includes, lubricating tightening. & Replacing of parts

(5) Breakdown Maintenance: It implies that the repairs are made after the equipment is out of order & it can't perform its normal functions any longer.

Lamination — A Laminate is a material that can be constructed by uniting two or more layers of material together. The process of creating a laminate is called lamination.

Instruction Manuals:

In Industries, instruction manuals is essential (documents), which has to be supplied along with or at the time of receipt of any equipment / system, be it small or big.

→ The instruction manual may not be only in the form of a book, but may include many drawings, work cards, video cassettes, power points or any combinations of these.

→ It provides a permanent record of clear technical information, about the operation, maintenance, along with any special precautions etc.

The information needed from such ma. may be of following types.

(1) What is the equipment / system & what is it for?

(2) What does it consist of?

(3) How to use it?

(4) How does it work?

(5) How do we handle it? How to unpack, install?

(6) How to maintain it?

(7) What cares, precautions & safety measures are to be taken?

(8) Details of improvements / changes from specifications

(9) Who is the supplier, suppliers subcontractors etc.

Scope of supply – Items supplied (1)

by supplier / manufacturer & items / facilities needed from users / purchaser.

(3) Operating information :-

→ Description of operating ~~methods~~ modes.

→ procedures, with safety instructions

→ operation's fault diagnosis & also necessary minor repairs, etc.

→ procedure for monitoring & reporting defects / failure etc.

(4) Technical descriptions :

→ Full technical details of equipments

→ " " descriptions of parts / components

→ Full technical description of supporting equipments / instruments & facilities (power & drive sources, etc)

Based on the above mentioned requ... Handbook

the manuals are generally divided

into following sections :-

① Technical data (specification)

→ supply requirements, performance data (capacity, size, & rate of output, volume, pressure, speed etc.), dimensions, weight & other essential details.

→ Environmental factors, special safety & hazard warning & precautions in connection with the use & handling of that equipment.

→ List of data (reports, drawings, leaflets ...)

Handling Instructions:

→ Erection, installation & connection details

→ Testing, commissioning & certifying procedure.

→

(6) Maintenance Instructions:

→ various performance checklists & fault diagnosis instructions (daily, weekly, monthly)

→ procedure about minor repair etc.

(7) Maintenance schedule:

→ periodical oiling & lubrication schedules

→ preventive maintenance schedule

(8) Spare part Identification & Requirement

For smaller equipments, spare parts are mentioned in the same manual, but for bigger equipments, separate spare parts catalogue / lists are supplied.

Maintenance Record

Records — Records are worksheets, registers, logbooks, forms, etc. & are used to capture information, activities or results, when performing a procedure.

→ Essential for monitoring, tracking, failure identification etc.

Methods of Record Keeping:

Advantages:

→ It present a clear & ready reference picture of maintenance programmes.

→ Jobs held-up / stopped can be identified quickly.

Life cycle : The stage through which a repairable item passes from the time of its removal or replacement until it is reinstalled or placed in stock in a serviceable condition.

What is TPM (Total productive maintenance)

Ans: Total productive maintenance is a maintenance program which involves a newly defined concept of maintaining plants & equipments.

-> The goal of TPM program is to significantly increase the production, & at the same time increasing employees job satisfaction

N/B ~~Aim of~~ T

-> Zero Accident
-> Zero Health damage
-> Zero fine