Unit I

Advanced Abrasive machining Process

Machining :-

machining involves the removal of Some material from the Workpiece (M/c Allowance) in order to Produce a Specific geometry at a definite degree of accuracy and Surface Quality

MRP- Method

Material Removal Process

- Conventional machining
  - Turning & Associated process
  - milling & " "
  - Drilling " "
- Abrasive Process
  - Grinding Process
  - other abrasive Process
- Non traditional Process / Advanced machining process
  - Electrochemical machining
  - chemical machining
  - Thermal Energy process

Non traditional Machining

- Material removal mechanism is basically different from other Process
- Remove Excess material by Various techniques involving mechanical, thermal, Electrical or Chemical Energy
- These Processes do not use a sharp Cutting tools

Classification of Advanced mfcing Process

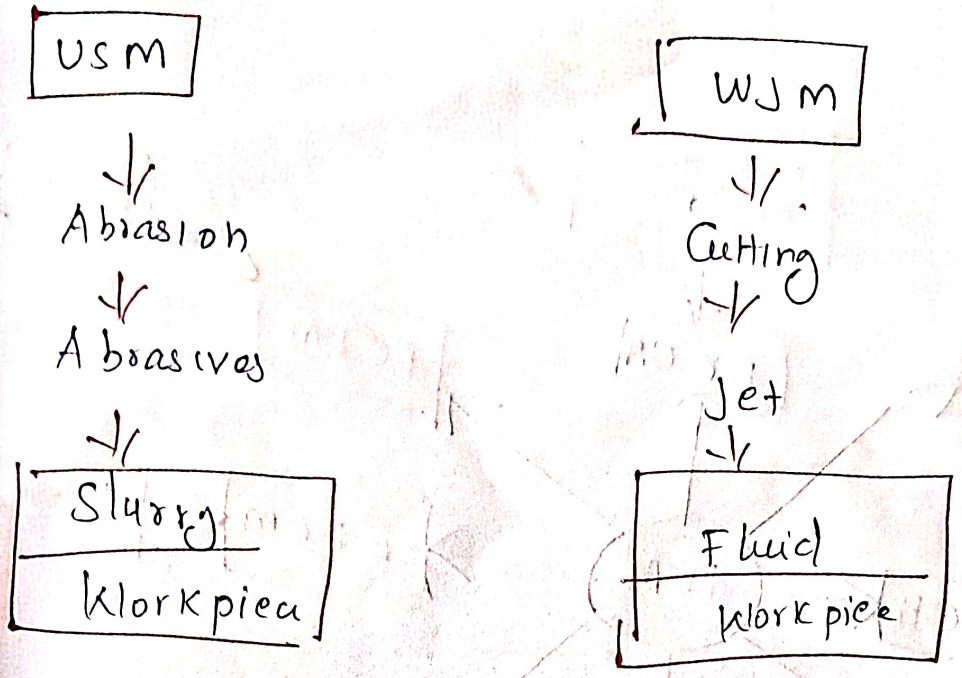
(1) Mechanical — Abrasive or fluid

(2) Thermal — material remove by fusion & Vaporiz

(3) Electro ~~thermal~~ chemical - reverse of electr

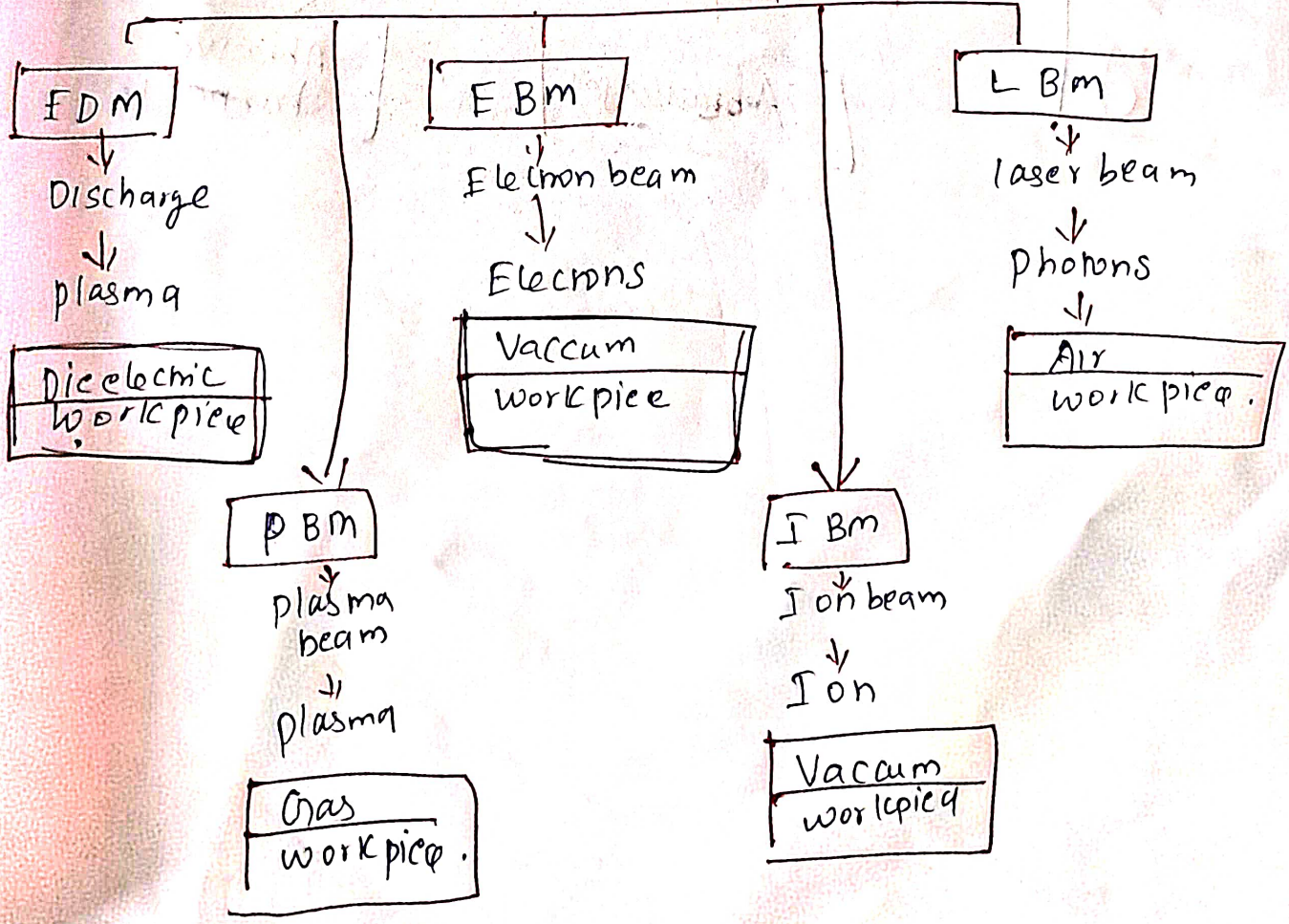
(4) Chemical — Chemical attact by acids & etchants

Mechanical Non-traditional Process

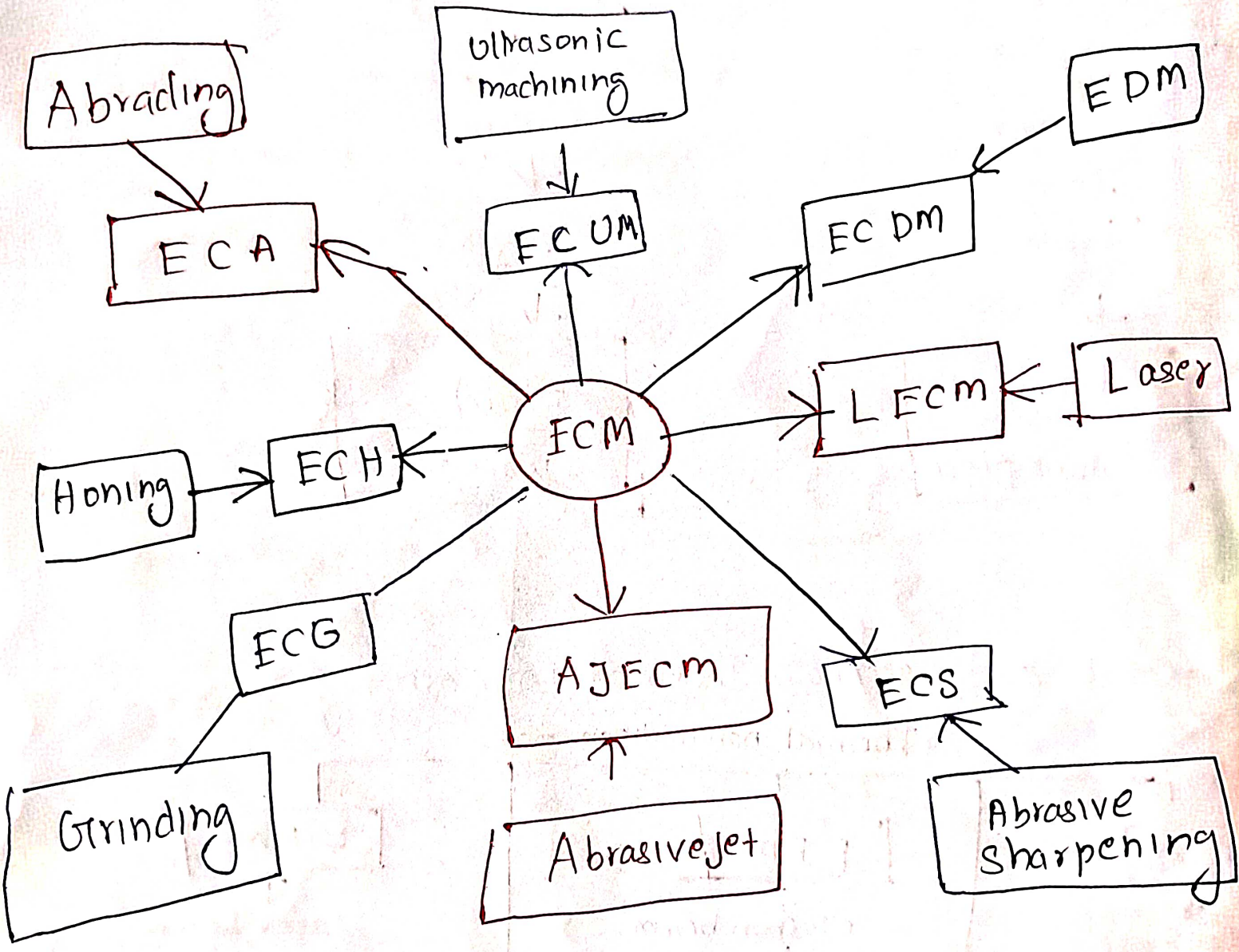


Thermal and electro-Thermal machining

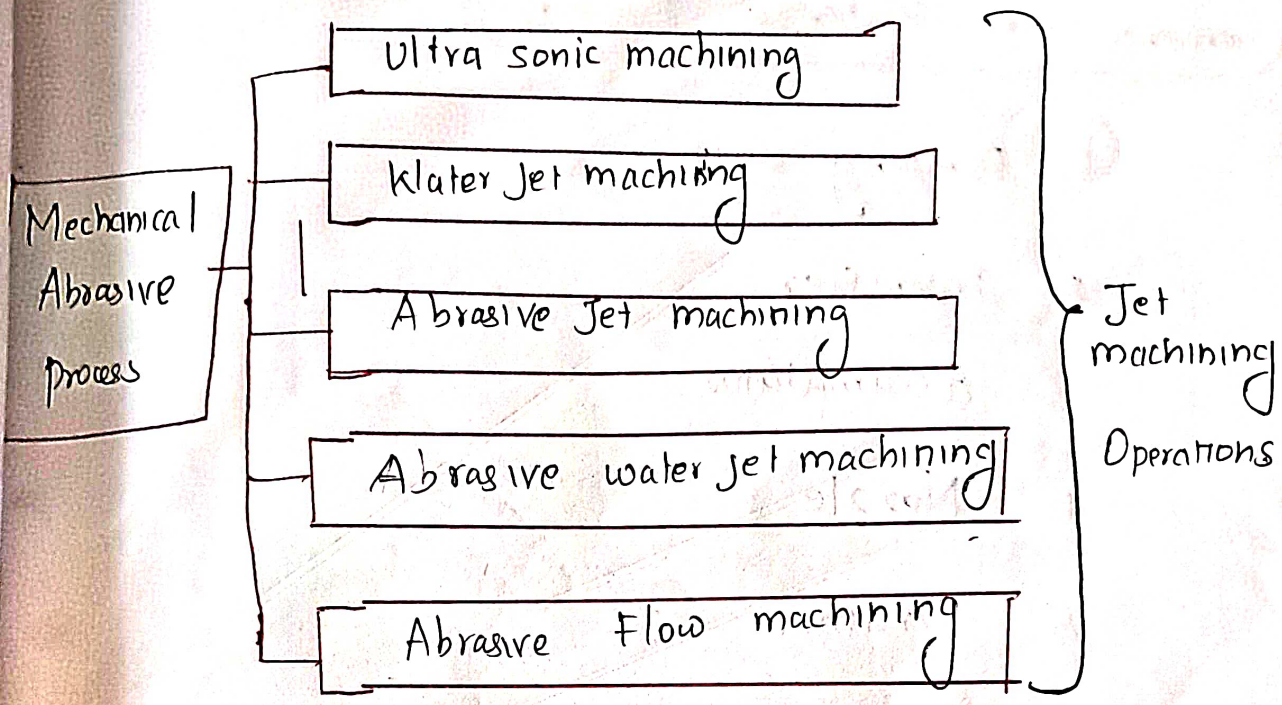
Thermal non tradition process



Hybrid machining Processes



Classification of Mechanical Abrasive Process



Water Jet machining (WJM)

- Removes material through the erosion effects of a high velocity. Small diameter jet of water
- When the stream strikes a workpiece surface the erosive force of water removes the material rapidly.

. The klater, in this case, acts like a saw as it cuts a narrow groove in the klorkpiece materi

Elements of klaterjet machining

1. Pumping unit
2. Intenifier
3. Accumalator
4. Nozzle
5. Drainer

Pumping unit:

- Pumping unit has the oil pump
- Electric motor is used to run the oil pum
- oil from the reservoir is pumped to an Intensifier

Intensifier:

- produce high Pressure klater
- klater pressure is 40 times higer than oil pressure
- BN

- Klater pressure calculated

$$P_w = (P_o \times A_o) / A_w$$

P_w = Klater Pressure

P_o = oil Pressure

A_o = Area of oil Piston

A_w = Area of klater piston

Accumalator:

- It is a container which is used to store high pressure klater to ensure the smooth out flow.
- Rigid h. pressure tubing and connector are used to tranfer the klater to nozzle from the accumalator

Nozzle

- Nozzle life (250 - 500hours)
- It is a synthetic material
- Dia range from 0.07mm to 0.50mm.

Catcher / Drainer:

It is used to absorb the residual energy of the water jet and dissipate the same

Dr. Karthikeyarathy

- Klater Pressure Calculated by following expression

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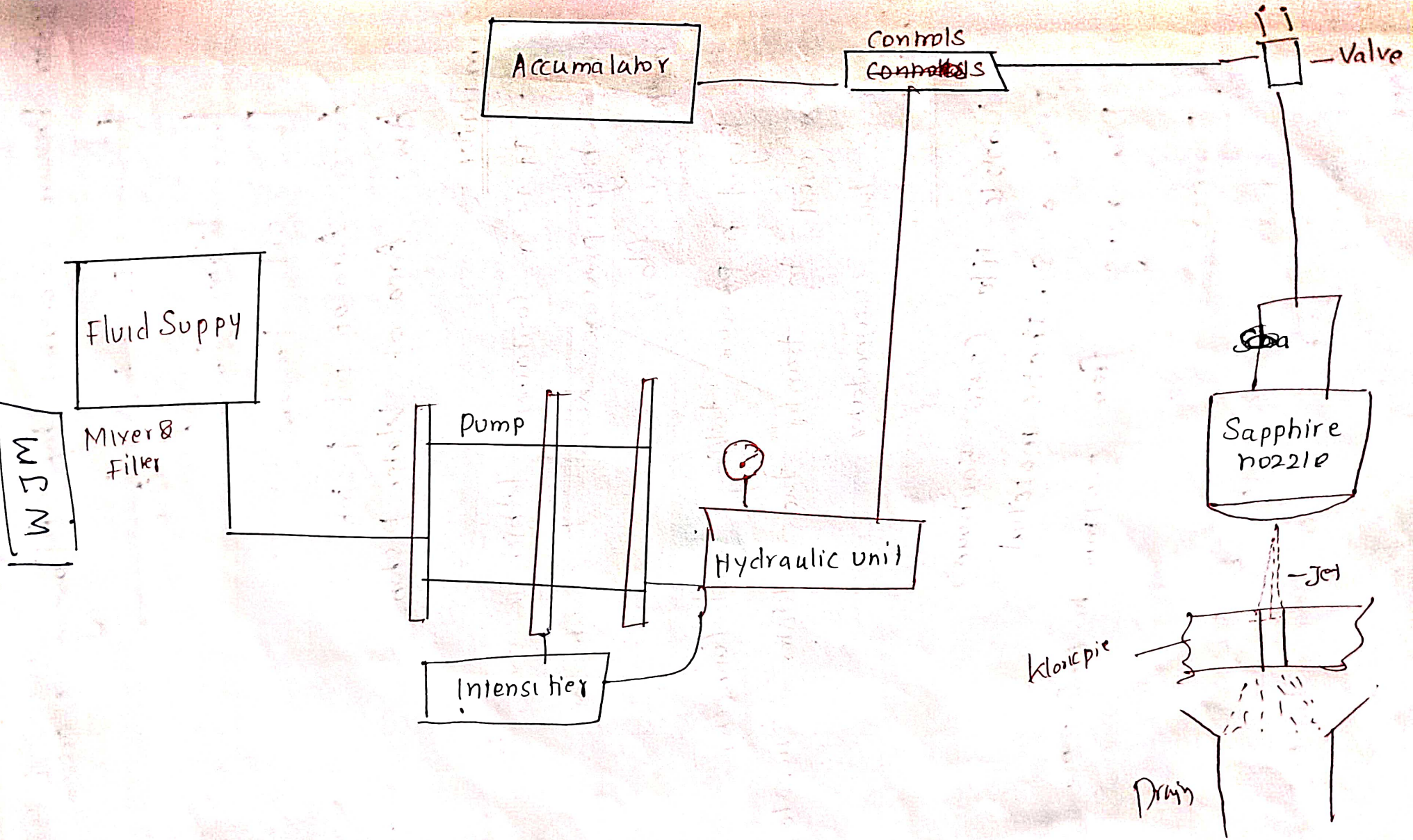
Klorking


Accumalator
Controls
Valve
Fluid Suppy
Mixer & Filter
WJM
Pump
Hydraulic unit
Intensifier
Sapphire nozzle
Jet
Klonicpie
Drain

Working Principles :

- Oil from the reservoir enters in to an Intensifier
- An intensifier raises the water pressure as high as 40 times than that of oil pressure
- Water is tranferred to accumalator which acts as a pressure vessel to store high pressure water to minimize the pulsation during operation.
- Water is transforted from accumalator to nozzle through pressure tubes.
- Nozzle delivers the water in the form of small diameter jet with he very high velocity usally around 900 m/sec
- When this high velocity jet of water hits the work surface, it erodes the material in the form of microchips

• In Water Jet machining Water jet is a Cutting tool which never dulls or breaks.

Process Parameter

1. Water Pressure
2. Diameter of nozzle
3. Traverse rate

Process capability:

• Non conductive material can be machined effectively
• Process doesn't require any Pre drilled hole to start Cutting.
• Machined surface does not have burs.
• Very thick material can be cut by more th one pass.

Advantages:

• Water is cheap
• Process requires limited Volume of Water (100-2
• Tool nozzle doesn't wear
• Very low cost
• Completely eliminates heat affected zones,

- most flexible and effective solution available for a variety of Industrial needs.
- The process provides clean and sharp cut
- It is applicable for laser reflective materials such as glass, copper and aluminium.

Limitations:

- WJM is not safe in operation if safety precautions are not strictly followed.
- Machine cost is high
- Need skill operator
- It is not suitable for mass production.

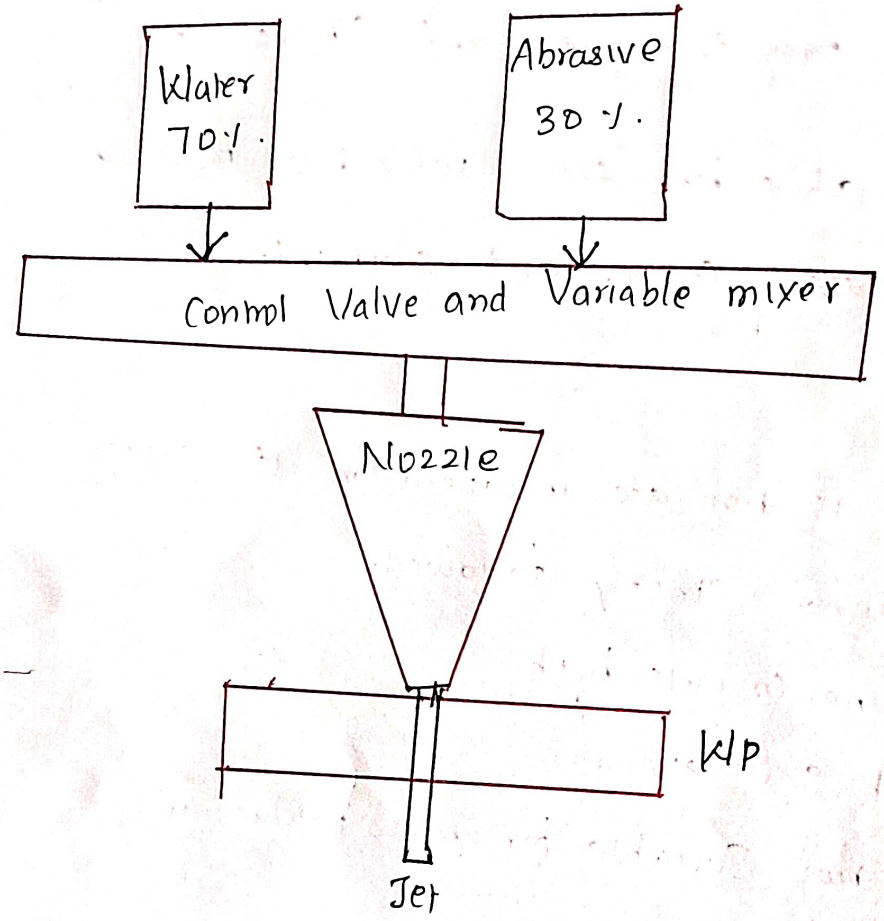
Disadvantages:

- Very thick parts can't be cut with Water Jet Cutting
- Dimension accuracy is also the problem
- Taper is a problem with water Jet Cutting in very thick materials.

Applications:

- Aerospace industries
- Ship building industry
- Cutting of rocks, granite

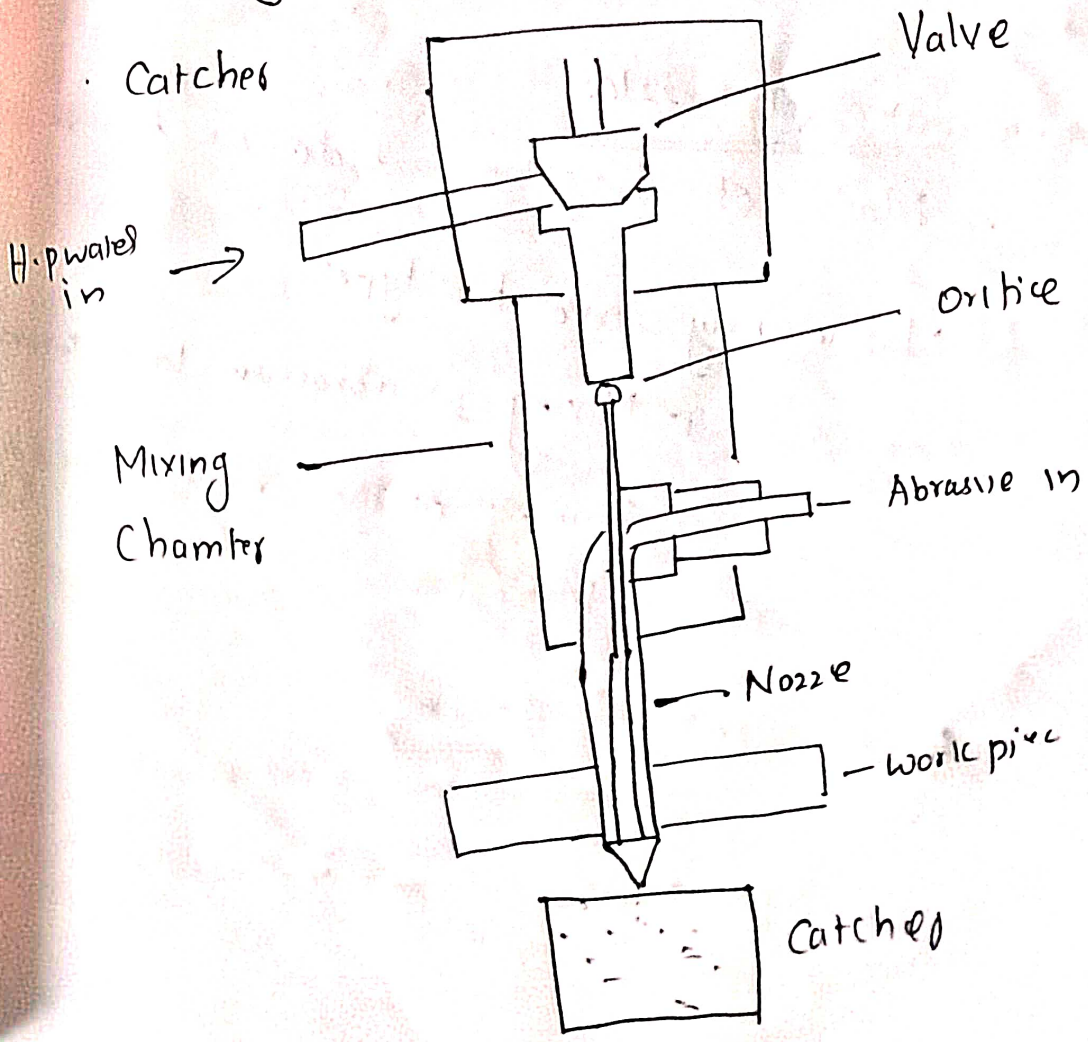
Abrasive Jet machining (AJM)



- Only use Pure water for machining process
- It is Suitable for Cutting plastics, foods rubber Insulation.
- Mixing of Abrasive with water jet enhance the material removal rate

machine system

- Water delivery
- Abrasive hooper and feeder
- Intensifier
- Filter
- Mixing chamber
- Cutting Nozzle
- Catcher



Pumping unit:

Supply h.p Water to mixing chamber.

Abrasive feed system

- Control the Supply of Abrasive Particles to nozzle.
- Two types of Abrasive system
  - (i) Ste dry abrasive delivers to nozzle
  - (ii) Mixed abrasive delivers to feed system

Abrasive water jet nozzle:

- Made of tungsten Carbide or boron Carbide

Nozzle may serve two types

1. Mixing of abrasive with water
2. Forming of the high velocity abrasive Water jet

Based on internal design

(i) Single side feed jet jet nozzle

(2) Multi jet Central feed nozzle.

Catcher:

- It uses the hard and replaceable inserts to break the jet Quickly and Completely.
- Cather is used to absorb the residual energy of the Klater jet and dissipate the same.

Klorking principle:

- Abrasive Comming from two direction mixup & flow through nozzle.
- Velocity of abrasives rises rapidly by gaining the momentum of Klater jet
- The Pressure of Klater is maintained about 400Mpa Klhich produces a jet Speed of about 900 mlsec.
- This Velocity Strike the Klorkpiece and has the ability to machine Ceramics, Composites rocks etc.

Process Parameter:

1. Pressure of Klater
2. Mass flow rate of Kater
3. Size of the abrasive particle
4. Abrasive flow rate.

Application:-

1. Metal and non metal can cut

   Metal - copper, Aluminium tungsten Carbide

   Non-metals - Silica, glass graphite

Advantages:

- economical
- No need Secondry operation
- No Cutter induced distortion
- Low Cutting forces on work piece
- No need of direct physical tool
- No heat affected zone

Disadvantages:-

- Can't drill flat bottom
- Cant cut the material Quickly
- Frequently used for rough cutting

Cause Study - klater Jet machining

A leading aerospace parts manufacturer, Specializing in Complex Components for Commercial and military aircraft faced challenges in machining intricate geometries from tough materials like titanium and Composites.

Problem statement:

Milling and laser Cutting were either too slow for intricate design or Caused undesireable thermal effects like heat affected zones in sensitive materials. The mfg needed a Precise, efficient, and Versatile Cutting Solution.

Solution WJM

1. Precision Cutting

klJm Can achieve high precision (±0.001 inch) Suitable for Complex geometries klith out Compromising material integrity

2. Versatility:

It Can Cut · klide rage of Materials including metals Caluminum, tita Composites · glass, Ceramics with minimum changes

3 No thermal damage:-

Unlike traditional methods, Waterjet machining is a cold cutting process, eliminating thermal Stress and HAZ, Crucial for maintaining material Properties in aero Space Components.

Implementation:-

. Prototyping :- RPT of few Component design to Verify fit and function.

. Production: Batch production of Complex Parts with Consistent Quality and reduced Lead time Compared to traditional method.

Results:-

Improved efficiency

1. Reduce m/c time
2. faster Cutting
3. minimal Secondry operations.

Cost Saving:-

1. lower Bodily cost
2. reduce the scrap rate

Quality assurance:- Precise Cut

Conclusion :-

WJM ~~providing~~ proved to be a game changer for the aerospace manufactures offering reliable solution for complex component manufacturing with improved efficiency, reduce cost and superior Quality

This Cause Study highlight how waterjet machining can address specific challenges in aerospace manufacturing demonstrating its application beyond traditional methods.

Case Study - AJM

Automotive Parts Supplier Specializing in Precision Components faced Challenges in efficient machining intricate future on hardned Steel Components for high Performance engines.

Problem Statement:.

milling, grinding where either slow for Intricate designs or Caused excessive tool Wear due to the hardness of the materials. The Supplier need a precise and Cost effective method to achieve intricate geometries Without Compromising on Surface finish and dimensional accuracy.

Solution:. - AJm

1. High Precision (0.1 mm)

2. Material Capatibility : It is effect for machining hard materials Such as tool Steel and alloys without including thermal damage or altering material Properties.

3. Flexibily : AJm Can be easily automated for batch production and is capable for milling

4. Cost efficiency:

lower tooling cost and reduceselop times

Compared to traditional grinding or EDM proces.

Implementation :.

The ~~each~~ automotive Pass Soppler integrated AJM into Production line for:.

Valve Seat Machining:.

precision maching of Valve

Seats and Gude in engine cylinder heads to Oprimize Combustion efficieny and Performanc.

Turbo Charger Componenks :.

MIcing turbine blades and impellers with Complex internal Passages and Profile to improve airflow and efficieny.

Resolts :.

Improved Productivity

Enhanced Quality

Cost effectiveness

Conclusion :-

AJM proved to be a high effective Solution for the automotive Parts Supplier offering precise and efficient machining capabilities for high Performance engine Components

This Case Study illustrates how abrasive Jet machining can address specific challenges in Automotive Component manufacturing, Providing a Competitive edge through advanced milling technology tailored to the demands of precision engineering in the automotive industry.