# SNS COLLEGE OF TECHNOLOGY

## Department of Aerospace Engineering

19AST202-Aircraft Production Technology

UNIT III POWDER METALLURGY AND UNCONVENTIONAL MACHINING

Principles of working and applications of Water and Abrasive jets

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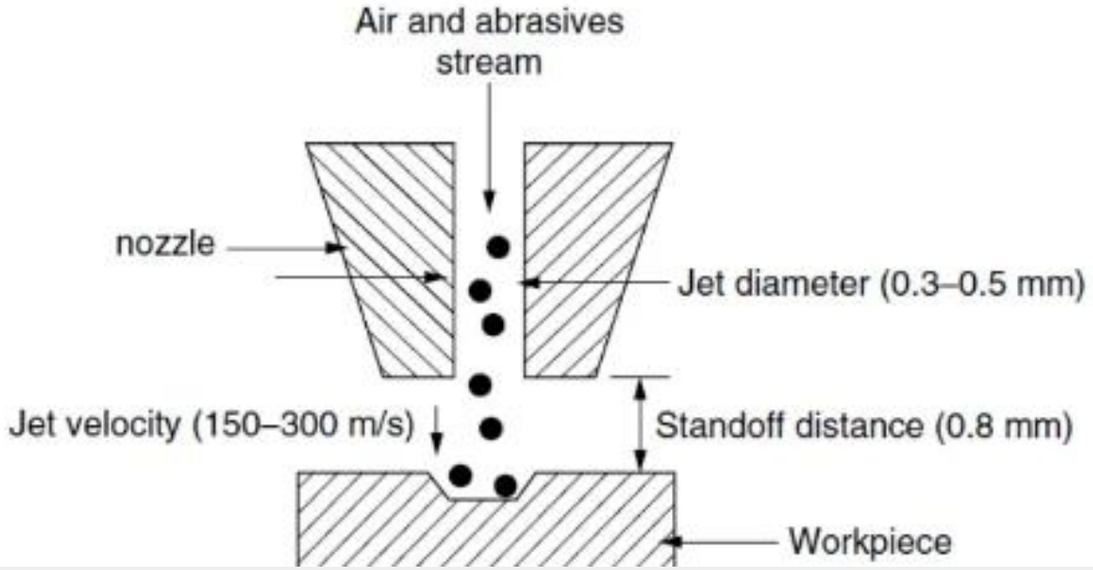
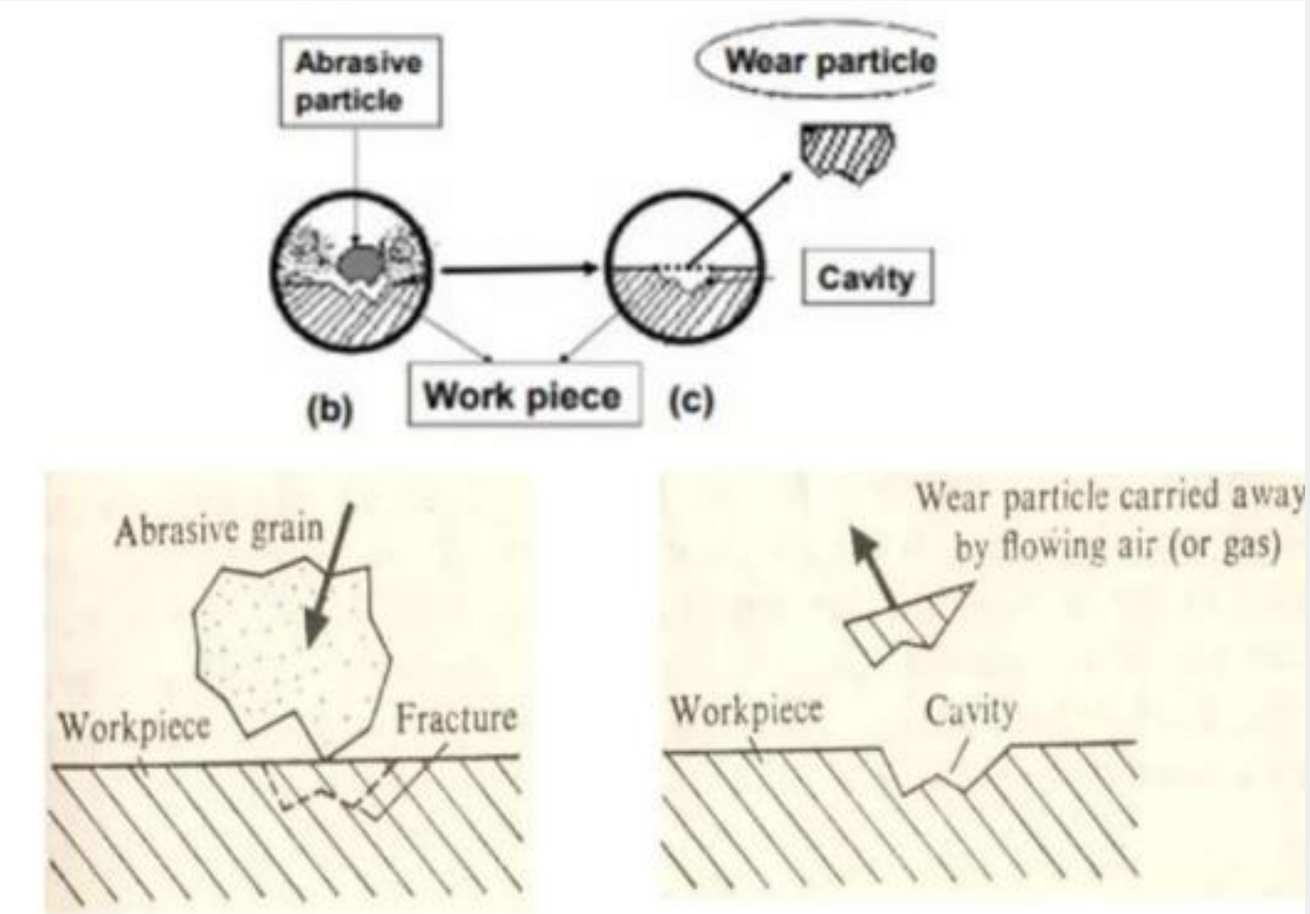
Water and Abrasive jets

## Abrasive Jet Machining (AJM)

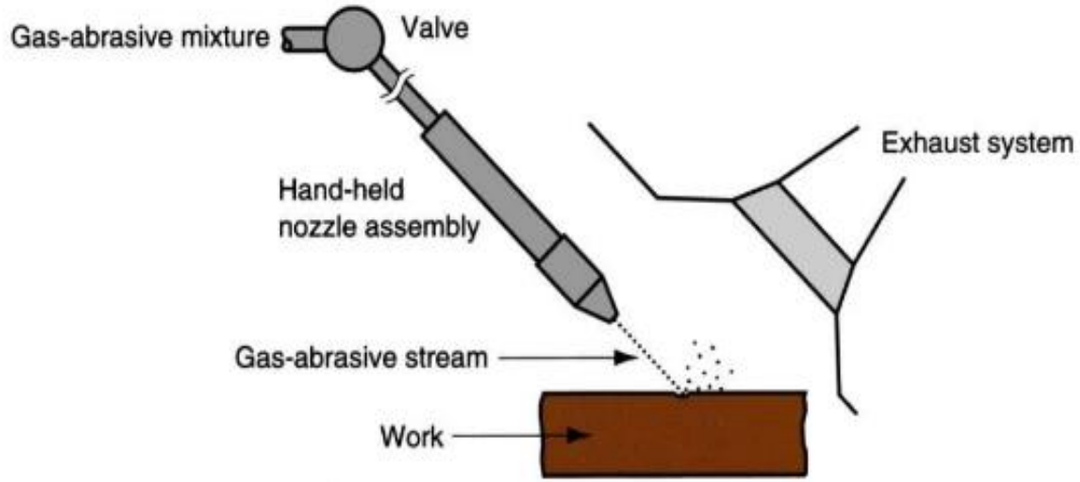
In abrasive jet machining process, a high speed stream of abrasiv particles mixed with high pressure air or gas are injected through nozzle on the workpiece to be machined.



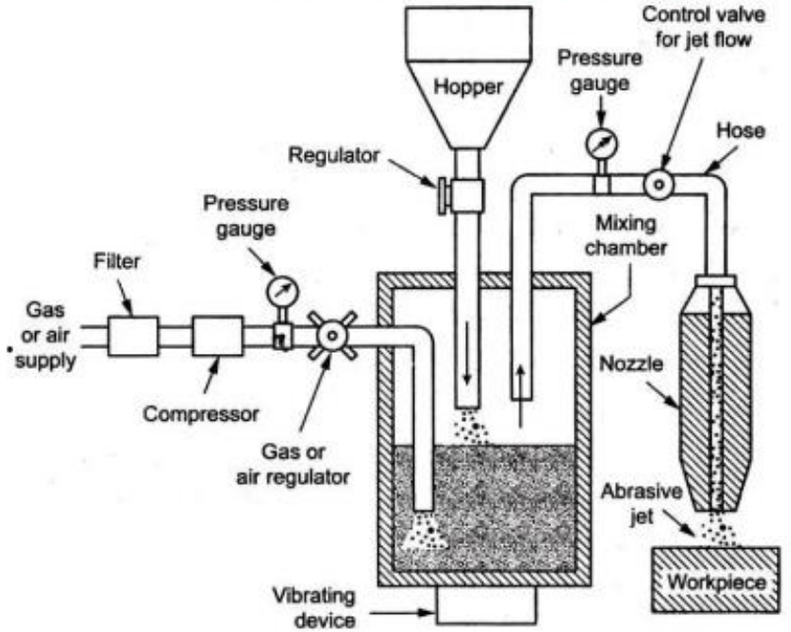
Water and Abrasive jets



## Abrasive Jet Machining

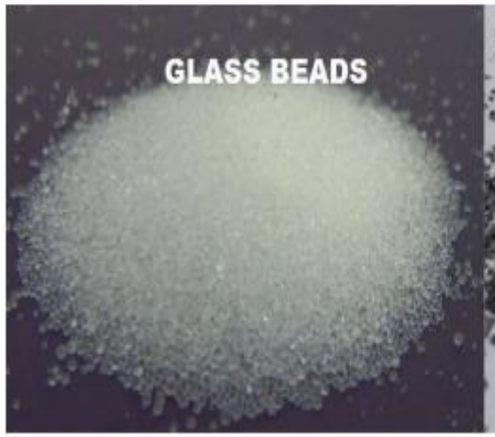



## Arrangement of Abrasive Jet Machining (AJM)



## Construction details

| | |
|---|---|
| Gas Used | Nitrogen , Carbon di-oxide , compressed air |
| Abrasive Particles Used | Aluminium oxide , Silicon Carbide, Glass Powder , Dolomite and Specially Prepared sodium bicarbonate |
| Nozzle | Tungsten Carbide , Synthetic Sapphire (Ceramic) |





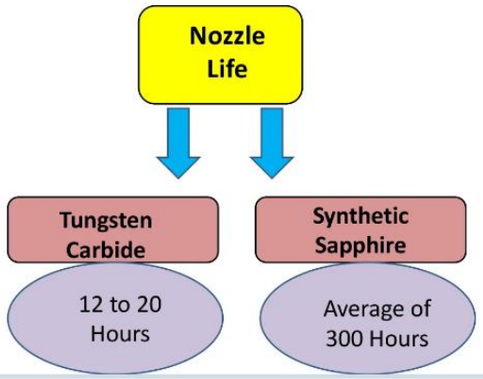

## Construction details

### Abrasive Particle Sizes

- Aluminium oxide ($Al_2O_3$ ) - 10 to 50 microns
- Silicon Carbide (SiC) - 25 and 50 Microns
- Glass Powder - 0.3 to 0.6 mm

## Abrasives used in Abrasive Jet Machining:

| Abrasives | Grain Sizes | Application |
|---|---|---|
| Aluminium oxide($Al_2O_3$) | 12, 20, 50 microns | Good for cleaning, cutting and deburring |
| Silicon carbide (SiC) | 25,40 microns | Used for similar application but for hard material |
| Glass beads | 0.635 to 1.27mm | Gives matte finish |
| Dolomite | 200 mesh | Etching and polishing |
| Sodium bi carbonate | 27 microns | Cleaning, deburring and cutting of soft material |



The Shape and Size of Cut is controlled by a movement adjusting mechanism given to work piece or Tool

Cam Mechanism

Pantograph Mechanism

Air Pressure

2 Kg/cm2 to 8 Kg/cm2

AJM

**Process criteria** : For successful utilization of AJM process, it is necessary to analyze the following process criteria.

1. Material removal rate
2. Geometry and surface finish of work piece
3. wear rate of the nozzle

**Process parameters:** Process criteria are influenced by the following process parameters as enumerated below:

1. Abrasives
2. Carrier Gas
3. Abrasive Jet
4. Nozzle.

## MRR - PARAMETERS

1. Mass flow rate.
2. Abrasive grain size.
3. Gas pressure.
4. Velocity of abrasive particles.
5. Mixing ratio.
6. Nozzle tip clearance.

## Advantages

1. We can cut all kind of materials
2. No heat produced in process , so no thermal damage
3. Very thin and brittle material can be machined
4. Low initial investment
5. Good Surface Finish
6. Intricate holes can be cut in hard and brittle material

## Dis-Advantages

1. Low MRR
2. Soft Material cannot be machined
3. Machining accuracy is poor
4. Nozzle Wear Rate is High
5. Abrasive Powder cannot be reused
6. Embedding of Abrasive particle in work piece is the high damage thing in this process
7. It requires Dust Collection System

## Application

1. Machining of hard and brittle materials like quartz, ceramics, glass, sapphire, etc.
2. Fine drilling and microwelding.
3. Machining of semi-conductors.
4. Machining of intricate profiles on hard and brittle materials.
5. Cleaning and polishing of plastics, nylon and teflon components.
6. Frosting of the interior surface of the glass tubes.
7. Surface etching and surface preparation.

## Characteristics of AJM

| | | |
|---|---|---|
| Work material | – | Hard and brittle materials like glass, quartz, ceramics, mica, *etc.* |
| Abrasive | – | Aluminium oxide ($Al_2O_3$), Silicon carbide (SiC), Glass powder, dolomite. |
| Size of abrasive | – | Around 25 µm |
| Flow rate | – | 2 – 20 g/min |
| Medium | – | $N_2$ (or) $CO_2$ (or) Air |
| Velocity | – | 125 – 300 m/s |
| Pressure | – | 2 to 8 kg /$cm^2$ |
| Nozzle material | – | Tungsten carbide (WC) or synthetic sapphire |
| Life of nozzle | – | Tungsten carbide – 12 to 20 hours<br>Sapphire – 300 hours |
| Nozzle tip clearance | – | 0.25 to 15 mm |
| Tolerance | – | ± 0.05 mm |
| Machining operation | – | Drilling, cutting, deburring, cleaning, *etc.* |

# WATER JET MACHINING

## Introduction

Water Jet Machining (WJM) process is an extension of abrasive jet machining process. In this process, high pressure and high velocity stream of water is used to cut the relatively soft and non-metallic materials like paper boards, wood, plastics, rubber, fibre glass, leather, *etc.*

## Principle

When the high velocity of water jet comes out of the nozzle and strikes the material, its kinetic energy is converted into pressure energy including high stresses in the work material. When this induced stress exceeds the ultimate shear stress of the material, small chips of the material get loosened and fresh surface is exposed.

### PARTS

- Pump
- Accumulator
- Control Valve
- Regulating Chamber
- Nozzle

**Pump or Intensifier**

Used to Increase the water Pressure Up to 1500 – 4000 N / $mm^2$

**Accumulator**

Used to Store the water

Used to avoid water Pulsation

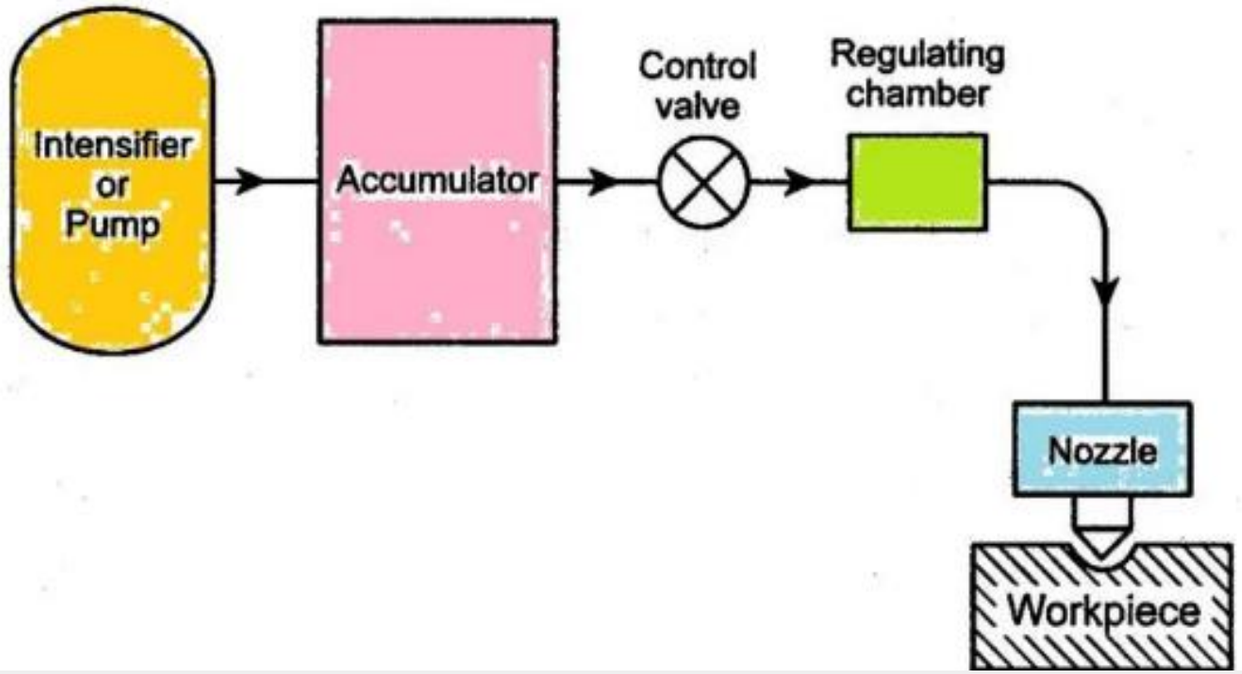
## Nozzle

- Used to Increase the velocity of water jet
- Made up of Sintered Diamond, Tungsten Carbide and Synthetic Sapphire
- Nozzle Exit Diameter 0.05 – 0.35mm
- Velocity of Water Jet From Nozzle 920 m/s

## Regulating Chamber

- Used to Control the flow of water jet to Nozzle

## WJM




## PROCESS PARAMETERS

(*i*) Material Removal Rate (MRR).

(*ii*) Geometry and surface finish of work material.

(*iii*) Wear rate of the nozzle.

Geometry and surface finish of work material mainly depends upon the following parameters.

1. Nozzle design,
2. Jet velocity,
3. Cutting speed,
4. Depth of cut, and
5. Properties of the material to be machined.

Nozzle wear rate depends upon the following factors.

1. Hardness of the nozzle material,
2. Pressure of the jet,
3. Velocity of the jet, and
4. Nozzle design.

## ADVANTAGES

1. In WJM process, water is used as energy transfer medium. It is cheap, non-toxic and easy to dispose.
2. Low operating cost.
3. Low maintenance cost.
4. The work area remains clean and dust free.
5. Very less amount of heat is generated during cutting operation. So, there is no thermal damage to the work.
6. Easily automated.

## DIS-ADVANTAGES

1. Initial cost of this process is high.
2. It is difficult to machine hard material.
3. Noise operation.

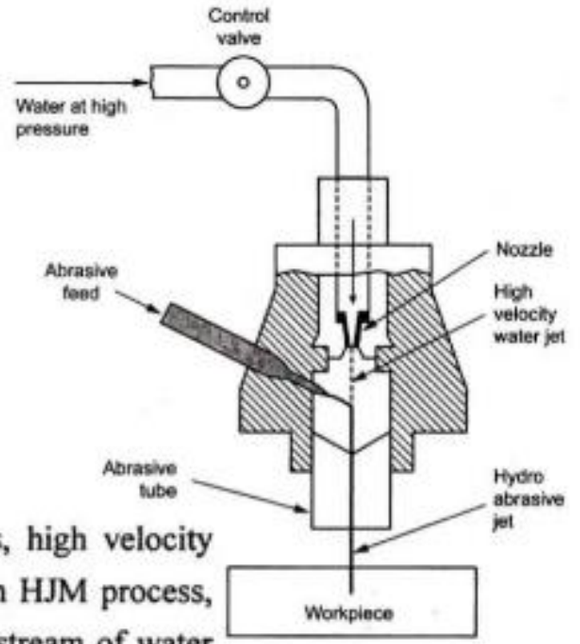
## APPLICATION

1. This process is very convenient for cutting relatively soft and non-metallic materials like paper boards, plastic, wood, rubber, leather, fibre glass, *etc.*
2. It can be used to cut intricate contours.


WATER JET

# Abrasive Water jet Machining

## Hydro-dynamic jet Machining




In WJM process, high velocity stream of water jet is used to cut the material. But in HJM process, abrasive particles are also added to the high velocity stream of water jet.

The mixture of water and abrasives that comes out of the nozzle with very high velocity are directed to the workpiece. The material is removed from the workpiece due to combined effect of abrasion and water impact.

Any material can be cut through this process by using proper abrasive and adequate water pressure.


Thank You!