UNIT II

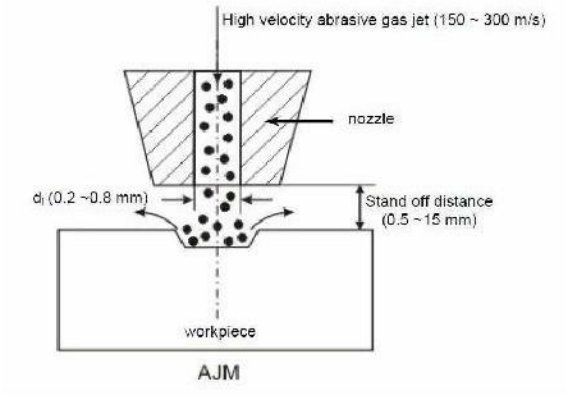
MECHANICAL ENERGY BASED PROCESSES

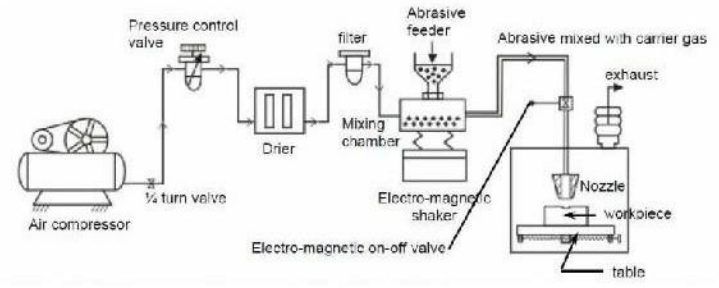
ABRASIVE JET MACHINING (AJM) :

WORKING PRINCIPLES:

In Abrasive Jet Machining (AJM), abrasive particles are made to impinge on the work material at a high velocity. The high velocity abrasive particles remove the material by micro-cutting action as well as brittle fracture of the work material. In AJM, generally, the abrasive particles of around 50 μm grit size would impinge on the work material at velocity of 200 m/s from a nozzle of I.D. of 0.5 mm with a standoff distance of around 2 mm. The kinetic energy of the abrasive particles would be sufficient to provide material removal due to brittle fracture of the work piece or even micro cutting by the abrasives.

EQUIPMENT USED :





Skematic Arrangement Of AJM

PROCESS PARAMETERS :

Abrasive : Material – Al2O3 / SiC / glass beads

Shape – irregular / spherical

Size – 10 ~ 50 μm

Mass flow rate – 2 ~ 20 gm/min

Carrier gas : Composition – Air, CO2, N2

Density – Air ~ 1.3 kg/m3

Velocity – 500 ~ 700 m/s

Pressure – 2 ~ 10 bar

Flow rate – 5 ~ 30 lpm

Abrasive Jet : Velocity – 100 ~ 300 m/s

Mixing ratio – mass flow ratio of abrasive to gas

Stand-off distance – 0.5 ~ 5 mm

Impingement Angle – 600 ~ 900

Nozzle : Material – WC

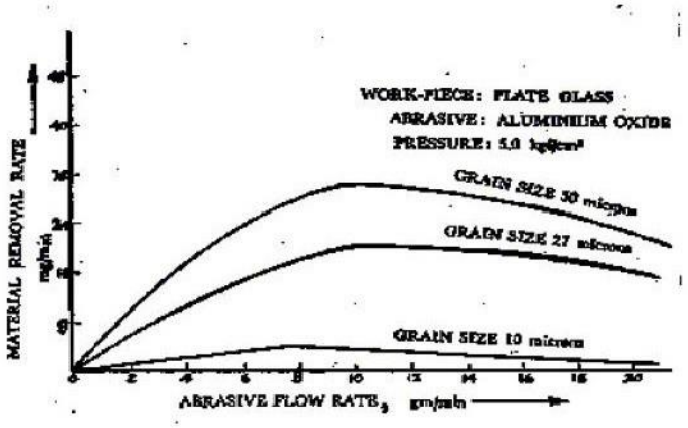
Diameter – (Internal) 0.2 ~ 0.8 mm

Life – 10 ~ 300 hours

MATERIAL REMOVAL RATE (MRR) :

1.Effect of abrasive flow rate and grain size on MRR :

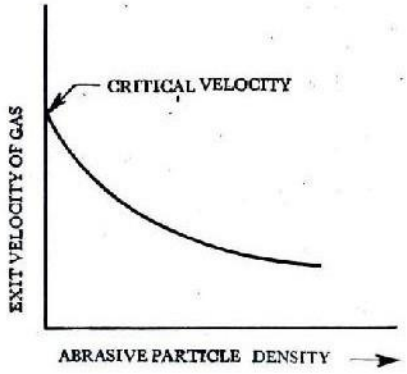
It is clear from the figure that at a particular pressure MRR increase with increase of abrasive flow rate and is influenced by size of abrasive particles. But after reaching optimum value, MRR decreases with further increase of abrasive flow rate.



This is owing to the fact that Mass flow rate of gas decreases with increase of abrasive flow rate and hence mixing ratio increases causing a decrease in material removal rate because of decreasing energy available for erosion.

2. Effect of exit gas velocity and abrasive particle density :

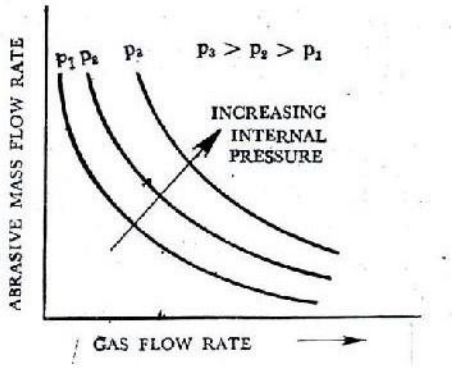
The velocity of carrier gas conveying the abrasive particles changes considerably with the change of abrasive particle density as indicated in figure. The exit velocity of gas can be increased to critical velocity when the internal gas pressure is nearly twice the pressure at exit of nozzle for the abrasive particle density is zero. If the density of abrasive particles is gradually increased exit velocity will go on decreasing for the same pressure condition. It is due to fact that Kinetic energy of gas is utilized for transporting the abrasive particle.



3.Effect of Nozzle pressure on MRR :

The abrasive flow rate can be increased by increasing the flow rate of the carrier gas. This is only possible by increasing the internal gas pressure as shown in the figure. As the internal gas pressure increases abrasive mass flow rate increase and thus MRR

increases. As a matter of fact, the material removal rate will increase with the increase in gas pressure Kinetic energy of the abrasive particles is responsible for the removal of material by erosion process. The abrasive must impinge on the work surface with minimum velocity for machining glass by SIC particle is found to be around 150m/s.



APPLICATIONS :

(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.

WATER JET MACHINING (WJM) :

Water jet cutting can reduce the costs and speed up the processes by eliminating or reducing expensive secondary machining process. Since no heat is applied on the materials, cut edges are clean with minimal burr. Problems such as cracked edge defects, crystalisation, hardening, reduced wealdability and machinability are reduced in this process.

WORKING PRINCIPLES :

Water jet technology uses the principle of pressurizing water to extremely high pressures, and allowing the water to escape through a very small opening called "orifice" or "jewel". Water jet cutting uses the beam of water exiting the orifice to cut soft materials. This method is not suitable for cutting hard materials.

EQUIPMENT USED :

The inlet water is typically pressurised between 1300 –4000 bars. This high pressure is forced through a tiny hole in the jewel, which is typically 0.18 to 0.4 mm in diameter.

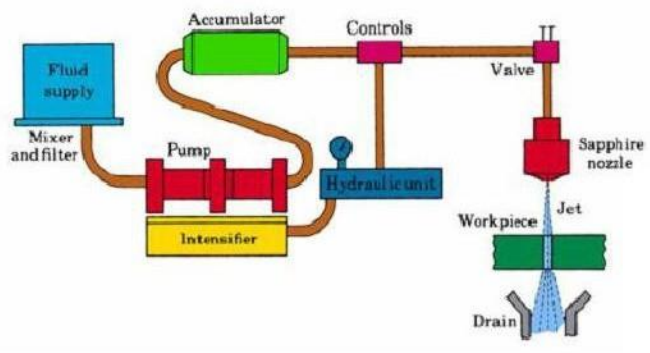


Fig : Water Jet Machining

PROCESS PARAMETERS :

Water Jet : Velocity – 100 ~ 300 m/s

Mixing ratio – mass flow ratio of abrasive to gas

Stand-off distance – 0.5 ~ 5 mm

Impingement Angle – 60°~ 90°

Nozzle : Material – WC

Diameter – (Internal) 0.2 ~ 0.8 mm

Life – 10 ~ 300 hours

MATERIAL REMOVAL RATE (MRR) :

Material removal rate is directly proportional to the force of the jet.

$$MRR \alpha m v$$

Where,

m = mass flow rate

v = velocity of water jet