Unconventional Machining Processes

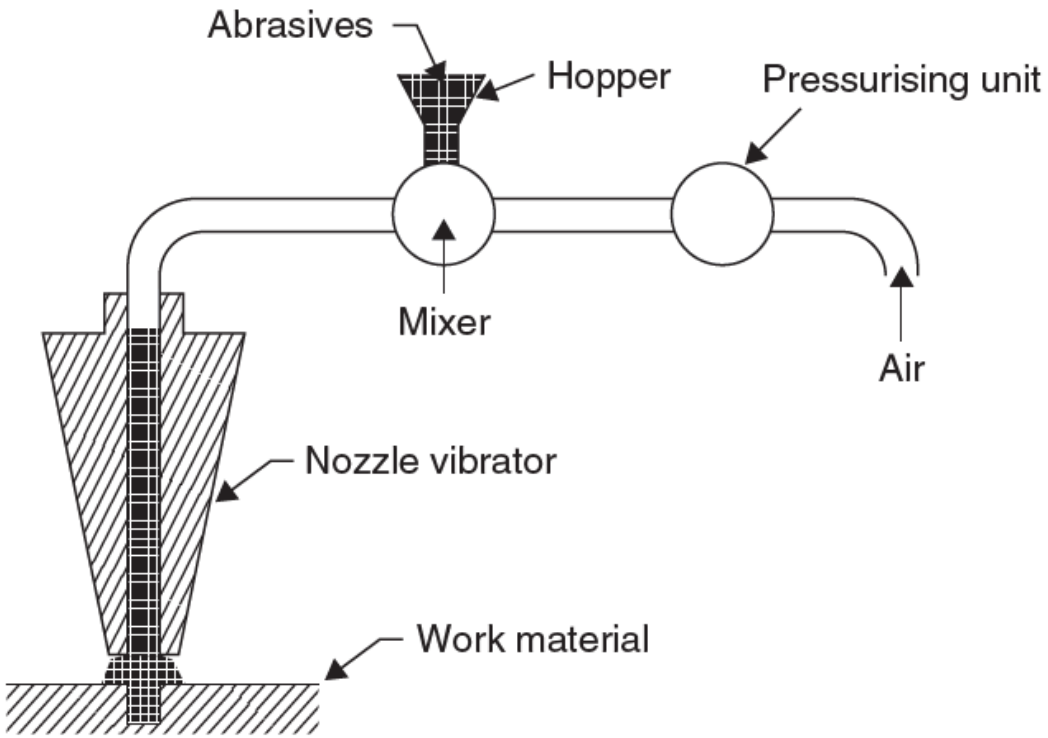
Unconventional machining (UCM) process is completely non-mechanical. In this process, there is no chip formation. Melting and evaporation of unwanted metal or removal of the metal in the form of powder due to brittle fracture of the metallic layers performs machining operation. These processes are used for machining of difficult profile and for very hard materials

Main Characteristics of UCM

The main characteristics of UCM can be summarized as follows:

- There is no chip formation.
- No residual stress set-up in work materials.
- There is no mechanical contact of tool and work materials.
- Tools wear is lesser compared to conventional process.
- Tool need not to be harder than work material.
- Better surface finish and close tolerance may be achieved.
- Intricate shape, very hard, and fragile materials can be machined.

ABRASIVE JET MACHINING (AJM)



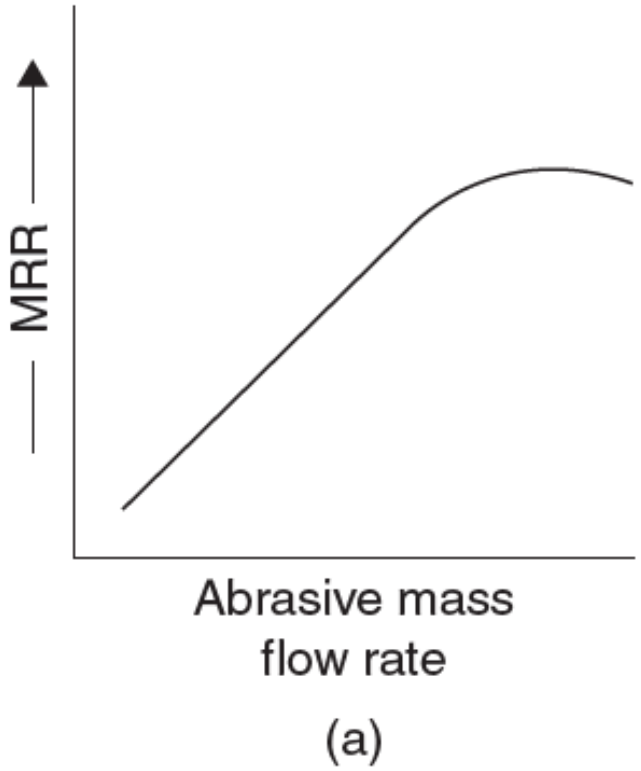
A Conceptual Diagram for AJM

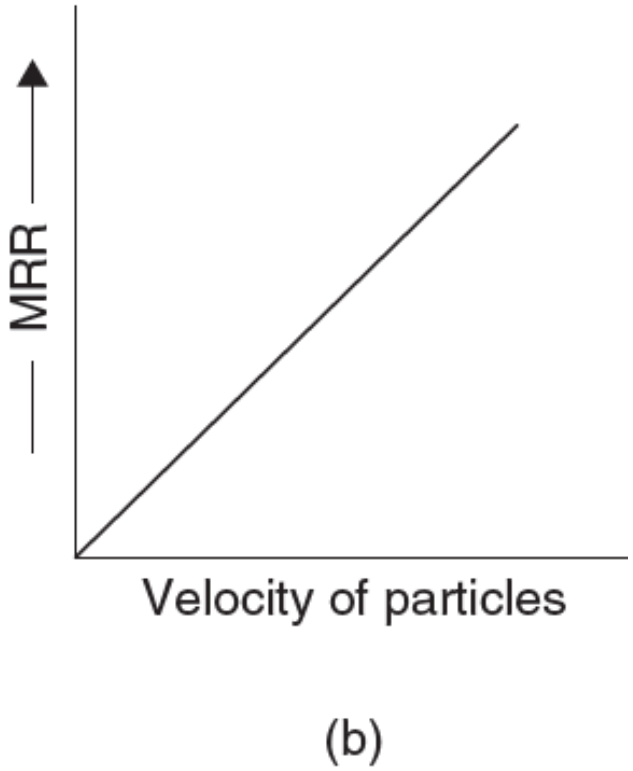
ABRASIVE JET MACHINING (AJM)

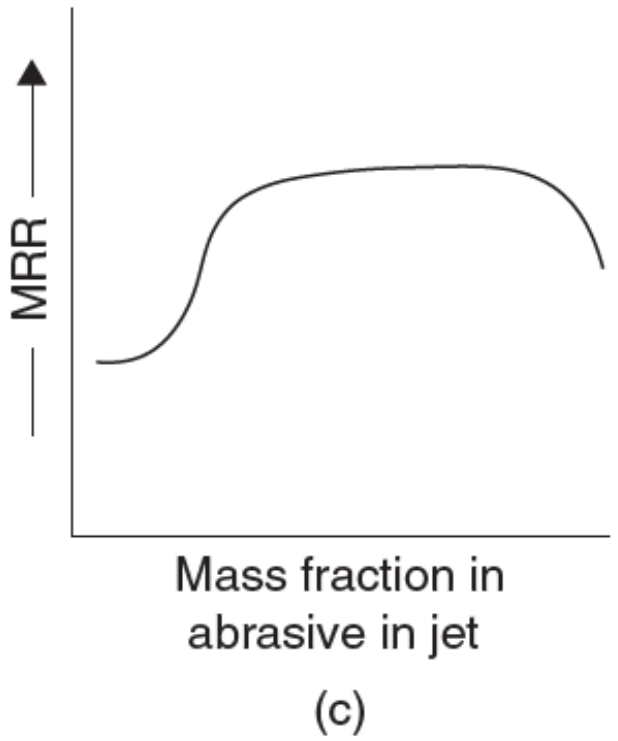
Principle of Operation

- In this process, material removal takes place due to tiny brittle fracture of metallic layer with high velocity impact of abrasive particles. Therefore, this method of machining is more suitable for brittle materials.
- A high velocity jet of dry air, CO2 or nitrogen gas containing abrasive particles strikes the workpiece at the point where cutting or machining is desired. These gases are carrier medium for abrasives Al2O3, SiC, boron carbide, and diamond (generally used as abrasives).
- Abrasives' sizes may range from 10 to 50 mm, and jet velocity ranges from 150 to 300 m/s. The gap between nozzle tip and work surface is kept about 1 mm.

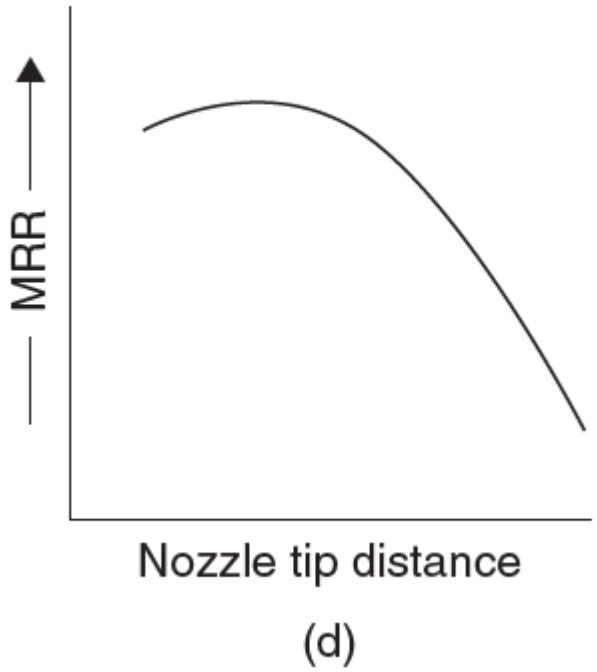
ABRASIVE JET MACHINING (AJM)-Process Parameters



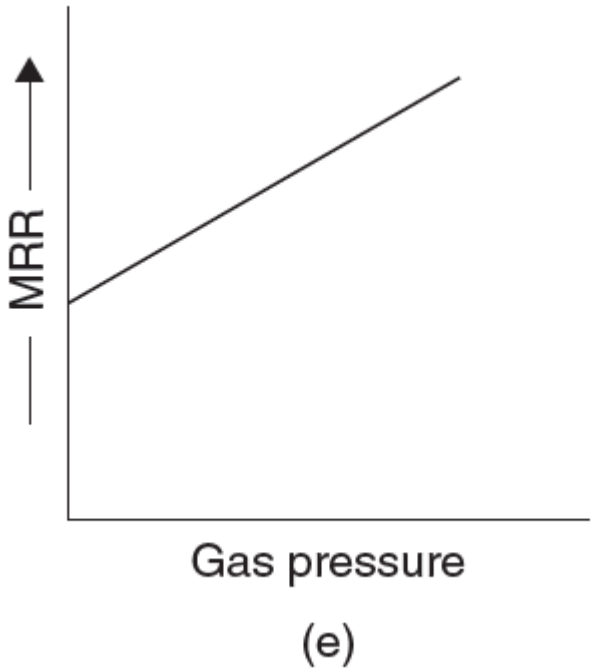




ABRASIVE JET MACHINING (AJM)-Process Parameters



(d)



(e)

ABRASIVE JET MACHINING (AJM)-Process Parameters

The variation in material removal rate with different parameters is shown graphically in Figure

- (a), the material removal rate increases with increase in mass flow rate, and after the certain limit again material removal rate decreases with increase in material removal rate.
- (b), with increase in the velocity of abrasive particles material removal rate always increases.
- (c), with increase in mass fraction of abrasive in jet material removal rate increases but after a certain limit again material removal rate starts to decrease.

ABRASIVE JET MACHINING (AJM)-Process Parameters

- (d), it is observed that for a certain range of nozzle tip distance material removal rate is constant but below or above this range material removal rate decreases. The nozzle tips are made of tungsten carbide or sapphire. Orifice area ranges from 0.05 to 0.2 mm2. Nozzle tip distance ranges from 0.25 to 75 mm.
- (e), with increase in gas pressure material removal rate always increases. The gas pressure ranges from 2 to 10 atm.

Application of AJM

AJM is used for machining, cleaning, etching, marking, deburring for brittle materials like glass, ceramics,refractories, germanium, silicon, quartz, mica, etc. Following are the frequent applications of AJM.

- Fine drilling in printed circuit board (PCB) and micro welding.
- Aperture drilling for electronic microscope.
- Machining of semiconductors.
- Machining of hard and fragile materials.
- Frosting and abrading of glass.

Advantages of AJM

- Low capital investment is involved.
- Brittle materials of this section can be easily machined.
- Cavities and holes of any shape can be drilled in material of any hardness.
- Amount of heat generation is low.
- There is no direct contact of tool and workpiece. Therefore, tool damage rate is very low.

Limitations of AJM

- This process is not suitable for machining of ductile material due to embedding of abrasive particles in work surface.
- Metal removal rate is very low.
- It gives poor machining accuracy.
- There is requirement of cleaning after the operation to remove the abrasive particles from work surface.
- The abrasive powder cannot be reused.