Government Women College of engineering, Ajmer
Mechanical Engineering Department
Mid Term paper (March, 2018)

Semester:- VI
Subject:-NEWER MACHINING METHODS

Answer any FOUR questions:- **(4*5=20)**

1) Illustrate the effect of abrasive flow rate, nozzle tip distance, nozzle pressure and mixing ratio on Material removal rate. State the reason of variation in material removal rate for each parameter briefly.

2) What do you mean by flaring? What is the cause of flaring? What are the different methods by which flaring could be avoided?

3) What are the differences between traditional and non-traditional machining processes? What do you mean by hybrid machining?

4) Illustrate the schematic diagram of working of ultra sonic machining set up. What are the different types of transducers used? Which one is most commonly used and why?

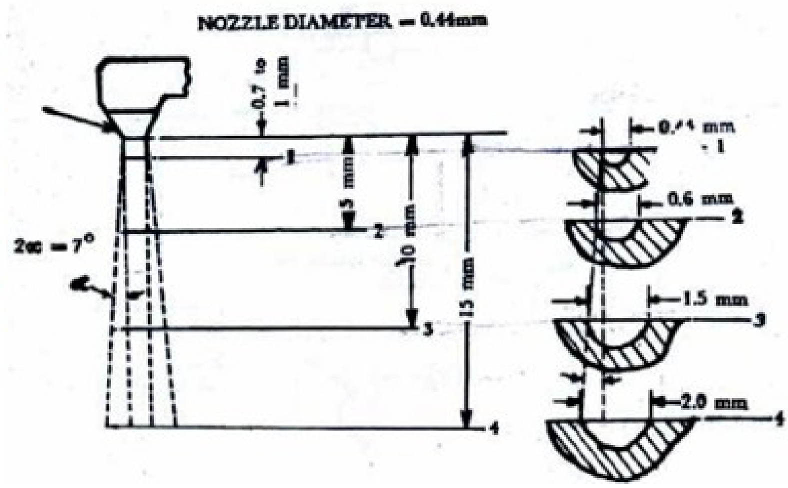
5) What are the different elements of ultra sonic machining? State the required properties of tool holder, tool and abrasive particles.

6) Illustrate the variation of penetration rate with amplitude of vibration, frequency of vibration and abrasive grain size.

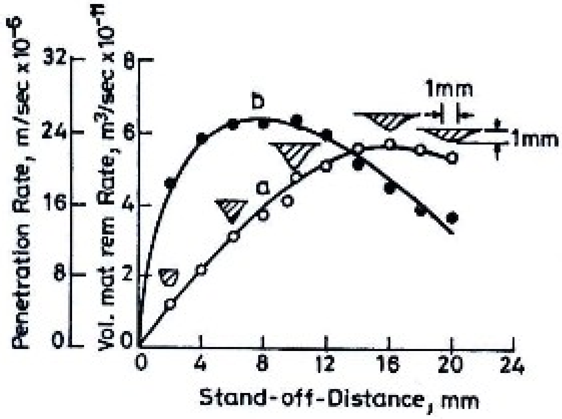
Question 1

Stand off distance.

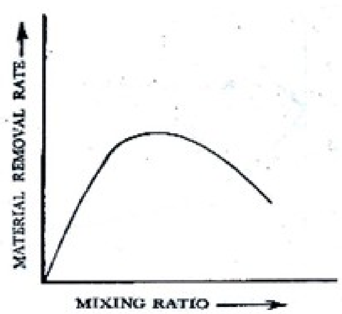
Stand off distance is defined as the distance between the face of the nozzle and the work surface of the work. SOD has been found to have considerable effect on the work material and accuracy. A large SOD results in flaring of jet which leads to poor accuracy.



It is clear from figure that



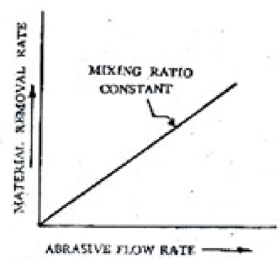
Efect of Mixing ratio on MRR



Increased mass flow rate of abrasive will result in a decreased velocity of fluid and will thereby decreases the available energy for erosion and ultimately the MRR. It is convenient to explain to this fact by term MIXING RATIO. Which is defined as

$$\text{Mixing ratio} = \frac{\text{Volume flow rate of carrier gas}}{\text{Volume flow rate of carrier gas}}$$

The effect of mixing ratio on the material removal rate is shown above.

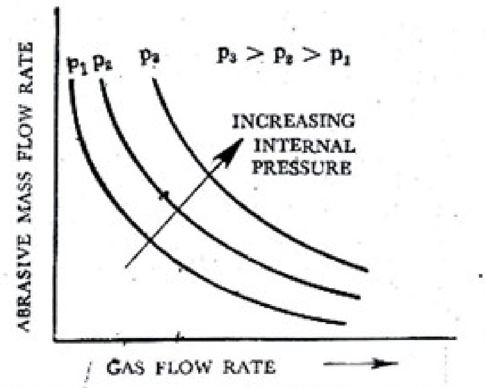


The material removal rate can be improved by increasing the abrasive flow rate provided the mixing ratio can be kept constant.The mixing ratio is unchanged only by simultaneous increase of both gas and abrasive flow rate.

An optimum value of mixing ratio that gives maximum MRR is predicted by trial and error. In place of Mixing ratio, the mass ratio (α) may be easier to determine. Which is defined as

$$\alpha = \frac{\text{Mass flow rate of carrier gas}}{\text{Mass flow rate of carrier gas and abrasive}} = \frac{\dot{m}_a}{\dot{m}_{a+g}}$$

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.

Question 2

Flaring is the phenomenon by which the jet disperses and get away from the desired path resulting in inaccurate machining of the workpiece. The force with which the unflared jet could have made the impact decreases due to flaring. The cause of flaring can be attributed to the high nozzle tip distance. The different methods by which the flaring could be avoided is by applying mask of lighter material than the workpiece and optimizing the nozzle tip distance.

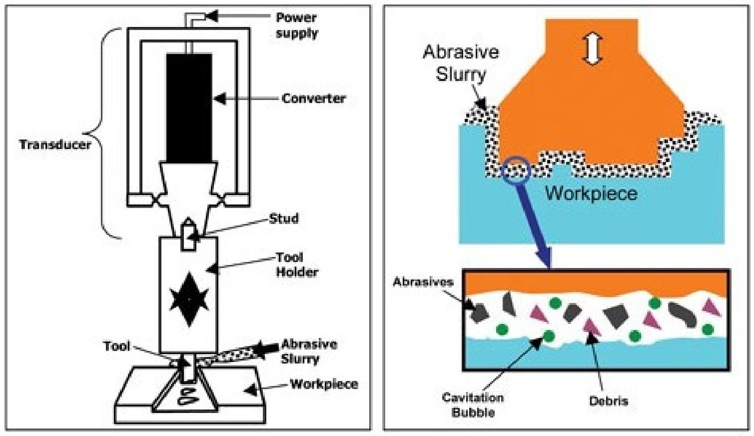
Question 3

Traditional machining process is increases hardness of work pieces material results in a decrease of economical growth.
So the newer machining processes developed are often called"**Non Traditional machining process** " or "**Unconventional machining process**".In this employs some form of energy like mechanical chemical thermal electro chemical etc.for cutting the material.
Non Traditional manufacturing processes can be as a group of processes or activities that cut material by utilizing mechanical thermal and chemical energy or combination of this energies.
The parameters required to difference between these are following:
1.Tool Geometry
2.Cutting ability
3.Metal removal rate
4.Profile
5.Application
6.Example
This parameter we considered to comparison between them.Lets start to differentiate between Conventional and Non Traditional processes to differentiate.
First Traditional machining process are explained with parameter...
1.Tool Geometry:In this cutting tool have fixed geometry.
2.Cutting ability: Difficult to cut a hard material.
3.Metal removal rate:Metal removal rate is higher than other process.
4.Profile:In this complex shapes can not be produced or difficult.
5.Application:small or minute hole can not be produced.
6.Example:Shaping,Milling,Turning etc.
Second Non -Traditional machining process are explained with parameter..
1.Tool Geometry:Cutting tool have can not fixed geometry.
2.Cutting ability:Any hard material can be cut.
3.Metal removal rate:Metal removing rate is comparatively low.
4.Profile: Difficult or complex shape can easily produced.
5.Application :Very small or minute hole can produce.
6.Example : Electric discharge Machine (EDM).

Question 4

Ultrasonic Machining Process

The tool present in the machine for cutting the materials is made from a soft material as compared to the work piece. The tool is usually made from materials such as soft steels and nickel. When the tool vibrates, the abrasive slurry (liquid) is added which contains abrasive grains and particles. The abrasive slurry is added till the work pieces interacts with the grains. Due to the particles of liquid added, the work brittleness of the work piece abrades the surface meanwhile the tool deforms gradually.



Working Principle of Ultrasonic Machining

The time spent on **ultrasonic machine** entirely depends on the frequency of the vibrating tool. It also depends on the size of grains of the abrasive slurry, the rigidity and the viscosity as well. The grains used in the abrasive fluid are usually boron carbide or silicon carbide as they are rigid than others. The used abrasive can be carried away easily if the viscosity of the slurry fluid is less.

An ultrasonically vibrating mill consists of two major components, an electroacoustic transducer and a sonotrode, attached to an electronic control unit with a cable. An electronic oscillator in the control unit produces an alternating current oscillating at a high frequency, usually between 18 and 40 kHz in the ultrasonic range. The transducer converts the oscillating current to a mechanical vibration. Two types of transducers have been used in ultrasonic machining; either piezoelectric or magnetostrictive:

- *Piezoelectric transducer*: This consists of a piece of piezoelectric ceramic, such as barium titanate, with two metal electrodes plated on its surface. The alternating voltage from the control unit applied to the electrodes causes the piezoelectric element to bend back and forth slightly, causing it to vibrate.
- *Magnetostrictive transducer*: This consists of a cylinder of ferromagnetic material such as steel inside a coil of wire. Magnetostriction is an effect which causes a material to change shape slightly when a magnetic field through it changes. The alternating current from the control unit, applied to the coil, creates an alternating magnetic field in the magnetostrictive cylinder which makes it change shape slightly with each oscillation, causing it to vibrate.

Question 5

Equipment:

Ultrasonic Machining consists of :

1. High Power sine wave generator
2. Magneto-strictive Transducer
3. Tool Holder
4. Tool

High power sine wave generator
This unit converts low frequency (60 Hz) electrical power to high frequency (20kHz) electrical power.

Transducer
The high frequency electrical signal is transmitted to traducer which converts it into high frequency low amplitude vibration. Essentially transducer converts electrical energy to mechanical vibration. There are two types of transducer used

1. Piezo electric transducer
2. Magneto-stricitve transducer.

Piezo electric transducer: These transducer generate a small electric current when they are compressed. Also when the electric current is passed though crystal it expands. When the current is removed , crystal attains its original size and shape. Such transducers are available up to 900 Watts. Piezo electric crystals have high conversion efficiency of 95%.

Magneto-strictive transducer: These also changes its length when subjected to strong magnetic field. These transducer are made of nickel , nickel alloy sheets. Their conversion efficiency is about 20-30%. Such transducers are available up to 2000 Watts. The maximum change in length can be achieved is about 25 microns.

Tool holder. OR Horn.
The tool holder holds and connects the tool to the transducer. It virtually transmits the energy and in some cases, amplifies the amplitude of vibration. Material of tool should have good acoustic properties, high resistance to fatigue cracking. Due measures should be taken to avoid ultrasonic welding between transducer and tool holder. Commonly used tool holders are Monel, titanium, stainless steel. Tool holders are more expensive, demand higher operating cost.
Tool holder can be classified as :

Tool
Tools are made of relatively ductile materials like Brass, Stainless steel or Mild steel so that Tool wear rate (TWR) can be minimized. The value of ratio of TWR and MRR depends on kind of abrasive, work material and tool materials.

Question 6

1. Effect of amplitude on MRR

Increase in amplitude of vibration increases MRR. To maximize the amplitude of vibration concentrator should operate at resonance frequency. Under certain circumstances this limits also the maximum size of abrasive to be used.

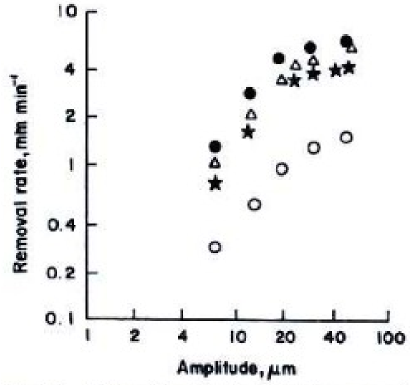
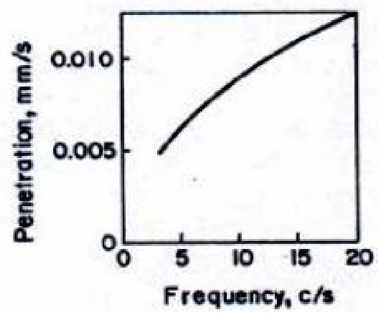


Fig. 3.6 Effects of amplitude of vibration on material removal rate during USM. Workpiece: glass; tool: steel; abrasive: B_4C (120 mesh size); pressure: • 0.20 MPa; Δ 0.16 MPa; * 0.10 MPa; ○ 0.04 MPa. [*Kremer et al.*, 1981].

2. Effect of Frequency on MRR

Frequency has significant effect on MRR. Frequency used for machining process must be resonant frequency to obtain the greatest amplitude at the tool tip and thus achieve the maximum utilization of the acoustic system.



3. Effect of abrasive grain size

An increase in abrasive grain size results in higher MRR but poorer surface finish.

Maximum MRR is achieved when abrasive grain size is comparable with amplitude of vibration of the tool. Hardness of the abrasives and method of introducing the slurry has also effect on MRR.