APPLICATIONS :

Water jet cutting is mostly used to cut lower strength materials such as wood, plastics and aluminium. When abrasives are added, (abrasive water jet cutting) stronger materials such as steel and tool steel can be cut.

ABRASIVE WATER JET MACHINING (AWJM) :

WORKING PRINCIPLES :

Abrasive water jet cutting is an extended version of water jet cutting; in which the water jet contains abrasive particles such as silicon carbide or aluminium oxide in order to increase the material removal rate above that of water jet machining. Almost any type of material ranging from hard brittle materials such as ceramics, metals and glass to extremely soft materials such as foam and rubbers can be cut by abrasive water jet cutting.

EQUIPMENT USED :

The narrow cutting stream and computer controlled movement enables this process to produce parts accurately and efficiently. This machining process is especially ideal for cutting materials that cannot be cut by laser or thermal cut. Metallic, non-metallic and advanced composite materials of various thicknesses can be cut by this process. This process is particularly suitable for heat sensitive materials that cannot be machined by processes that produce heat while machining. It is similar to water jet cutting apart from some more features underneath the jewel; namely abrasive, guard and mixing tube. In this process, high velocity water exiting the jewel creates a vacuum which sucks abrasive from the abrasive line, which mixes with the water in the mixing tube to form a high velocity beam of abrasives.

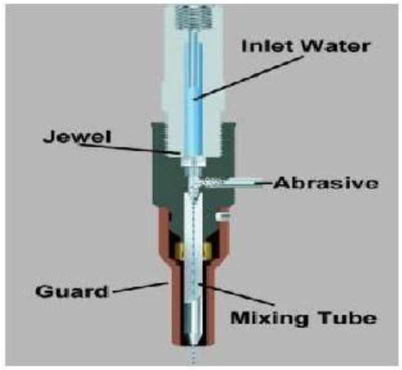


Fig : Water Jet Nozzle

PROCESS PARAMETERS,MRR :

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 – 60°~ 90°

Nozzle : Material – WC

Diameter – (Internal) 0.2 ~ 0.8 mm

Life – 10 ~ 300 hours

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

APPLICATIONS :

Abrasive water jet cutting is highly used in aerospace, automotive and electronics industries. In aerospace industries, parts such as titanium bodies for military aircrafts, engine components (aluminium, titanium, heat resistant alloys), aluminum body parts and interior cabin parts are made using abrasive water jet cutting. In automotive industries, parts like interior trim (head liners, trunk liners, door panels) and fiber glass body components and bumpers are made by this process. Similarly, in electronics industries, circuit boards and cable stripping are made by abrasive water jet cutting.

ULTRASONIC MACHINING(USM) :

USM is mechanical material removal process or an abrasive process used to erode holes or cavities on hard or brittle work piece by using shaped tools, high frequency mechanical motion and an abrasive slurry. USM offers a solution to the expanding need for machining brittle materials such as single crystals, glasses and polycrystalline ceramics, and increasing complex operations to provide intricate shapes and work piece profiles. It is therefore used extensively in machining hard and brittle materials that are difficult to machine by traditional manufacturing processes. The hard particles in slurry are accelerated toward the surface of the work piece by a tool oscillating at a frequency up to 100 KHz - through repeated abrasions, the tool machines a cavity of a cross section identical to its own. USM is primarily targeted for the machining of hard and brittle materials (dielectric or conductive) such as boron carbide, ceramics, titanium carbides, rubies, quartz etc. USM is a versatile machining process as far as properties of materials are concerned. This process is able to effectively machine all materials whether they are electrically conductive or insulator.

EQUIPMENT USED :

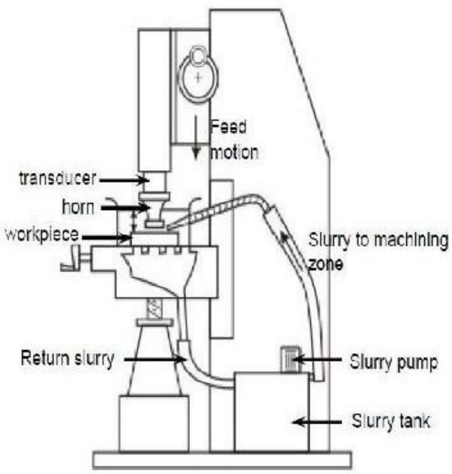
The basic mechanical structure of an USM is very similar to a drill press.However, it has additional features to carry out USM of brittle work material. The workpiece is mounted on a vice, which can be located at the desired position under the tool using a 2 axis table. The table can further be lowered or raised to accommodate work of different thickness. The typical elements of an USM are,

- Slurry delivery and return system
- Feed mechanism to provide a downward feed force on the tool during machining
- The transducer, which generates the ultrasonic vibration
- The horn or concentrator, which mechanically amplifies the vibration to the required amplitude of 15 – 50 μm and accommodates the tool at its tip.

The ultrasonic vibrations are produced by the transducer. The transducer is driven by suitable signal generator followed by power amplifier. The transducer for USM works on the following principle

- Piezoelectric effect
- Magnetostrictive effect
- Electrostrictive effect

Magnetostrictive transducers are most popular and robust amongst all.The horn or concentrator is a wave-guide, which amplifies and concentrates the vibration to the tool from the transducer.



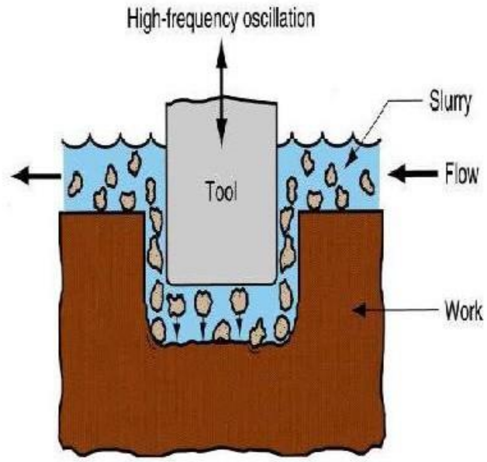


Fig : Ultrasonic Machining

PROCESS PARAMETERS :

During discussion and analysis as presented in the previous section, the process parameters which govern the ultrasonic machining process have been identified and the same are listed below along with material parameters

- Amplitude of vibration (ao) – 15 – 50 μm
- Frequency of vibration (f) – 19 – 25 kHz
- Feed force (F) – related to tool dimensions
- Feed pressure (p)
- Abrasive size – 15 μm – 150 μm
- Abrasive material – Al_2O_3
    - SiC
    - B_4C
    - Boronsilicarbide
    - Diamond
- Flow strength of work material
- Flow strength of the tool material
- Contact area of the tool
- Volume concentration of abrasive in water slurry

MATERIAL REMOVAL RATE (MRR) :

USM is generally used for machining brittle work material. Material removal primarily occurs due to the indentation of the hard abrasive grits on the brittle work material. As the tool vibrates, it leads to indentation of the abrasive grits. During indentation, due to Hertzian contact stresses, cracks would develop just below the contact site, then as indentation progresses the cracks would propagate due to increase in stress and ultimately lead to brittle fracture of the work material under each individual interaction site between the abrasive grits and the workpiece. The tool material should be such that indentation by the abrasive grits does not lead to brittle failure. Thus the tools are made of tough, strong and ductile materials like steel, stainless steel and other ductile metallic alloys.

APPLICATIONS :

- Used for machining hard and brittle metallic alloys, semiconductors, glass, ceramics, carbides etc.
- Used for machining round, square, irregular shaped holes and surface impressions.
- Machining, wire drawing`, punching or small blanking dies.