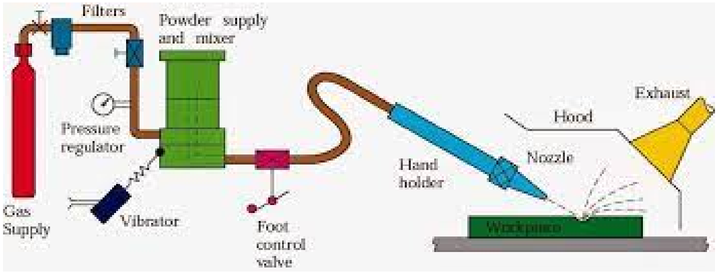
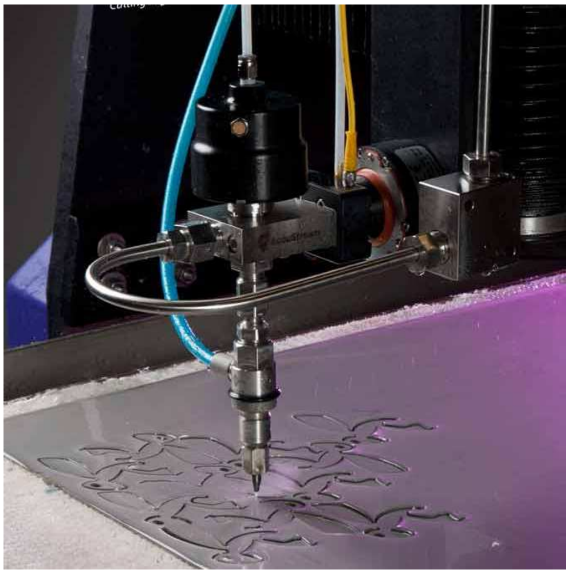
19AST202 AIRCRAFT PRODUCTION TECHNOLOGY





ABRASIVE JET MACHINING (AJM)

Principle and Working : Refer to Fig. 12.9.

This process consists of directing a stream of fine abrasive grains, mixed with compressed air or some other gas at high pressure through a nozzle on to the surface of the workpiece to be machined. These particles impinge on the work surface at high speed and the erosion caused by their impact enables the removal of metal. *The metal removal rate depends upon the flow rate and size of abrasive particles.*

— The abrasives may be Al_2O_3, SiC, sodium bicarbonate, dolomite, glass beads etc. The abrasive particles should have irregular shape consisting of short edges. Round particles are useless. Their size is 10 to 50 microns. The carrier is usually air, CO_2 or N_2.

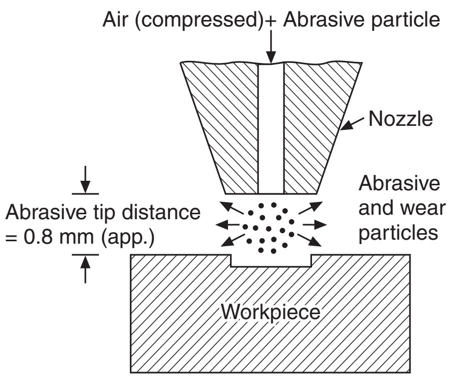


Fig. Abrasive Jet Machining (AJM).

Characteristics of AJM :

- *Material removal :* By impinging abrasive grains at high speed.
- *Critical parameters :* Abrasive flow rate and velocity, nozzle tip distance, abrasive grain size.

Advantages :

1. Low capital investment required.
2. Brittle materials of thin sections can be easily machined.
3. Intricate cavities and holes of any shape can be machined in materials of any hardness.
4. There is no direct contact between the tool and workpiece.
5. Normally inaccessible portions can be machined with fairly good accuracy.

Disadvantages :

1. Low metal removal rate.
2. Unsuitable for machining of ductile materials.
3. The abrasive powder used in the process cannot be reclaimed or reused.
4. Machining accuracy is relatively poorer.
5. There is always a danger of abrasive particles getting embedded in the work material. Hence cleaning needs to be necessarily done after the operation.

Applications :

1. Machining of intricate profiles on hard and fragile materials.
2. Fine drilling and micro-welding.
3. Frosting and abrading of glass articles.
4. Aperture drilling for electronic microscopes.
5. Machining of semiconductors.

Note : This process should not be misunderstood as *sand blasting* because this process is *basically meant for metal removal with the use of small abrasive particles,* whereas the sand blasting process is a surface cleaning process which *does not involve any metal cutting.*

CHEMICAL MACHINING (CHM)

Chemical machining *is a process used to dissolve the workpiece material in chemical solutions.* Metal can be removed from selected portions or from the entire surface of the workpiece, according to requirement. If selective machining is desired, the portions required to be left unmachined are covered with a resistant material called a '*resist*' or '*maskant*' which can be stripped away after machining.

The chemical machining process can be *classified* as follows :

1. Chemical blanking. It is used for cutting out parts from thin sheet metal.

2. Chemical contour machining. It is also known as '*Chemical milling*' and is employed for selective or overall metal removal from thicker workpieces.

3. Chemical engraving.

A typical chemical operation entails the following steps :

(*i*) Clean the workpiece thoroughly so as to ensure that the masking material will adhere to the workpiece well to reduce any possibility of stray etching due to *maskant* debonding.

(*ii*) Apply a chemical resistant mask on the workpiece surface where no material is to be removed.

(*iii*) Dip the workpiece into the chemical solution called *etchant* and leave it for sufficient time to get the necessary depth of etching. The strength of the etching is maintained since it becomes weak by absorbing the workpiece material with time.

(*iv*) Remove the mask and clean the workpiece.

Advantages :

1. Very low tool cost.
2. Low design change cost.
3. Complex contours can be easily machined.
4. Tooling time is substantially reduced.
5. Both faces of the workpiece can be machined simultaneously.
6. The part produced is free of burrs.
7. Hard and brittle materials can be machined.
8. It is a flexible process from design point of view.

Disadvantages :

1. It is slow process, since the metal removal rate is low.
2. Larger floor space is required.
3. Skilled operators are needed.
4. Sharp corners cannot be produced.
5. High manufacturing cost.
6. Metal thickness that can be machined is limited.

Applications :

Chemical machining is generally used when *very small amounts of material are to be removed from the surface in any application.* In *aerospace application* a large volume of unwanted material is removed from the surface to reduce the weight, thereby increasing the strength to weight ratio which is conveniently done with chemical machining.

COMPARISON OF UNCONVENTIONAL MACHINING METHODS

The comparison of Unconventional machining methods is given (in tabular form) below :

Table Comparison of Unconventional Machining Methods

S. No.	*Process*	*Material removal rate (mm^3/s)*	*Dimensional accuracy (μm)*	*Surface finish (μm)*	*Capital cost*	*Power consumption (kWh)*
1.	*Electric Discharge Machining (EDM)*	10–20	15–50	0.2–2.5	Medium	2–4
2.	*Electro-Chemical Machining (ECM)*	200–300	15–100	0.1–2.5	Very high	100–150
3.	*Ultrasonic Machining (USM)*	5–10	7–15	0.2–2.5	Low	2–3
4.	*Laser Beam Machining (LBM)*	0.001–0.002	10–100	0.5–1.5	Low/medium	0.003–0.005
5.	*Chemical Machining (CHM)*	0.15–30	25–100	0.5–2.5	Medium	—