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WORKSHOP TECHNOLOGY

Unit-2 **Cutting Tool Materials and Introduction to welding processes**	• Properties and uses of cutting tool material viz; High-speed steel, tungsten carbide, cobalt steel cemented carbides, ceramics and diamond • Introduction, Function and its types, Specification and selection of cutting fluid • Electric arc welding: working principle, use of AC and DC current in welding • TIG welding, MIG welding, Introduction to gas welding.

Properties and uses of cutting tool material:

1. **High-speed steel**

   General use of HSS is 18-4-1.
   18- Tungsten is used to increase hot hardness and stability.
   4 – Chromium is used to increase strength.
   1- Vanadium is used to maintain keenness of cutting edge.
   In addition to this 2.5% to 10% cobalt is used to increase red hot hardness. Rest iron

   Properties and Uses

   - Superior woking hardness.
   - High wear hardness.
   - Excellent toughness.
   - H.S.S is used for drills, milling cutters, single point cutting tools, dies, reamers etc.
   - It looses hardness above 600°C.

2. **Tungsten carbide**

   Tungsten carbide (WC) carbide containing equal parts of tungsten and carbon atoms.

   Properties and Uses

   - High density
   - High melting point of 2600 °C,
   - High values of electric and thermal conductivity
   - High hardness
   - It is used in Cutting tools for machining
   - Its is used for Mining & Foundation Drilling
   - Used in Surgical instruments

3. **Cemented Carbides**

   Due to their high hardness and excellent impact resistance, **cemented carbides** are most commonly **used** for cutting tools in lathes and similar industrial machines.

   Properties

   - Speed can be used 6 to 8 times that of H.S.S.

- Can withstand up to 1000°C.
- High compressive strength is more than tensile strength.
- They are very stiff and their young's modulus is about 3 times that of the steel.
- High wear resistance.
- High modulus of elasticity.
- Low coefficient of thermal expansion.
- High thermal conductivity, low specific heat, low thermal expansion.

4. Ceramics and sintered oxides

Ceramics and sintered oxides are basically made of Al_2O_3.These are made by powder metallurgy technique.

Properties and uses

- Used for very high speed (500m/min).
- Used for continuous cutting only.
- Can withstand upto 1200°C.
- Have very abrasion resistance.
- Used for machining CI and plastics.
- Has less tendency to weld metals during machining.

5. Diamond

Diamond has

- ✓ Extreme hardness
- ✓ Low thermal expansion.
- ✓ High thermal conductivity.
- ✓ Very low coefficient of friction.

- Cutting tool material made of diamond can withstand speeds ranging from 1500 to 2000m/min.
- On ferrous metals diamond are not suitable because of the diffusion of carbon atoms from diamond to work-piece.
- Can withstand above 1500°C.
- A synthetic (man made) diamond with polycrystalline structure is recently introduced and made by powder metallurgy process.

Cutting Fluid:

During the metal cutting process, heat is generated due to plastic deformation of metal and friction of tool workpiece interface. This will be increasing the temperature of both workpiece and tool. Hence, the harness of tool will be decreased. This leads to tool failure. Cutting fluid are used to avoid heat production during the machining process. At the same time, it reduces the friction between tool and chip. The cutting fluid usually in the form of liquid applied to chip zone to improve the cutting life or condition.

Function of cutting fluid in Machining:

- The cutting fluid cool the tool and workpiece. When the heat produced during the machining operation is carried out by the fluid. It done by supply adequate quality of cutting fluid. It is necessary to cool the tool to prevent metrological damage and assist in decrease friction at the tool and workpiece interface. When the friction will be decreased, the life of tool will be increased and also the surface finish of work will be improved. The cutting fluid is prevent the workpiece from excessive thermal distortion.
- The cutting fluid lubrication of cutting tool and reduce the coefficient of friction in between work and tool. That property will be reduce the energy or power consumption in metal removal. So, the wear on the tool is reduced and the tool life will be increased.
- The cutting fluid improve the surface finish as stated earlier. It courses the ship to break up into small parts. It protect the surface finish from corrosion. The cutting fluid washes away chip from the tool. That help to prevent the tool from foulings. It also prevent corrosion of machine and work.

Types of cutting fluids:

The different types of cutting fluid used depends upon machining method characteristics and work material.They are basically two main types of cutting fluid,

- Water based cutting fluid
- Straight or heat oil based cutting fluid

Water based cutting fluid

To improve the cooling and lubrication properties of cutting fluid such as water, the Mineral oil or soft soap could be added it. It is known as soluble oils. Soluble oil are emulsion composition of around 80% of water and remaining soap or Mineral oil. The shop act as emulsifying agent which break the oil in to minutes particles to disperse them throughout water. The water based cutting fluid are mostly used for quit commonly.When the grinding operation process the soda solution are used as it have good flushing and cooling effect. The water used as coolant in small industry or laboratory but it causes rust and corrosion.

Straight or heat oil based cutting fluid

Straight oil based cutting fluid mean undiluted or pure oil based fluid. Nowadays, most of oil are not directly used in industry but mixing of other oil or oil with chemical such as Sulphur and chlorine. It is classified as below

- Mineral oil
- Chlorinated oil
- Straight fatty oil
- Sulphurised oil

Properties of cutting fluid:

- High heat absorbing capacity

- High flash point
- Non corrosive to tool and work material
- It should be harmless to operate and bearing
- It has good lubrication properties to reduce frictional force and to reduce the power consumption
- It having high heat conductivity, high specific heat and high film coefficient
- It should be having odourless

The selection of cutting fluids depends upon following factors,

- Feed rate
- Tool and workpiece material
- Velocity of cutting fluids
- Life of cutting fluids
- Cutting speed
- Depth of cut
- Tool life to be expected
- Economical aspects

Electric Arc Welding:

The arc welding is a fusion welding process in which the heat required to fuse the metal is obtained from an electric arc between the base metal and an electrode.

The electric arc is produced when two conductors are touches together and then separated by a small gap of 2 to 4 mm, such that the current continues to flow, through the air. The temperature produced by the electric arc is about 4000°C to 6000°C.

A metal electrode is used which supplies the filler metal. The electrode may be flux coated or bare. In case of bare electrode, extra flux material is supplied. Both direct current (D.C.) and alternating current (A.C.) are used for arc welding.

The alternating current for arc is obtained from a step down transformer. The transformer receives current from the main supply at 220 to 440 volts and step down to required voltage i.e., 80 to 100 volts. The direct current for arc is usually obtained from a generator driven by either an electric motor, or patrol or diesel engine.

An open circuit voltage (for striking of arc) in case of D.C. welding is 60 to 80 volts while a closed circuit voltage (for maintaining the arc) is 15 to 25 volts.

Procedure of Electric Arc Welding:

First of all, metal pieces to be weld are thoroughly cleaned to remove the dust, dirt, grease, oil, etc. Then the work piece should be firmly held in suitable fixtures. Insert a suitable electrode in the electrode holder at an angle of 60 to 80° with the work piece.

Select the proper current and polarity. The spot is marked by the arc at the places where welding is to be done. The welding is done by making contact of the electrode with the work and then separating the electrode to a proper distance to produce an arc.

When the arc is obtained, intense heat so produced, melts the work below the arc, and forming a molten metal pool. A small depression is formed in the work and the molten metal is deposited around the edge of this depression. It is called arc crater. The slag is brushed off easily after the joint has cooled. After welding is over, the electrode holder should be taken out quickly to break the arc and the supply of current is switched off.

Working Principle of Electric Arc Welding

The working principle of arc winding is, in a welding process the heat can be generated with an electric arc strike among the workpiece as well as an electrode. This is glowing electrical discharge among two electrodes throughout ionized gas.

The **arc welding equipment** mainly includes AC machine otherwise DC machine, Electrode, Holder for the electrode, Cables, Connectors for cable, Earthing clamps, Chipping hammer, Helmet, Wire brush, Hand gloves, Safety goggles, sleeves, Aprons, etc

Electric Current for Welding:

Both D.C. (direct current) and A.C. (alternating current) are used to produce an arc in electric arc welding. Both have their own advantages and applications.

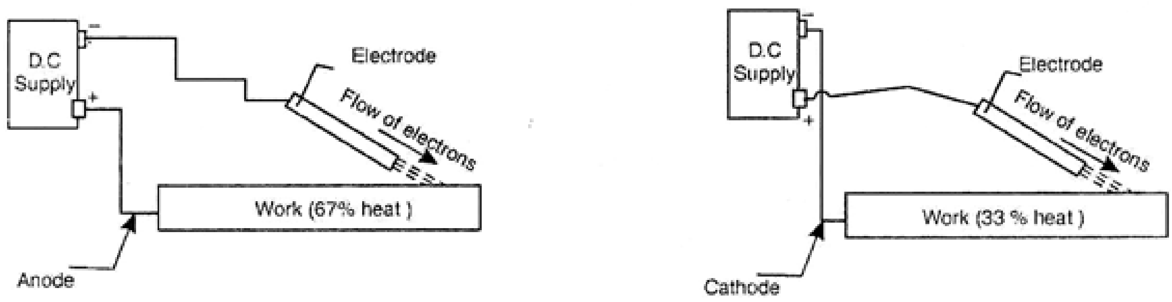
The D.C. welding machine obtains their power from an A.C. motor or diesel/petrol generator or from a solid state rectifier.

Significance of Polarity:

When D.C. current is used for welding, the following two types of polarity are available:

(i) Straight or positive polarity.

(ii) Reverse or negative polarity.



(a) Straight polarity. (b) Reverse polarity

Fig. 7.16. Polarity for D.C. Arc Welding.

When the work is made positive and electrode as negative then polarity is called straight or positive polarity, as shown in Fig. 7.16 (a).

In straight polarity, about 67% of heat is distributed at the work (positive terminal) and 33% on the electrode (negative terminal). The straight polarity is used where more heat is required at the work. The ferrous metal such as mild steel, with faster speed and sound weld, uses this polarity.

On the other hand, when the work is made negative and electrode as positive then polarity is known as reverse or negative polarity, as shown in Fig. 7.16 (b). In reverse polarity, about 67% of heat is liberated at the electrode (positive terminal) and 33% on the work (negative terminal).

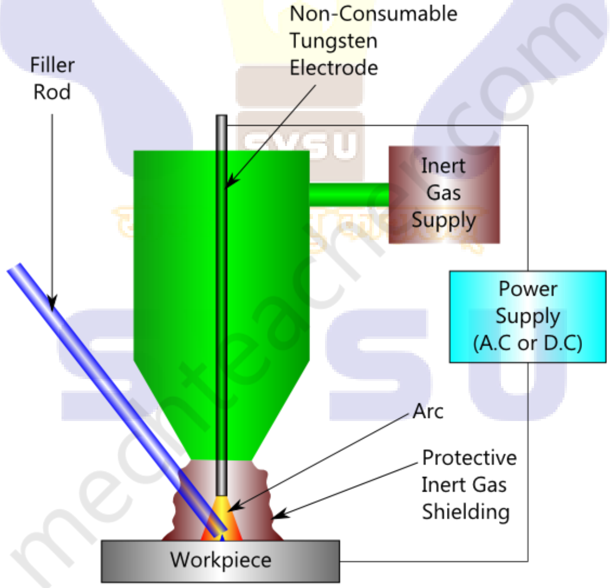
Tungsten Inert Gas Welding (TIG Welding):

Tungsten Inert Gas Welding (TIG Welding), also known as Gas Tungsten Arc Welding (GTAW), is an arc welding method that uses a non-consumable tungsten electrode to weld two or more workpieces.

Components used in Tungsten Inert Gas Welding (TIG Welding):

The following components are necessary to perform Tungsten Inert Gas Welding:

1. Power Supply (A.C or D.C)
2. Non-consumable Tungsten Electrode
3. Inert Gas Supply
4. Filler Rod (used depending on the nature of workpiece)
5. Welding Head



Working:

The workpiece to be welded is placed on the worktable. The non-consumable tungsten electrode and the workpiece are connected to the power supply (A.C or D.C).

As the electrode is brought near the workpiece (leaving a small air gap), an arc is produced. This arc is used for melting and welding the workpiece.

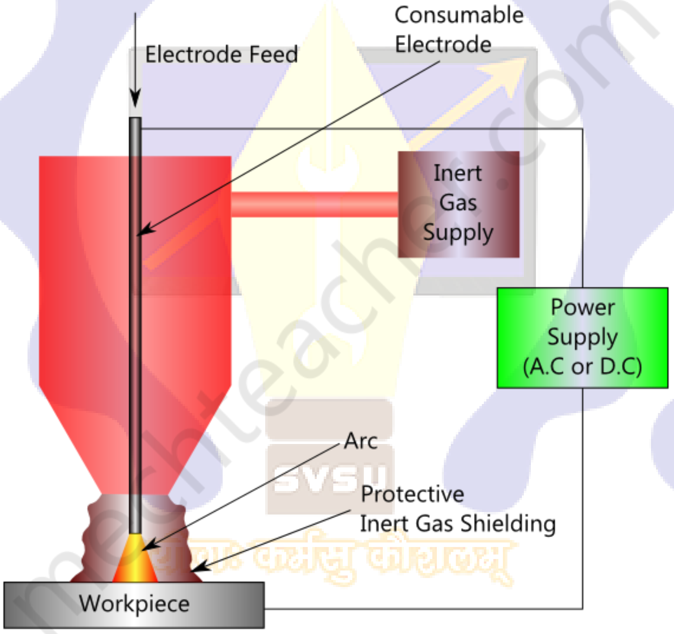
Tungsten has high melting point (3422 °C). Hence, tungsten electrode does not melt during the welding process.

In tungsten inert gas welding, filler rod may or may not be used. The usage of filler rod depends on the nature of the workpiece to be welded. If filler rod is used, it is continuously melted by the arc and fed into the weld pool.

Inert gas supply is constantly provided around the electrode during the welding process. The inert gas forms a gas shielding around the weld. It protects the weld from the external atmosphere.

Metal Inert Gas Welding (MIG Welding):

Metal Inert Gas (MIG) Welding (also known as Gas Metal Arc Welding [GMAW]) is an arc welding technique in which a consumable electrode is used to weld two or more workpieces. A diagrammatic representation of metal inert gas welding is shown below:



Components used in Metal Inert Gas Welding (MIG Welding):

Metal Inert Gas Welding (MIG Welding) makes use of the following components:

1. Consumable Electrode
2. Inert Gas Supply
3. Welding Head
4. A.C or D.C Power Supply
5. Electrode Feeding Mechanism

Working:

The workpiece to be welded and the consumable electrode (in the form of wire) are connected to the Power Supply (D.C or A.C). Whenever the consumable electrode is brought near the workpiece (with a small air gap), an arc is produced. This arc melts the electrode. The melted electrode fills uniformly over the required regions of the workpiece.

An inert gas supply is provided around the electrode (hence the name 'Metal Inert Gas Welding') during the welding process. It forms a gas shield around the arc and the weld (See the diagram above). This is intended to protect the weld from the external atmosphere.

The type of electrode used and the shielding gas used primary depends on the material to be welded. In many cases the shielding gas used is a mixture of many gases.

If many workpieces are to be welded continuously an electrode spool (in the form of coil) is used. Consumable electrode is continuously supplied from this spool by a suitable feeding mechanism. Commonly, servo mechanisms are used for feeding long electrodes.

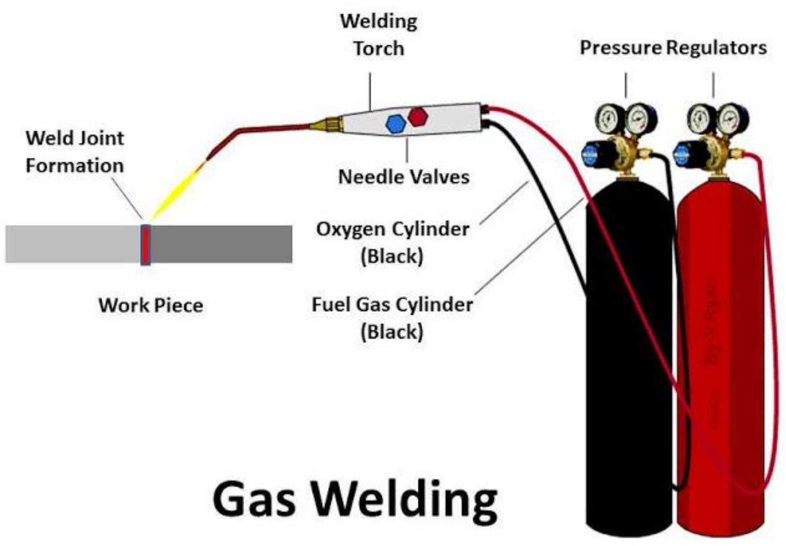
In MIG Welding, consumable electrode itself acts as filler metal. So, no seperate filler rod or filler wire is needed.

Gas Welding:

Gas welding is a type of liquid state welding process in which fuel gases burns to generate heat. This heat is further used to melt interface surfaces of welding plates which are held together to form a joint. In this process, mostly oxy-acetylene gas is used as fuel gas. This process can be done with or without help of filler material

Principle:

Gas welding is a most important type of welding process. It is done by burning of fuel gases with the help of oxygen which forms a concentrated flame of high temperature. This flame directly strikes the weld area and melts the weld surface and filler material. The melted part of welding plates diffused in one another and create a weld joint after cooling. This welding method can be used to join most of common metals used in daily life.



Working:

Gas welding process is quite simpler compare to arc welding. In this process all the equipment is connected carefully. The gas cylinder and oxygen cylinder connected to the welding torch through pressure regulators. Now the regulate pressure of gas and oxygen supplied to the torch where they properly mixed. The flame is ignited by a striker. Take care the tip of torch is pointing downward. Now the flame is controlled through valves situated in welding torch. The flame is set at natural flame or carburizing flame or oxidizing flame according to the welding condition. Now the welding torch moved along the line where joint to be created. This will melt the interface part and join them permanently.

Application:

- It is used to join thin metal plates.
- It can used to join both ferrous and non-ferrous metals.
- Gas welding mostly used in fabrication of sheet metal.
- It is widely used in automobile and aircraft industries.