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Internal Assessment Test 2 – October 2018

Sub:	METAL CASTING AND WELDING					Sub Code:	15ME35A	Branch:	MECHANICAL
Date:	16/10/2018	Duration:	90 min's	Max Marks:	50	Sem/Sec:	3rd Sem B		OBE

	Answer any FIVE FULL Questions	MARKS	CO	RBT
1.	Explain with a neat sketch principle and operation of atomic hydrogen welding.	[10]	CO6	L2
2.	Explain with a neat sketch thermit welding process.	[10]	CO7	L2
3.	Explain with a neat sketch construction and working of coreless induction furnace.	[10]	CO2	L2
4. (a)	What is welding and explain types of welding. Give its classification.	[06]	CO6	L2
(b)	Briefly explain the types of flame on oxy-acetylene welding.	[04]	CO6	L2
5.	With a neat sketch explain the construction and working of direct electric arc furnace.	[10]	CO3	L2
6.	Explain with a neat sketch principle and operation of TIG welding.	[10]	CO6	L2
7.	What is the use of furnace? Explain gas fired pit furnace with a neat sketch.	[10]	CO3	L2

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Scheme of Evaluation Internal Assessment Test 1 – September. 2018

Sub:	METAL CASTING AND WELDING					Sub Code:	15ME35A	Branch:	ME
Date:	08/09/2018	Duration:	90 min's	Max Marks:	50	Sem / Sec:	3rd A & B		

	Answer any 5 question	Split up	Max. MARKS
1	Explain with a neat sketch principle and operation of atomic hydrogen welding. **Diagrams- 4 marks** **` Construction and Working- 4 Marks** **Advantages and disadvantages-2 Marks**	**2*5M**	[10]
2	Explain with a neat sketch thermit welding process. **Diagrams- 4 marks** **` Construction and Working- 4 Marks** **Advantages and disadvantages-2 Marks**	**4M** **4M** **2M**	[10]
3	Explain with a neat sketch construction and working of coreless induction furnace. **Diagram- 4 Marks** **Construction and Working- 4 Marks** **Advantages and disadvantages-2 Marks**	**4M** **4M** **2M**	[10]
4	(a) What is welding and explain types of welding. Give its classification. (b) Briefly explain the types of flame on oxy-acetylene welding. **(a)Defining welding-1 Mark - 1 Mark** **Explaining types of welding-2 Marks** **Giving classification-3 Marks** **(b) Explaining 3 flames with diagram- 4 Marks**	**1M** **2M** **3M** **4M**	[10]
5	With a neat sketch explain the construction and working of direct electric arc furnace. **Diagram- 4 marks** **Construction and Working- 4 Marks** **Advantages and disadvantages-2 Marks**	**4M** **4M** **2M**	[10]
6	Explain with a neat sketch principle and operation of TIG welding. **Diagram- 4 Marks** **Construction and Working- 4 Marks** **Advantages and disadvantages-2 Marks**	**4M** **4M** **2M**	[10]

7	What is the use of furnace? Explain gas fired pit furnace with a neat sketch. **Giving use of furnace- 2 Marks** **Diagram- 2 Marks** **Construction and Working- 4 Marks** **Advantages and disadvantages-2 Marks**	**2M** **2M** **4M** **2M**	[10]

SOLUTION OF 2nd IAT

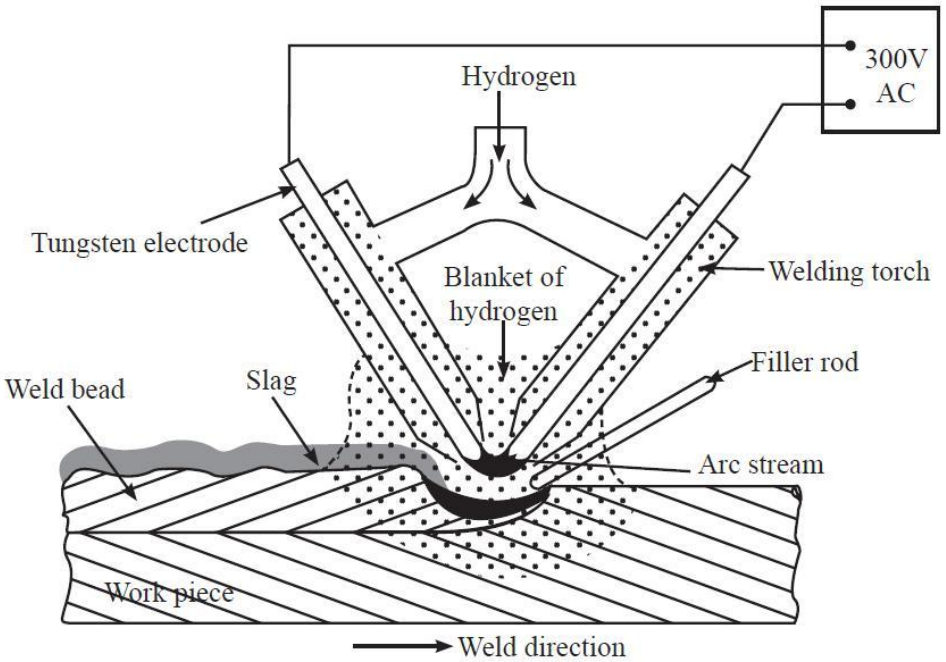
1. Main component of welding process

1.Twin electrode torch used to hold the two non consumable electrodes at an angle. Usually an alloy of tungsten with zirconium or with thorium is used for the welding electrode material, to achieve higher current carrying capacity, arc stability and resists contamination.

2 .Hydrogen gas cylinder used to supply hydrogen gas to both the torches, through the passage provided and then impinges on the workpiece through the nozzles.

3. Pressure regulators and control valves are used to provide controlled flow of hydrogen gas.

4. Welding power: The power supply is connected only between the two electrodes and workpiece is free from the circuit. It required equal amount of heat to be supplied to both the electrodes, thus A.C. power is more suitable compared to D.C. Figure 4.7 shows Atomic hydrogen welding process.



Operation

- .At first the job is cleaned and all types of contaminants like grease, oil, dirt, scale and paint are removed. The surfaces of the electrodes are also made very clean. Filler rod of required composition to suit the parent metal is selected.
- Two electrodes are held in the torch, are inclined at an angle and adjusted to maintain a stable arc. Power connections are switched ON. The hydrogen gas supply is turned ON.
- Initially an arc is struck between two electrodes by touching each other keeping away from the parent metal and instantaneously separated a distance of 2mm so that arc remains between the electrodes.
- At the same time hydrogen gas is passes through torch nozzle around the electrode and forms the gas blanket around the arc. The high temperature of the arc dissociates some molecules of the hydrogen gas into atoms, a large quantity of heat being absorbed by the hydrogen during dissociation. $H2 \leftrightarrow H+H- 422$ kJ Each high energized hydrogen atoms will flow towards the low energized parent metal.
- Each hydrogen atom will comes in contact with cold parent metal and recombine, forming molecules of hydrogen and liberating intense heat sufficient to melt surfaces to be welded. $H+H \leftrightarrow H2+422$ kJ
- This intensity heat melts the workpiece metal and forms the molten pool. Simultaneously filler metal is inserted into the welding area so that filler metal also melts and fills the gap between the workpiece, forms the globules of molten metal.
- The hydrogen gas which is not ionized forms the blanket around the molten metal pole, to protect it from atmospheric contamination.
- The welding head is moved along the surface to be welded and the filler metal is continuously fed to the joint to complete the weld. As the welding is continued forward, the preceding molten metal starts solidifying and forms the strong joint between the workpiece.

Advantages

1. No flux or separate shielding gas is used; hydrogen itself acts as a shielding gas and avoids weld metal oxidation.
2. Due to high concentration of heat, welding can be carried out at fast rates and with less distortion of the workpiece.
3. This process suitable to thin materials.
4. The workpiece does not form a part of the electric circuit. The arc remains between two tungsten electrodes and can be moved to other places easily without getting extinguished.

Dis-advantages

1. High operating cost compared to other.
2. Process cannot be used for depositing large quantities of metals.
3. Welding speed is less compared to TIG & MIG welding process.

2. It is a fusion welding process that makes use of intense heat generated by exothermic chemical reaction of the thermit mixture (a mixture of a metal oxide and aluminum powder).

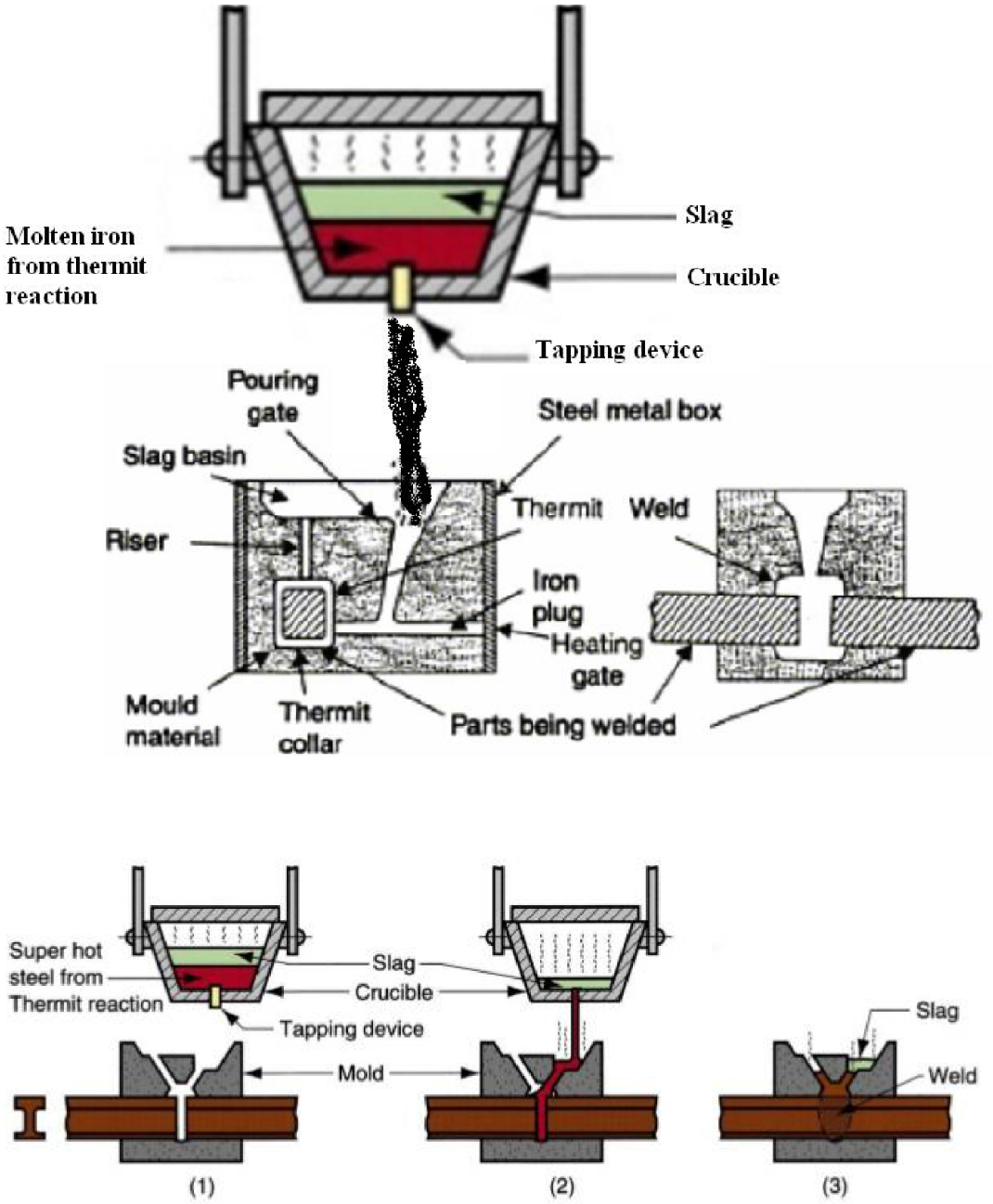
Thermit is a non-explosive mixture consists primarily of finely divided aluminium and iron oxide in the ratio of about 1: 3 by weight. Other metal oxides that can be used in place of iron oxide include oxides of Copper, Nickel, Chromium or Manganese but Iron oxide Thermit is the most commonly used.

The thermit mixture is kept in a refractory lined crucible and the mixture is ignited with a highly inflammable powder consisting of Barium Peroxide, an ignition temperature of 1150^0 C is attained which initiates the main thermit reaction. The reaction is self sustaining and very rapid as it is exothermic, producing molten iron and slag releases high heat of order of 3000^0 C. the reaction is as follows.

$8Al + 3Fe_3O_4$ – -> $9Fe + 4Al_2O_3$ (Slag) + Heat

Slag being very light floats over the thermit steel thereby protecting the metal from atmospheric gases. Apart from the basic ingredients of the thermit mixture other materials may be added to produce a desired thermit melt for any specific application. The molten metal, produced by the reaction, acts as a filler material joining the work pieces after Solidification. The

process is thus essentially a combination of casting and welding processes. The process of welding is illustrated in Figure



Working Operation:

1. In operation the workpiece edges are cut to provide a gap with parallel faces and are cleaned to remove grease, dirt.

2. Here a wax pattern of desire shape is prepared and placed in a gap.

3. The wax pattern is then surrounded by sheet iron box and the space between box and the pattern is filled and rammed with moulding sand and care is taken to provide openings for the runner, riser and a heating gate.

4. Flame is directed into the heating gate due to which the wax pattern melts and drains out, the heating is continued to raise the temperature of the parts to be welded. The heating gate is then closed with an iron plug or sand core to prevent flow of thermit metal.

5. Thermit reaction is started in the crucible and is placed above the pouring cup, the resulting molten iron is then run into the mould and fuses with the parts to be welded and forms the thermit collar at the joint. allowed to flow into the mould, from the bottom of the crucible and it

6. The slag being lighter floats over the molten metal in the crucible. It flows last and remains at the top of the mould where it solidifies. Clean metal enters the mould around the sections to be welded.

Advantages:

1. The heat necessary for welding is obtained from a chemical reaction and thus no costly power – supply is required. Therefore broken parts (rails etc.) can be welded on the site itself.

Limitations

1.Applicable only for ferrous metal parts

2. The process is uneconomical If used to weld cheap metals or light parts.

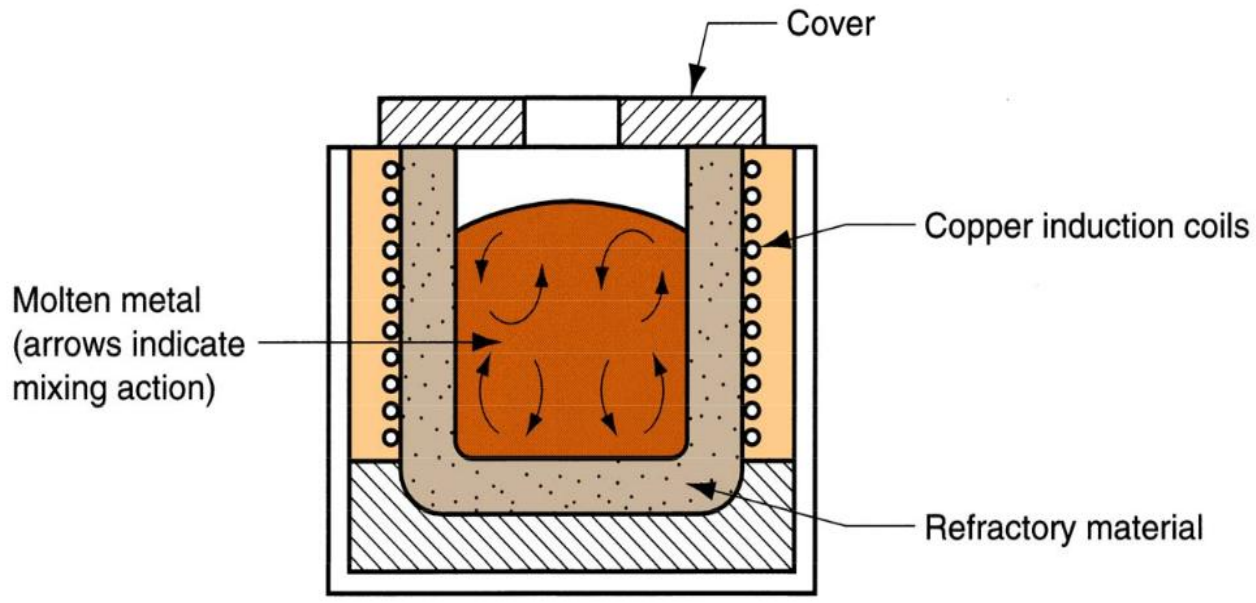
3.

Heating by the induction method occurs when an electrically conductive material is placed in a varying magnetic field. Induction heating is a rapid form of heating in which a current is induced directly into the part being heated. Induction heating is a non-contact form of heating. Melting steel, cast iron, and aluminum alloys are common applications in foundry work

The induction furnace works on the principle of a transformer, when high frequency A.C. current is passed through the induction coil, a magnetic field is set up. This magnetic field induces eddy current in the work metal which converts the electric energy to heat without any physical contact between the induction coil and the work piece. A schematic diagram of induction furnace is shown in Figure

Construction:

1. The furnace consists of an outer cylindrical steel shell; inside it is coated with insulating materials made up of mica, glass or asbestos and the bottom surface is covered with refractory bricks.
2. Inside this shell, a refractory graphite crucible which contains the charge rests on the brick work and surrounded by a copper tube in the form of coil, that act as a primary coil of the transformer.



3. The copper tube being a heavy tube requires active cooling so it is connected to water line for cooling the coil.
4. The space between the crucible and the shell is packed by a dry refractory material that provides the necessary insulation.
5. Furnace top is closed by lid or cover lined with silica bricks facilitates the lowering and lifting of the crucible.

Working

1. The crucible is charged with raw-materials of the alloy to be melted and the lid is closed.
2. In this case, copper coil acts as primary coil and the charge (steel scraps) as secondary coil. When a high frequency electric current is passed through the copper tube, a much heavier secondary current is induced in the charge. Heat is generated due to the resistance offered by the charge metal causing it to melt.
3. Heat is generated within the metal itself so it reaches melting temperature in a short time. Simultaneously copper tube also gets heated and is cooled by passing cooling water.
4. The liquid metal undergoes a stirring action due to the 'eddy currents' induced that is concentrated in the center of the circular primary coil.
5. The flux in the charge reacts and forms the slag, floats on the molten metal.
6. Once the metal reaches the required pouring temperature, the lid is opened to lift the crucible out of the furnace and slag is removed. The clean molten metal is poured into the mould cavities.

Advantages of Induction Furnace

- Induction heating is a clean form of heating
- High rate of melting or high melting efficiency
- Alloyed steels can be melted without any loss of alloying elements
- Controllable and localized heating

- Temperature control in the furnace is easy and faster
- Electromagnetic stirring action takes place

Dis-advantages of Induction Furnace

- High capital cost of the equipment
- High operating cost

4

a. Welding is a process of joining two similar or dissimilar metals by fusion. It joins different metals/alloys, with or without the application of pressure and with or without the use of filler metal.

Welding processes are classified based on the basic principles employed as;

1. Plastic welding.
2. Fusion welding.

Plastic welding: -The parts to be joined are heated only up to the plastic state and then fused together by applying the external pressure. Plastic welding is also called as pressure welding. Ex: Forge welding, resistance welding etc.

Fusion welding: - The joint is made by melting the parts at the interface so that after solidification, the components are fused of joined together. In many cases extra metal is melted along the joint, to completely fill the joint region. Ex: Arc welding, Gas welding etc.

Welding process can be classified into different categories depending upon the following criteria:

1. Oxy-Fuel Gas Welding Processes

- Air-acetylene welding
- Oxy-acetylene welding
- Oxy-hydrogen welding
- Pressure gas welding

2. Arc Welding Processes

- Carbon Arc Welding
- Shielded Metal Arc Welding
- Submerged Arc Welding
- Gas Tungsten Arc Welding
- Gas Metal Arc Welding
- Plasma Arc Welding
- Atomic Hydrogen Welding
- Electro-slag Welding
- Stud Arc Welding
- Electro-gas Welding

3. Resistance Welding

- Spot Welding

- Seam Welding
- Projection Welding
- Resistance Butt Welding
- Flash Butt Welding
- Percussion Welding
- High Frequency Resistance Welding
- High Frequency Induction Welding

4. Solid-State Welding Processes

- Forge Welding
- Cold Pressure Welding
- Friction Welding
- Explosive Welding
- Diffusion Welding
- Cold Pressure Welding
- Thermo-compression Welding

5. Thermit Welding Processes

- Thermit Welding
- Pressure Thermit Welding

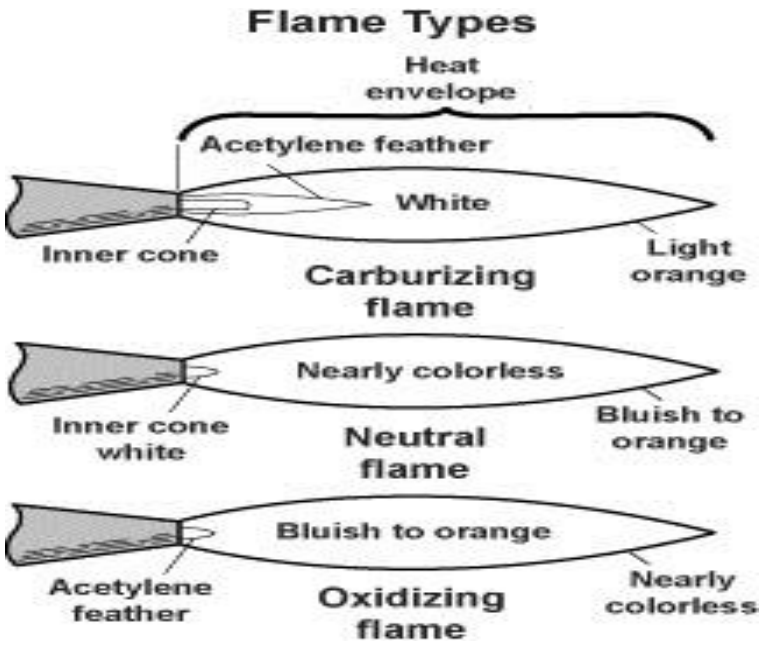
6. Radiant Energy Welding Processes

- Laser Welding
- Electron Beam Welding

b. **Neutral Flame**: This type of flame is produced when equal volumes of oxygen and acetylene are burnt together. In this flame there are two distinct zones: the inner white cone, which is clearly defined, and the outer envelope. The neutral flame is used when welding steels, stainless steel, cast iron, copper and aluminum, etc.

Carburizing Flame: If the volume of oxygen being supplied to the neutral flame is reduced, the resulting flame is rich in acetylene. It is rich in carbon and capable of yielding carbon to the steel being welded. Its effect is to reduce the melting temperature of the steel in the localized area of the weld. The carburizing flame is recognized by the ragged bluish white feather surrounding the large central white cone. The carburizing flame is used for hard facing.

Oxidizing Flame: If the neutral flame is adjusted until it burns with an excess of oxygen, the flame produced is called an oxidizing flame. It can be recognized by the small white cone surrounded by the ragged bluish white feather. It tends to be hotter than the neutral flame. The oxidizing flame is used to weld brass.



5

1) This furnace consists of a cylindrical shell with hemispherical bottom made of thick mild steel shell. The furnace shell is lined in the side, bottom and roof with refractory bricks to protect it from internal heat. Fig shows direct arc electric furnace.
2) The base is mounted on rollers to enable tilting of the furnace forward for pouring molten metal into ladle through pouring spout and can also tilt backward to remove slag through charging door.
3) The roof is a dished dome made of steel shell lined inside with refractory bricks, which can be opened to charge the raw materials into the furnace.
4) The roof is provided with three holes, through which non-consumable graphite electrodes are inserted into the furnace and these electrodes which in turn are connected to the 3-phase power supply.
5) The charging door is provided in the front side for observation, minor charging, slagging etc., while a pouring spout is provided on the opposite side to remove molten metal.

Working

1) The furnace is charged with raw materials through the charging door. The electrodes are lowered down and fixed at proper position.
2) The arc is produced, when the tip of the electrodes are struck with the charge metal, on supplying necessary current.
3) The suitable gap is maintained between electrodes and charge metals by regulating the movement of the electrodes so that stabilised arc is maintained between them
4) The metal below the electrodes starts melting; gradually it melts remaining metal in the furnace. As the charge starts melting, the flux reacts to form slag containing all the

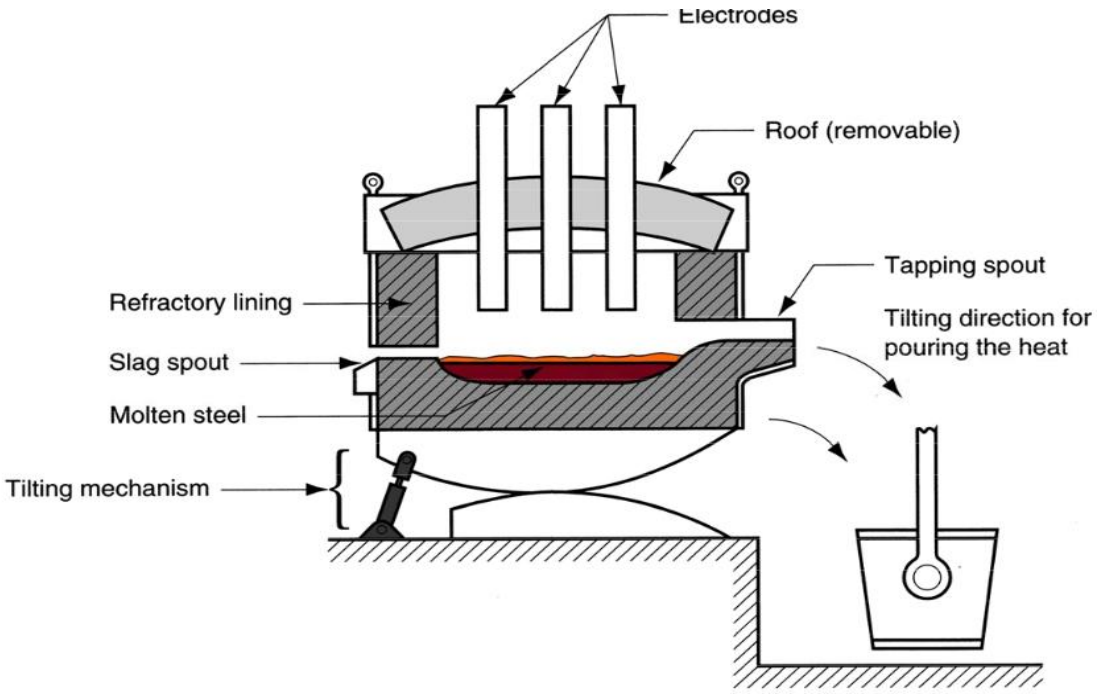


Figure 6.9 - Electric arc furnace for steelmaking

impurities. Once the metal reaches the required pouring temperature, the arc is disconnected by raising the electrodes.

5) Slag is removed through the charging door by tilting the furnace backward and also clean molten metal is removed through spout by tilting it forward.

Advantages

1) It has faster melting rate compared to arc furnace.
2) Energy consumption per ton melted metal is much lower.
3) Simple mechanism and lower maintenance cost.
4) Lower pollution and better working condition.

Dis-advantages

1) Refining of metal is difficult
2) Need high quality scrap
3) Need of costly capacitor bank

6 . Main component of TIG

1. **Welding torch**- used to hold the electrode wire rigidly with the help of collet.

2. **Shielding gas cylinder:** shielding gas is flows from the cylinder to the torch, through the passage provided in the torch and then impinges on the workpiece through the torch nozzle as shown in figure 4.6.

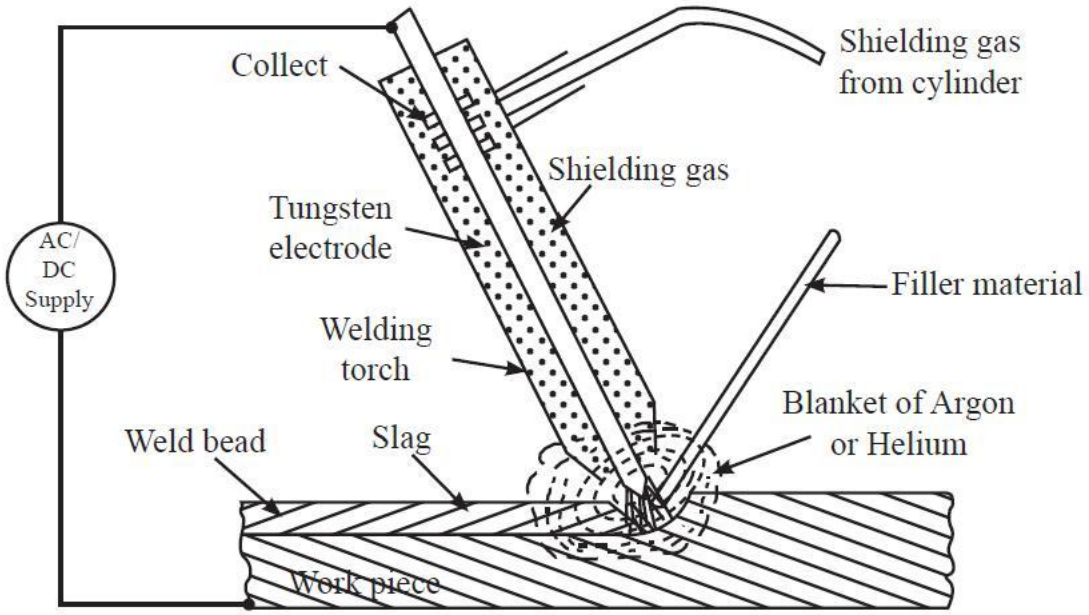
3. **Pressure regulators and control valves** are used to provide controlled flow of shielding gas.

4. **Welding power**: Either A.C. or D.C. power is used. Thoriated Ti electrodes have high emissivity, better current carrying capacity and longer life and normally preferred in DC welding. Pure Ti electrodes are usually preferred for AC welding of aluminium and magnesium. The current carrying capacity is lower than that of alloyed electrodes.

Operation

1. At first the job is cleaned and all types of contaminants like grease, oil, dirt, scale and paint are removed. The surfaces of the electrodes are also made very clean.

2. Power connections are switched ON. The inert gas supply is turned ON through the regulator. An arc is then struck with the actual workpiece to be welded and instantaneously the electrode is separated from the workpiece by a small distance of about 2-4 mm so that arc remains between the electrode and the workpiece.



3. The arc thus struck, due to high intensity of arc melts the workpiece metal and forms the molten pool.

4. Simultaneously filler metal is inserted manually into the welding area so that filler metal also melts and fills the gap between the workpiece, forms the globules of molten metal.

5. At the same time shielding gas is impinges on the workpiece and covered the molten pool completely to protect it from atmospheric contamination.

6. The welding head is moved along the surface to be welded and the filler metal is continuously fed to the joint to complete the weld.

7. As the welding is continued forward, the preceding molten metal starts solidifying and forms the strong joint between the workpiece.

Advantages of Tungsten Inert Gas Arc Welding:

- Weld composition is close to that of the parent metal;
- High quality weld structure
- Suitable for thin metals.
- Weld zone is clearly visible, hence control is easier.
- There are no weld cracks and no weld spatter.
- Slag removal is not required (no slag);
- Thermal distortions of work pieces are minimal due to concentration of heat in small zone.

Disadvantages of Tungsten Inert Gas Arc Welding :

- Low welding rate;
- Relatively expensive;
- Requires high level of operators' skill.
- Not suitable for heavier sections

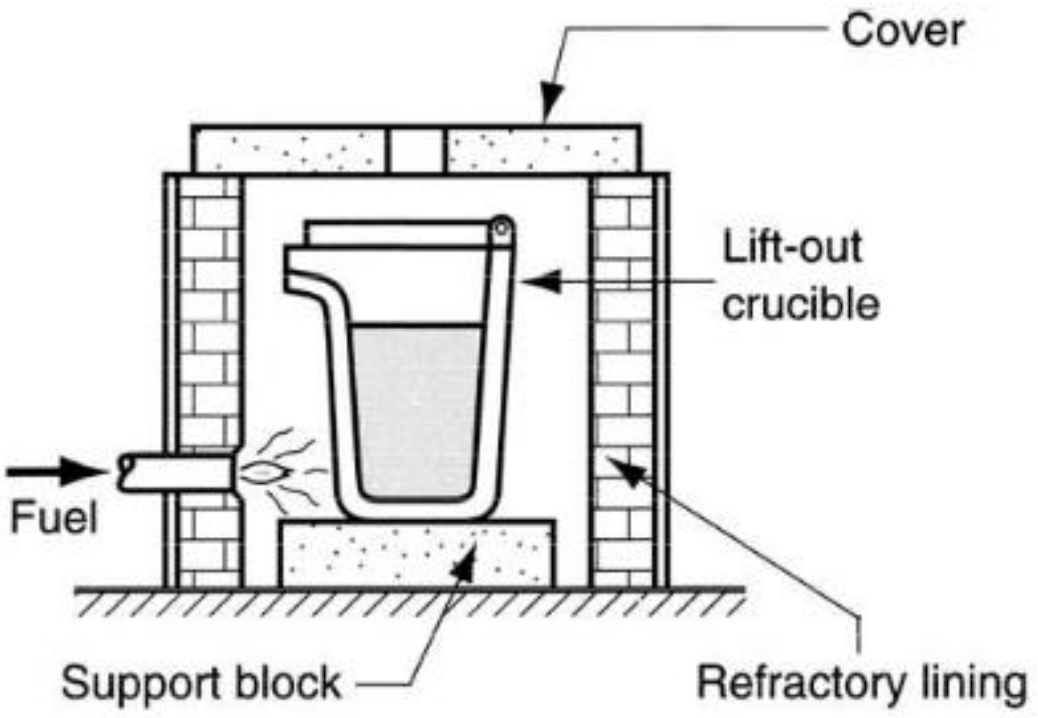
7. A furnace is an equipment to melt metals for casting or heat materials for change of shape (rolling, forging etc) or change of properties (heat treatment).

Construction

1) The walls of furnaces are made of refractory bricks or fire bricks to resist the heat and walls are covered outside with cylindrical steel shell.
2) The crucible is kept in the pit at a convenient height with a suitable support. The crucible is usually made of clay and silicon carbide material.
3) The fuel or oil burner is placed at bottom side of the pit and it is directed towards the crucible.
4) Furnace top is covered with lid which can be opened to lower and to lift the crucible, also to charge the raw-materials into the crucible. The lid is provided with small opening, which allows the burned gases to escape out.

Working

1) The crucible is charged with raw-materials of the alloy to be melted and the lid is closed. Burner is turned on and tip of the burner is tilted at an angle which causes the flame or hot flues swirl around the crucible and rises up.



2) After some time of burning, the crucible gets heated by the surrounding flame and simultaneously charge starts melting.
3) As the charge starts melting, the flux reacts to form slag containing all the impurities. Once the metal reaches the required pouring temperature, the lid is opened to lift the crucible out of the furnace and slag is removed. The clean molten metal is poured into the mould cavities.

Advantages

1) Used for medium capacity 50 to 500 kg batch.
2) Fast melting rate.
3) There is no problem of ash handling.
4) Possible to achieve good quality.
5) High thermal efficiency than coke.

Dis-advantages

1) Higher investment than coke fired.
2) Low fuel efficiency
3) Not suitable for high melt rates.