LESSON PLAN

Date_____ Trade:- Welder

Name_____ Unit/Lesson:-Thirty Five

Subject:- Submerged arc welding, process, principal, equipments, advantages and limitations. Electro slag and electro gas welding processes-principle, equipments, advantages and limitations.
Motivation:- in previous lesson we read about post heating and its benefit. Process of post heat treatment and its application.

PREPARATION

1) (Materials, Tools, Models, Charts and other aids)

INTRODUCTION:- Submerged arc welding are most using welding for thick plates. We weld till 25mm plates by SAW. In this process arc submerge in flux flow so this welding called submerged arc welding.

Topic	Information Point	Spot Hint
Submerged Arc welding	In this process arc submerge in flux flow , so called submerged arc welding.	
Applications	Mostly used for 6mm to 25 mm thickness .	
Limitations	Used for only Butt joint , lap joint and flange joint in flat position only. For ferrous metals only High costly equipments Need skilled welder	
Equipments	1. Power Source 2. Wire feeder 3. Flux hopper and air compressor 4. Base or rail for operation	
Power Source	It used AC or DC power source both	
Types	1. Manual Process 2. Semiautomatic 3. Fully automatic	
Advantages	Thick metals weld properly . High quality welding .	

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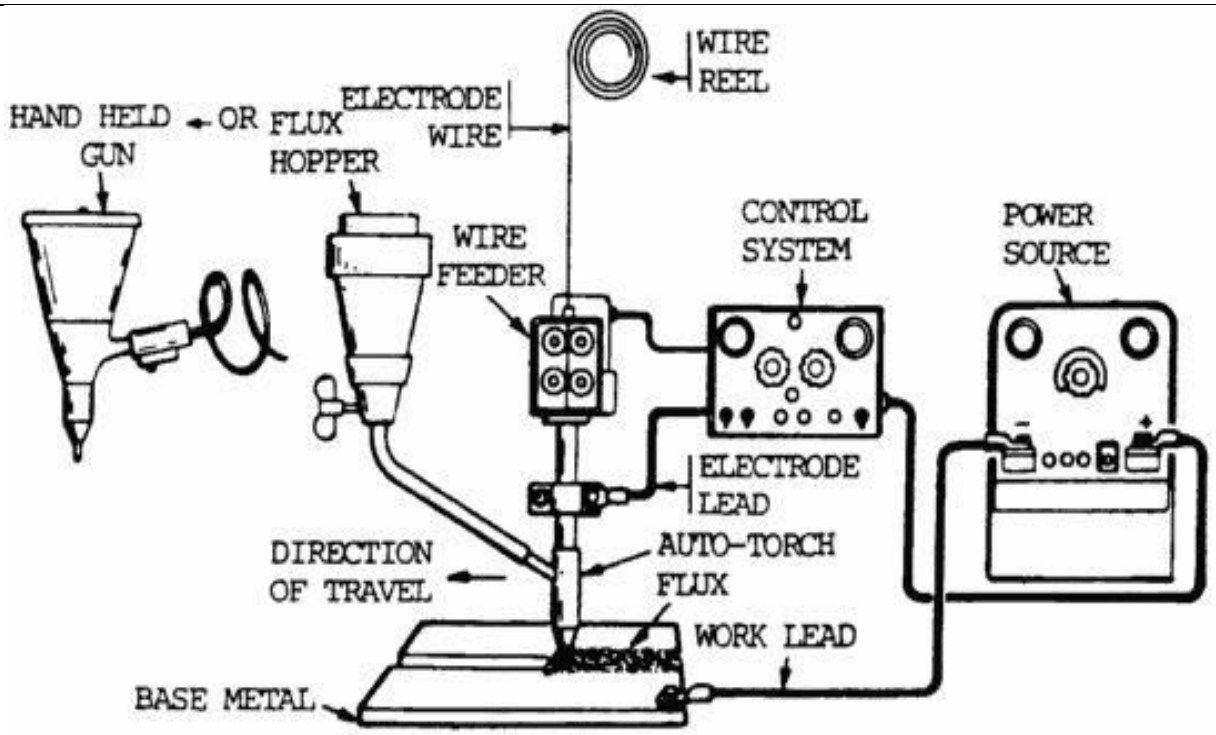
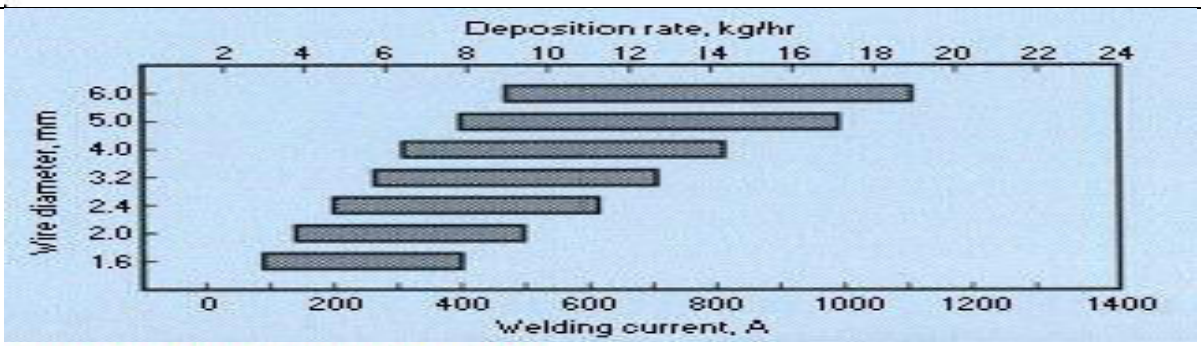
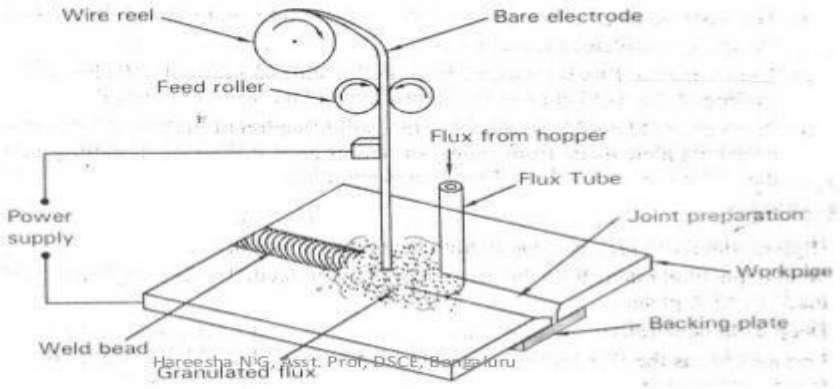


Figure 10-59. Block diagram - SAW.



SUBMERGED ARC WELDING (SAW)

- Submerged arc welding is a group of arc welding process in which the workpieces are joined by the heat obtained from an electric arc struck between a bare consumable electrode and workpiece.
- The arc is struck beneath a covering layer of granulated flux.
- Thus, the arc zone and the molten weld pool are protected from atmospheric contamination by being *'submerged under a blanket of granular flux.*
- *This gives the name 'submerged arc welding' to the process.*
- *Figure shows the submerged arc welding process.*



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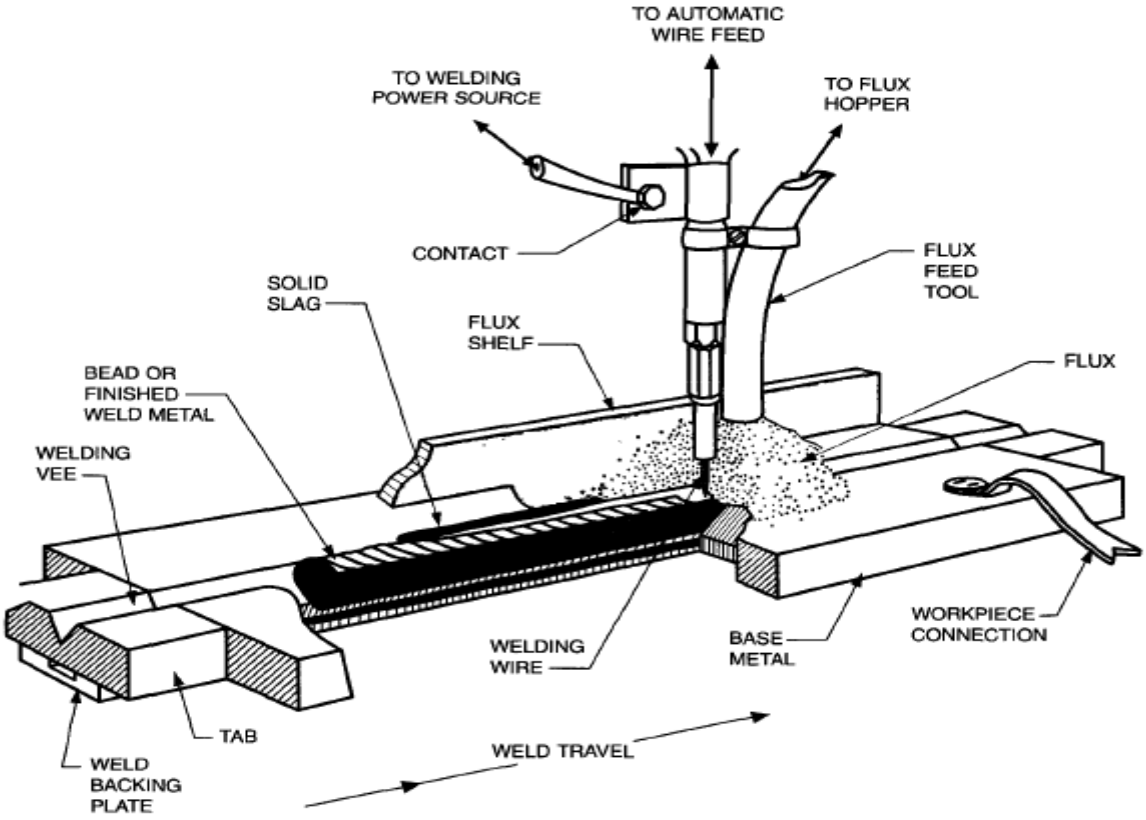

Figure S-27—Schematic View of Submerged Arc Welding Process

Table II
Deposition Rate Comparison

Wire Size		Current	SAW DC+ve			Generation I			AC Ctr.Waveform 50/50*		Generation II		
mm	inches	amps	EE"	lbs/hr	kg/hr	EE"	lbs/hr	kg/hr	lbs/hr	kg/hr	EE	lbs/hr	kg/hr
4.0	5/32	500	1-1/4	11.1	5.0	2-3/4	13.1	6.0	14.7	6.7	3-3/4	18.0	8.2
4.0	5/32	600	1-1/4	14.7	6.7	2-3/4	18.3	8.3	18.8	8.5	3-3/4	23.5	10.7
4.0	5/32	700	1-1/4	18.2	8.3	2-3/4	26.8	12.2	23.7	10.8	3-3/4	27.5	12.5
4.0	5/32	800	1-1/4	22.1	10.0				28.6	13.0	3-3/4	33.7	15.3
3.2	1/8	450	1	10.1	4.6	2-1/2	15.1	6.9	14.2	6.5	3	16.0	7.3
3.2	1/8	500	1	11.5	5.2	2-1/2	16.3	7.4	16.3	7.4	3	17.5	8.0
3.2	1/8	600	1	14.8	6.7	2-1/2	22.5	10.2	21.3	9.7	3	24.0	11.0
3.2	1/8	700	1	18.8	8.5	2-1/2	26.8	12.2	26.1	11.9			
2.4	3/32	450	1	11.8	5.4	2-1/4	17.6	8.0	15.2	6.9			
2.4	3/32	500	1	13.1	6.0	2-1/4	20.6	9.4	17.6	8.0			

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Welding Process & Filler Metal Type	Filler Metal Spec	Filler Metal Type	Color Match	Machineable Deposit
SMAW (Stick)				
Cast iron	E-CI	Cast iron	Good	Yes
Copper-tin[2]	ECuSn A & C	Copper-5 or 8% tin	No	Yes
Copper-aluminum[2]	ECuAl-A2	Copper-10% aluminum	No	Yes
Mild steel	E-St	Mild steel	Fair	No
Nickel	ENi-CI	High nickel alloy	No	Yes
Nickel-iron	ENiFe-CI	50% Nickel plus iron	No	Yes
Nickel-copper	ENiCu-A & B	55 or 65% Ni + 40 or 30% W	No	Yes
Oxy Fuel Gas				
Cast iron	RCI & A & B	Cast iron-with minor alloys	Good	Yes
Copper zinc[2]	RCuZn B & C	58% Copper-zinc	No	Yes
Brazing[3]				
Copper zinc	RBCuZn A & D	Copper-zinc & copper-Zinc-nickel	No	Yes
GMAW (MIG)				
Mild steel	E60S-3	Mild steel	Fair	No
Copper base[2]	ECuZn-C	Silicon bronze	No	Yes
Nickel-copper	ENiCu-B	High nickel	No	Yes
FCAW				
Mild steel	E70T-7	Mild steel	Fair	No
Nickel type	No spec	50% nickel plus iron	No	Yes

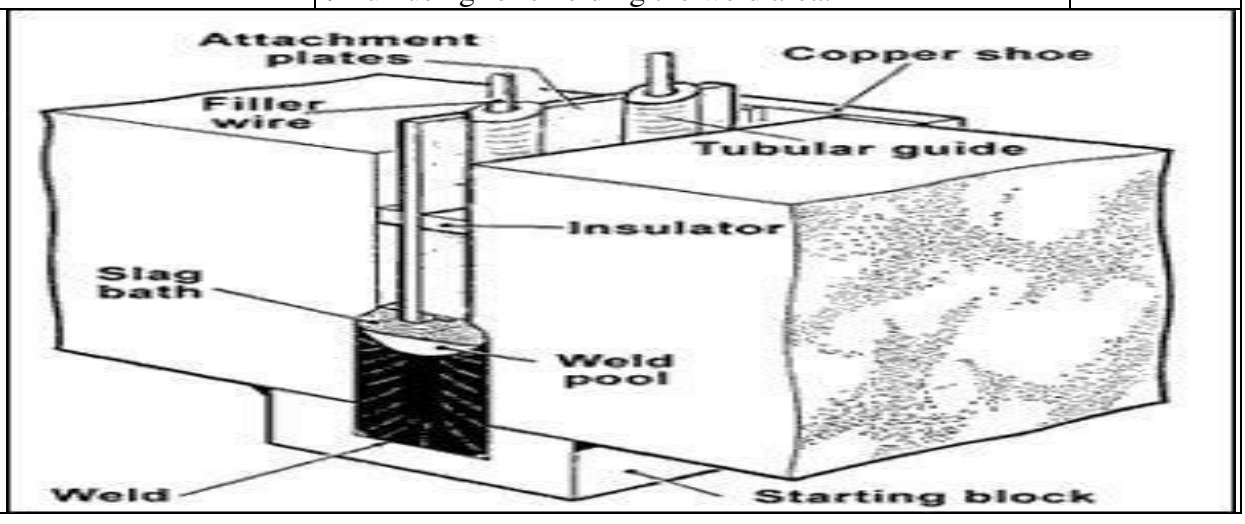
Questions:- What is SAW and its Process?

3 write two limitations of SAW.

3 . write types of SAW machines.

Electro slage Welding:-

Topic	Information Point	Spot Hint
Electro slag Welding	In this process arc produced on joint and flux cored wire / flux using for shielding the weld area.	



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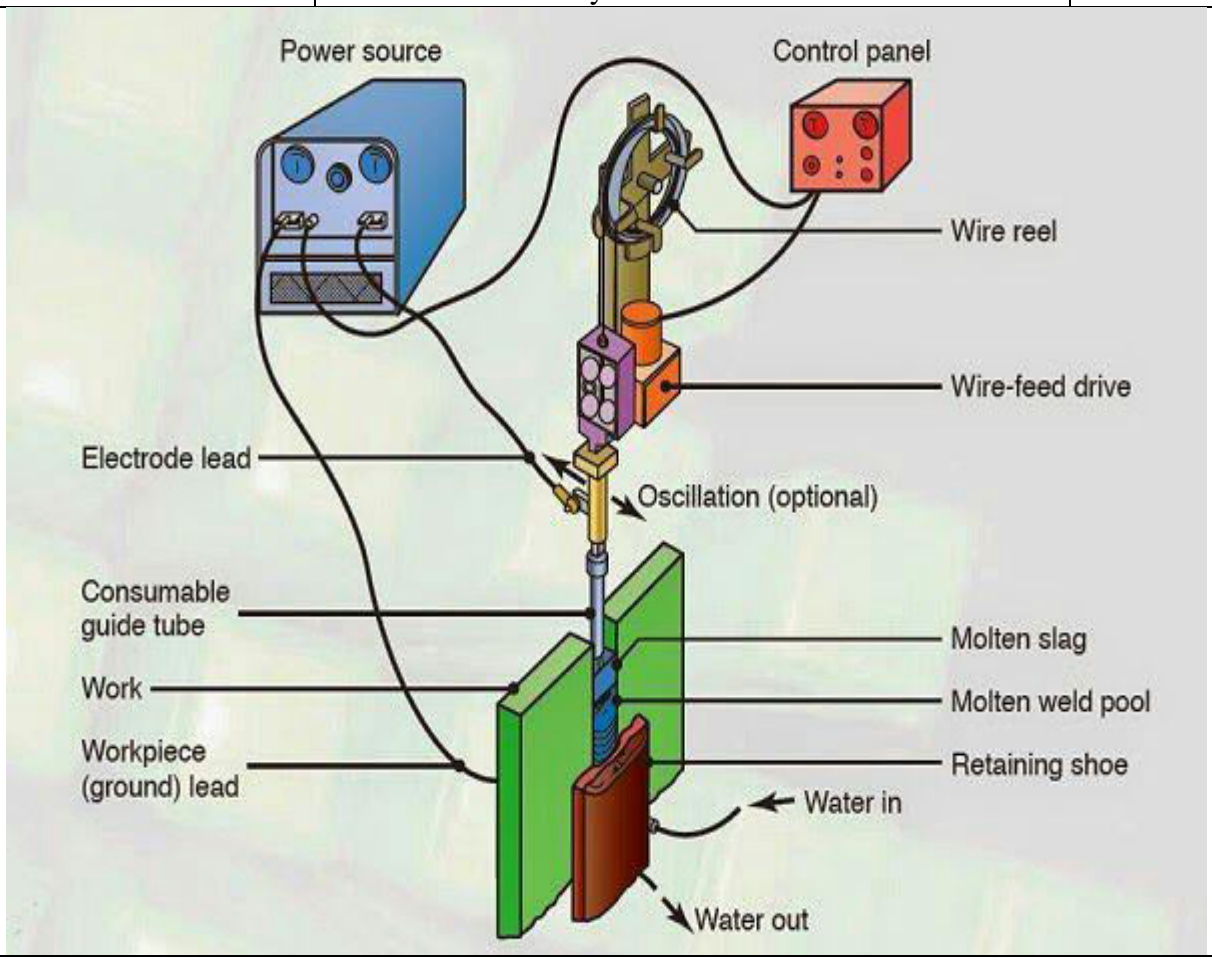
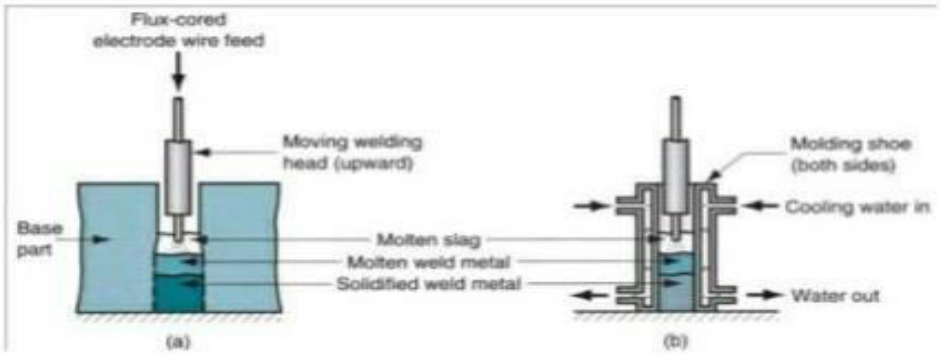
Process	First attached starting block and also side plate at both side on joint, then arc produced and slag continue produced on the joint and ago quality joint complete .	
Equipments	1. Power Source (AC/DC) 2. Welding head 3. Wire feeder 4. Control panel 5. Water cooling system 6. Low viscosity flux	



Types	1. Conventional 2. Consumable guide	
Conventional Electro slag	A non consumable guide tube used for supply filler materials and machine drive perpendicular direction also used molding shoes for cooling.	Used for 18-40 mm thick plates
Consumable guide ESW	Used consumable guide tube upper side of slag bath surface and machine has fix but electrode movement vertically. It has two type shoes stationary and non sliding shoes.	
Advantages	1. Weld 400 mm thick plates. 2. Less edge preparation. 3. High deposit rate. 4. Less flux consumption.	
Limitations	1. Costly for less then 60 mm. 2. Chances of hot cracks.	

	3. Uses for butt joint only.	
Electro gas welding	Electro gas welding is a process of gas metal arc welding and used gas supply as like flux cored arc welding.	

- Electrogas welding using flux-cored electrode wire: (a) front view with molding shoe removed for clarity, and (b) side view showing molding shoes on both sides

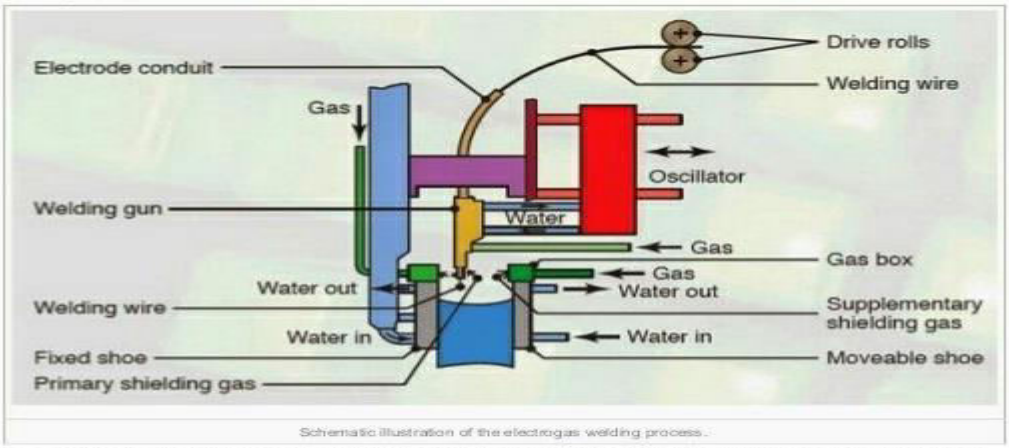


Types	1. Solid electrode 2. Flux cored electrode.	
Solid electrode	Set up the weld gun between plates and flow shielding gas. Start arc on starting plate. Arc molt the electrode and groove face.	
Flux cored wire	Used flux cored wire and other process same as above.	
Equipments	1. Power source DC 2. Welding head.	

Electrogas Welding

me-mechanicalengineering.com/2014/10/electrogas-welding.html

Electrogas welding (EGW) is an vertical positioned arc welding process, is used for welding the edges of sections vertically and in one pass with the pieces placed edge to edge (butt joint). It is classified as a machine-welding process, because for its operation requires special equipment. The weld metal is deposited into a weld cavity between the two pieces to be joined. The space is covered by two water-cooled copper dams(shoes) to prevent the molten slag from running off; mechanical drives move the shoes upward.



Schematic illustration of the electrogas welding process.

One or more electrodes are fed through a conduit and a continuous arc is maintained by flux-cored electrodes at up to 750 A or solid electrodes at 400 A. Power requirements is 20 kW. Shielding is done by means of an inert gas, such as argon or helium depending on the type of material being welded. The gas may be provided either from an external source, from a flux-cored electrode or from both the sources. The equipment of electrogas welding is reliable and training an operator is easy. Weld thickness is between 12 mm to 75 mm on steels, titanium and aluminum alloys.
Electrogas welding process is used in the construction of bridges, pressure vessels, thick-walled and large-diameter pipes, storage tanks, submarines and ships.

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Advantages	No need for heat treatment and welding completed in one pass	Used for 20-75 mm
Limitations	Not sufficient for 75 mm above and porosity defects in weld joints	

1. The electrode remains dipped in the molten slag and gets melted and deposited as the welding progresses. The slag remains in the molten state by the heat generated by it's resistance. The arc then gets extinguished and molten slag provides the conducting path to the current. The process is initiated by an arc that heats up the granulated flux and forms the slag. A welding process where fusion of base metal and filler metal is achieved from the heat generated by the electrical resistance of the molten slag. Weld pool shielded by the molten slag, which moves along the joint as welding progresses. .
2. 3. Non-consumable electrode guide cum contact tube¬ Two types of electro slag welding , Welds plates ranging in thickness from 19 to 460 mm. Types A progressive solidification takes place from bottom upwards, and always there is a molten metal pool over the solidifying weld metal. The molten slag bath over the weld pool acts both as the heat source as well as a shielding medium.
3. 4. Consistent with the electrode melting and¬Speed of this vertical movement determines the welding speed ¬ Shoes move vertically up Water cooled copper shoes are used on both sides of the plates to contain the molten metal and the molten slag. One or more electrodes are fed to the molten slag pool depending on the thickness of the metals being joined. Electrode with Non Consumable Guide
4. 5. Small amounts of flux is added at intervals to compensate for this consumption of slag.¬ The exposed surfaces are covered with a fine layer of slag. As the shoes move up, the solidified weld deposit gets exposed. Provides the required amount of reinforcement on the weld deposit. ¬ Contact surfaces of the shoes are shaped concave.
5. 6. With the progress of the weld as the metal solidifies, the shoes from below are removed and placed aboveFor longer joints, several sets of shoes are used. ¬Shoes are of same length as the joint. ¬Entire joint height is covered by the shoes. ¬ The consumable guide provides approximately 5 to 15% of the filler metal. In this method non sliding shoes are used. Metal deposition is from both electrode and the consumable guide. Consumable guide
6. 7. Load voltages generally range from 30 to 55 V¬Current rating of 500 to 1000 A. ¬ Constant potential DC power source is used This method can be used to weld sections of virtually unlimited thickness. Insulating tape. ¬Flux coating of the outer surface of the guide tube. ¬Required insulation may be provided by ¬Needs to be insulated. ¬ As the weld current is carried by the guide tube,

7. 8. Operating variables differ from those with conventional arc welding processes.Load voltages generally range from 30 to 55 V. Operating Variables ¬Current rating of 500 to 1000 A. ¬ Constant potential DC power source is used Power Supply
8. 9. Form factor is the ratio of the weld pool width to it's maximum depth.¬ Weld pool shape can be expressed by a "form factor". Angle at which the grains meet in the center is determined by the shape of the molten weld pool. ¬ Solidification of molten metal takes place at a slow rate. Form Factor
9. 10. Base metal composition, filler metal composition and joint restraint have a significant effect on crack formation.¬ Form factor alone doesn't control cracking . Maximum resistance to cracking is obtained with welds having high form factor. Low in case of obtuse angle. ¬High in case of acute angles ¬Grains meet at obtuse angle. The weld cracking resistance ¬ In case of low form factor, Grains meeting at an acute angle. ¬ A high factor weld deposit tends to solidify with
10. 11. For metals more prone to cracks, current below 500 A used. Generally currents of 500 to 700 A are used with 3.2 mm electrode. Effect of increasing current is to decrease the form factor and thus lowering the resistance to cracking. Increased depth of molten weld pool. ¬Increased heat input ¬ Increasing welding current Welding Current
11. 12. With thickness sections, higher voltages are Increases resistance to cracking. ¬Increases the form factor ¬Increases the width of the weld. ¬Increases the sideways depth of fusion in the base metal ¬ Increasing the voltage For stable operation voltages within 30 to 55 V per electrode are used. Welding Voltage An extremely important variable.
12. 13. Oscillation speeds vary between 8 to 40 mm/s, with increasing speed to match the plate thickness.¬It distributes the heat and thus helps to obtain better edge fusion. ¬ Oscillation of electrode is generally carried out horizontally across the thickness. Electrode Oscillation
13. 14. During the electro slag process since no arc exists no spattering or intense arc flashing occurs. Residual stresses and distortion produced are lower. Thickness up to 450 mm in plain and alloy steels can be welded without difficulty. Very thick sections can be welded in a single pass and more economically. Very high deposition rates can be achieved with ESW Advantages
14. 15. Only vertical position can be welded. Low toughness of the weld. Coarse grain structure of the weld. Electro slag welding is not suitable for joints below 60 mm. Limitations
15. 16. Led to large cost savings compared to conventional GMAW process for welding of very thick steel plates. Very useful for vertical welding of thick plates up to a thickness of about 100 mm in a single pass. Instead of resistance heating of molten slag, the electrode is melted by the arc heat in

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an inert gas environment, very similar to that of GMAW process. ¬ A further development of electro slag welding process. □

16. 17. Gives an advantage of extra melting of electrode wire leading to high deposition rate and produces less molten base material thereby resulting in lesser HAZ.□ Better notch toughness as compared to electro slag welding. □ Produces a smaller heat-affected zone (HAZ) □ Solid or flux cored wire electrodes are used. □
17. 18. Electrode is kept positive.□ Constant current DC power supply is generally used. □ The electrode is melted by a shielded arc. □ The weld pool is bound either by two sliding water cooled copper shoes or a sliding water cooled copper shoe in the front and ceramic backing strip at the back. □ It welds only in vertical direction. □ It is an automatic welding process. □Salient Features
18. 19. Stubbing of electrode in the molten pool (may lead to¬Arc unstability or ¬ Any mismatch will lead to □ Synchronization of the feeding of electrode and moving up of the shoes is extremely important. □In the process the molten material at the lower end of the groove solidifies and the process continues till it reaches the upper end. ¬In the arc heat the electrode and the plate edges along the vertical groove melts forming a weld pool covered side ways with copper shoes. ¬Process Once the arc is initiated,
19. 20. Is used to weld 50 mm thick steel plates.□ HAZ toughness and welding efficiency substantially increases. □Enables proper welding with adequate reinforcement on both sides of the plate. ¬ To attain a sound weld bead formation, the weld wire (nozzle) is oscillated in the plate thickness direction. □A fine diameter wire is used with a lower welding current and a narrow groove. ¬ To reduce the heat input, □Single electrode EGW
20. 21. This provides for a□ One of the electrode is made positive and the other is kept negative. □ Direct current power source is used. □ For plates having thickness greater than 50 mm single electrode EGW can't be used. Plates of thickness 50-70 mm is welded by double electrode EGW process. □Double electrode EGW Arc becomes highly unstable and leads to high amount of spatter.¬ If both electrodes have the same polarity, □stable arc.
21. 22. For a wide single V groove, the electrode on the wider groove surface is made positive and electrode on the rear side of the groove is made negative.□With deeper penetration ¬Narrow bead ¬With less penetration Negative polarity gives ¬Wider bead is formed ¬Also with electrode positive
22. 23. Bridges etc.□ Thick walled and large diameter pipes □ Ship Building □ Chemical Furnaces □ Blast furnaces □ Vertical Vessels □ Storage tanks □Applications Grain fully applied in Building of

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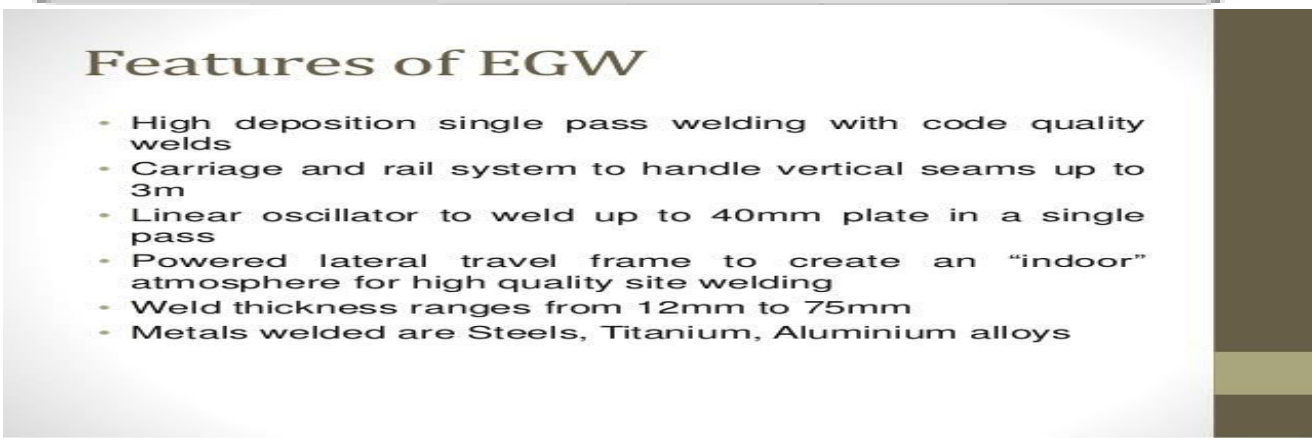
23.24. Massive, expensive welding equipment and guidance system are required. This process is limited for making vertical weld joints. Welded joints have better mechanical properties such as impact strength. Limitations High Deposition Rate as compared to manual welding. EGW process welds thicker plates in single pass. EGW process has higher welding speed. Advantages



Assignment:- Submerged arc welding, process, principal, equipments, advantages and limitations. Electro slag and electro gas welding process. process, principal, equipments, advantages and limitations.

Next lesson:- Thermit welding process, equipments, thermit mixtures types and applications. Use of Baking Strips and Bar.

Checked By_____ Instructor_____

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