Experimental Investigation on Cycle Time Reduction in Second Pass Roof Panels

[1] P.Viswabharathy, [2] R.Harimaheswaran, [3] E.Ajith Kumar, [4] A.Aravindhan, [5] I.Aravindan, [6] B.Chandra Prakash

[1, 2] Assistant Professor, Department of Mechanical Engineering, Shivani College of Engineering & Technology, Trichy,Tamilnadu, India.

[3, 4, 5, 6] UG Scholar, Department of Mechanical Engineering, Shivani College of Engineering & Technology, Trichy,Tamilnadu, India.

Abstract – This once through supercritical (OTSC) technology has become a focal point for increasing coal-based thermal power generation sector in India. Indian Ultra Mega Power Projects (UMPPs), typically 4,000 MW each, were undertaken during the 11th five year plan (ended in 2012) and are slated to address increasing coal-based thermal power generation throughout the 12th and 13th five year plans. OTSC technology is expected to account for 40% of all coal-based thermal capacity additions during the upcoming 12th five year plan and all coal-based capacity additions for the 13th plan. These aggressive plans are set against a backdrop of fuel shortages as coal consumption has increased 6% while proven domestic reserves have increased only about 2.5%. The use of imported coals continues to address indigenous coal supply shortfalls. The Indian Central Electricity Authority (CEA) stipulated in 2011 that all future indigenous coal based thermal power plant boilers are to be designed for utilization of fuel blend ratios of 30% imported coal/70% indigenous coal. Thus fuel flexibility will become an issue of increasing importance in the adoption of OTSC technology in India.

Index Terms – Once Through Supercritical (OTSC),Roof Panel,Cycle Time Reduction,PEMAMEK,Boiler

1. INTRODUCTION

The advantages of Once Through Supercritical (OTSC) technology have become a focal point for increasing coal-based thermal power generation sector in India. Indian Ultra Mega Power Projects (UMPPs), typically 4,000 MW each, were undertaken during the 11th five year plan (ended in 2012) and are slated to address increasing coal-based thermal power generation throughout the 12th and 13th five year plans. OTSC technology is expected to account for 40% of all coal-based thermal capacity additions during the upcoming 12th five year plan and all coal-based capacity additions for the 13th plan. These aggressive plans are set against a backdrop of fuel shortages as coal consumption has increased 6% while proven domestic reserves have increased only about 2.5%. The use of imported coals continues to address indigenous coal supply shortfalls. The Indian Central Electricity Authority (CEA) stipulated in 2011 that all future indigenous coal based thermal power plant boilers are to be designed for utilization of fuel blend ratios of 30% imported coal/70% indigenous coal. Thus fuel flexibility will become an issue of increasing importance in the adoption of OTSC technology in India.This paper will highlight the technical advantages of the 660 MWe super critical CFBC technology using multi fuel blends which offer favorable economics and fuel arbitrage advantages not only today but in the future . Also discussed will be the recent contract award from Korea Southern Power Company to Foster Wheeler for 4 units of 550 MWe CFB OTSC technology which utilizes a 2 on 1 configuration of 2 x 550MWe CFB OTSC boilers on two single 1000 MWe turbines. Essentially this provides a fuel flexible low emissions alternative for a 2 x1000 MWe solid fuel power block.

1.1OTSC BOILER

Over the past 35 years, circulating fluidized bed (CFB) boiler technology has evolved from a robust industrial boiler technology used to burn difficult fuels in the late 1970s through the successful installation and commercial operation in 2009 of the world's largest CFB boiler rated at 460 MWe. Established benefits of improved efficiencies, reduced emissions, fuel flexibility and lower costs all combine making CFB technology a highly competitive option for large-scale utility applications. CFB technology is now challenging pulverized coal technology in large scale energy generation with now over 80 CFB units of over 200 MWe and a 460 MWe supercritical unit in operation.

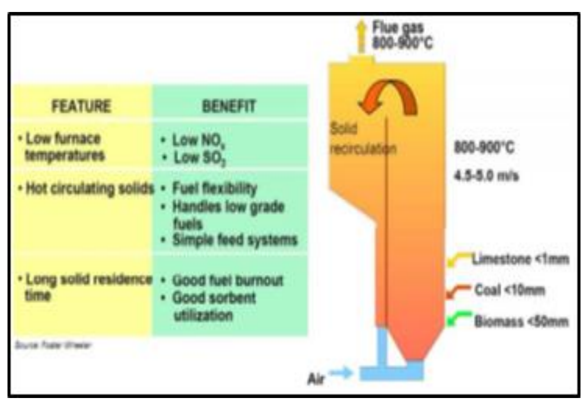

Fig 1.1 Diagram of CFB boiler

As indicated in Figure 1.1, the features of CFB combustion provide major benefits over pulverized coal steam generators. Utility scale PC fired steam generators are designed for a narrow range of fuels, typically coals with heating values above 6000 kcal/kg. CFB steam generators afford the maximum flexibility in fuel selection covering all coal types including low rank coals, petroleum coke, coal slurries, anthracite culm, biomass, and peat. As such, the fuel procurement flexibility for CFB steam generators provides long term fuel security and full access to the arbitrage in the global fuel market.

CFB combustion occurs at about 850^{0}C vs. 1500^{0}C for a PC boiler. In the PC boiler, melting ash has a high propensity for slagging in the furnace and soot blowing is required. Slagging and soot blowing are avoided in a CFB furnace.

Another major feature of CFB is control of NOx and SO2 emissions in the boiler. This avoids the EPC capital costs associated with SCR and FGD equipment. For a 600 MWe plant, Capex savings can exceed US$100 million. In addition, operating costs for ammonia and SCR catalyst management for SCR and limestone or lime for wet or dry FGD are avoided.

1.2 SALIENT FEATURES OF OTSC BOILERS

No thick walled drum. Instead , smaller separator vessels are provided.

- Types of evaporator system:
- High mass flux spiral wall,
- Medium mass flux vertical wall with orifice,
- Low mass flux vertical wall.

1.3REASONS TO GO SUPERCRITICAL

Supercritical boilers offer benefits in the three interrelated areas that mean the most to plant owners and operators today: efficiency, emissions, and cost. While supercritical boilers cost more than comparably sized subcritical boilers, the larger initial capital investment can be offset by the lifecycle savings yielded by the technology's improved efficiency, reduced emissions, and lower operating costs —all due to its higher steam temperature and pressure parameters.

1.4 Improved Efficiency

Supercritical and ultra-supercritical boilers' ability to operate at much higher pressures and temperatures than subcritical boilers translates into noticeably better efficiency ratings.Subcritical boilers typically run at 2400 psi/1000°F. By way of contrast, modern supercritical units can go as high as 3900 psi/1100°F. The even more advance ultra-supercritical units reach pressures and temperatures as high as 4600 psi/1120°F. Current research goals are set as high as 5300 psi/1300°F and seem to be on the horizon.

Table 1.1 Boiler Types And Efficiencies

Boiler Type	Efficiency Rating Spread	MIT Efficiency Rating
Subcritical	32–38%	34.3%
Supercritical	37–42%	38.5%
Ultra-supercritical	42–45%	43.3%

1.5 Reduced Emissions

Improved plant efficiency also translates into reduced emissions, particularly of CO_2 and mercury, which are difficult to manage otherwise. The general rule of thumb is that each percentage point of efficiency improvement yields 2–3% less CO_2.

1.6 Lower Operating Costs

For all fossil fuel–fired plants, fuel represents the largest operating cost. By reducing the amount of fuel needed to yield the requisite energy, supercritical plants make a noticeable dent in bottom lines when compared to subcritical plants.

1.7 WORKING PRINCIPLE OF OTSC BOILER:

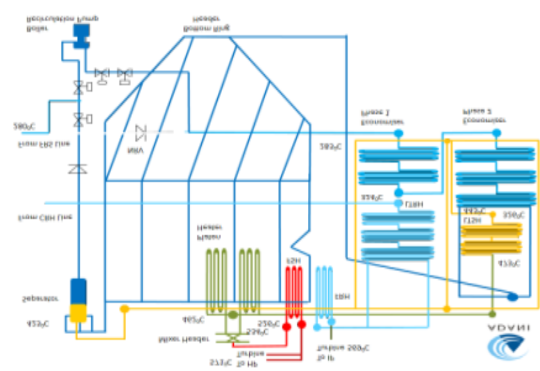

Fig 1.2Diagram for OTSC boiler

The super critical plant process, the above diagram utilizes similar condensate feed heating plant, boiler plant and turbine to the sub-critical plant with the following difference: The CEP and BFP raise the pressure of the boiler feed water above the critical pressure. As the boiler water in super critical plant does not exist as a two phase fluid it does not require any separation or recirculation of liquid through the evaporation stage hence no drum. The steam is considered to be superheated after it passes the ctitical temperature for the cycle pressure.

2. LITERATURE REVIEW

[1]Izzatul Aini Ibrahim, Syarulashrafmohamat, Amalina.amir,et. alperformed experiments in the effects ofdifferent parameters on welding penetration, micro structural and hardness measurement was measured in mild steel that having the 6mm

thickness of the base metal by using the robotic gas metal arc welding. The variable parameters are arc voltage, welding current and welding speed. The penetration, microstructure and hardness were measured for each specimen after the welding process and the effect it was studied. As a result, it obvious that increasing the parameter value of welding current increased the value of depth of penetration. Other than that, arc voltage and welding speed is another factor that influenced the value of depth of penetration. In these experiments use 100 % $_2$ shielding gas and wire electrode is ER70S 6 with 1.2 diameter nozzle to work distance is 12mm and only one pass on weld plate. In Figure ,The effect of welding current on penetration was present in welding speed as constant as 20 cm/min and the value of penetration was increased by increasing the value of welding current 90, 150 and 210 A. The highest penetration is 2.98 mm at 22 V and 210 A. Welding speed as constant as 40 cm/min and the value of penetration was increased by increasing the value of welding current 90, 150 and 210 A. The highest penetration is 3.26 mm at 22 V and 210 A. The change in the value depth of penetration is similar at voltage of 26V and 30V. The welding speed as constant as 60 cm/min and the value of penetration was increased by increasing the value of welding current 90, 150 and 210 A. The highest penetration is 2.79 mm at 26 V and 210 A.

[2]K. SRINIVASULU REDDY,et. al was investigated on insubmerged arc welding (SAW), weld quality is greatly affected by the weld parameters are closely related to the geometry of weld bead, a relationship which is thought to be complicated because of the non-linear characteristics. Bead-on-plate welds were carried out on mild steel plates using semi automatic SAW machine. Input parameter are used like, weld current, voltage, weld speed, electrode stick out with output parameter are carried out penetration, weld width, weld hardness using Taguchi's DOE. Data were collected as per Taguchi's Design of Experiments and L8 orthogonal Array, analysis of variance (ANOVA) was carried to establish input–output relationships of the process. By this relationship, an attempt was made to minimize weld bead width and maximum penetration is one objective and developing artificial neural network (ANN) models to predict the weld bead properties accurately along with sensitivity analysis is also the prime objective to determine optimal weld parameters. The optimized values obtained from these techniques were compared with experimental results and presented.

[3]Pawan kumar, Dr.B.K.Roywas worked carried out on platewelds AISI 304 & Low Carbon Steel plates using gas metal arc welding (GMAW) process. Taguchi method is used to formulate the experimental design. Design of experiments using orthogonal array is employed to develop the weldments. The input process variables considered here include welding current, welding voltage & gas flow rate. A total no of 9 experimental runs were conducted using an L9 orthogonal array and the ideal combination of controllable factor levels was determined for the hardness to calculate the signal-to-noise ratio. After collecting the data signal-to-noise (S/N) ratios were calculated and used in order to obtain optimum levels for every input parameter. The Nominal-the-better quality characteristic is considered in the hardness prediction. The Taguchi method is adopted to solve this problem. Subsequently, using analysis of variance the significant coefficients for each input parameter on tensile strength & Hardness (WZ & HAZ) were determined and validated.

[4]Chandresh N.Patelused Full factorial method for Designof Experiment for optimization work. By use of the experimental data optimal process parameter combination was achieved by grey relational analysis (GRA) optimization technique. In this work, input parameters for MIG welding were welding current, wire diameter and wire feed rate and the output parameter is hardness.

Also the input parameters for TIG welding are welding current, wire diameter and the output parameter was hardness. AISI 1020 or C20 material was used for welding. Experiments were performed on plates of thickness 5 mm and double V-groove joint is used. And input parameters for MIG welding were welding current, wire diameter and wire feed rate and the output parameter is hardness. Also the input parameters for TIG welding are welding current, wire diameter and the output parameter was This error is due to human ineffectiveness and machine vibration. By use of ANOVA analysis the percentage contribution of TIG welding for welding current is 73.36 % and wire diameter of 23.90 % and the error is of 2.74 %.

[5]G.Haragopal, P V R Ravindra Reddy and J V Subrahmanyampresented a method to design processparameters that optimize the mechanical properties of weld specimen for aluminium alloy (Al-65032), used for construction of aerospace wings.

The process parameters considered for the study were gas pressure, current, groove angle and pre-heat temperature. Process parameters were assigned for each experiment. The experiments were conducted using the L9 orthogonal array. Optimal process parameter combination was obtained. Along with this, identification of the parameters which were influencing the most was also done. This was accomplished using the S/N analysis, mean response analysis and ANOVA.

3.ROOF PANEL

Very few operational & maintenance personnel dare to visit this area. This is because there is always a pool of ash and one may end up in inhaling ash to his lungs. This ash leakage is not intended. But many of the boiler users are unaware that the designer's intention is to give a leak proof penthouse.

Due to ignorance of construction workers and due to urgency of commissioning the unit, the seal work remains incomplete. Moreover the sealing work is so cumbersome work, the erection staffs tend to compromise the work. If the work is incomplete, it results in ash leakage & air ingress while the boiler is in service. During a replacement / repair work, seals are ignored and it creates air ingress.

The effects of incomplete seal work are many:

1. Ash leaks and makes the boiler house dirty.

2. Air ingress leads to increased oxygen percentage in flue gas. Thus excess air setting would be wrong. This results in poor combustion efficiency.

3. ID fan gets overloaded. At times some users go for ID fan change.

3.1 FUNCTION

This was a pulverised coal fired boiler with load carrying oil burners. The visit was made to solve their recurring radiant SH tube failure problem. One of the causes for failure was related to heavy air ingress from roof. This boiler was of loose tangent tube waterwall construction. The side wall casings were in good condition. The unit was oil supported for many years. Recently due to management decisions, the oil support had been cut. The air ingress to penthouse had been quite high that the gas had condensed and damaged the convection SH hanger tubes. It had been corroding the side waterwall outlet header & roof beams inside the penthouse. The penthouse inspection door was not leak tight. Yet more leakage was seen from the roof floor that was not sealing against air ingress.

3.2 ESTABLISHMENT OF LINEBEND PROCESS IN BACKPASS ROOF PANELS OF OTSC BOILERS:

The Roof panels in the second pass of OTSC boilers are designed with 540 openings to enable the ECO & LTRH hanger tubes to pass through the panels as shown in the photograph below:

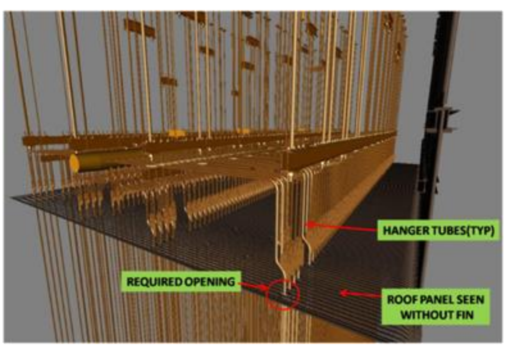

Fig 3.1 Roof Panel Arrangement

3.3 Roof panel arrangementPanel fabricated with Manual TIG joints (Old method)

This necessitates the introduction of 544 cut-out openings in the panel alternative tubes. This leads to 1560 additional Manual TIG joints to fabricate these openings in the 13 roof panels (in PGMAs 11-787 & 11-987).

To eliminate Manual TIG joints in these roof panels, we had taken pre bended tubes, these pre bended tubes were aligned into straight line along with fins according the drawing dimensions and then auto welding was carried out at pemamek panel formation machine.

The welding and dimensions are found satisfactory.A cycle time reduction of 45 shifts per panel is achieved by this new method due to the elimination of 1560 manual TIG joints (120 joints per panel).

4. MANUFACTURING OF ROOF PANELS

4.1 INTRODUCTION OF PEMAMEK WELDING MACHINE

Productivity and high quality – that's the output of a PEMA stationary panel welding machine. The most advanced submerged arc welding process ensures not only the welding quality and high speed, but also a good working environment without welding fumes or arc radiation.

4.2 PEMAMEK MACHINE

PEMAMEK OY a leading European company specializing in the supply of welding automation and mechanization services for efficient shipyard production automation. Lately, PEMAMEK have been focusing on new technology & solutions for shipyard automation.

- LARGE FLAT PANEL LINES Welding preparation on edge beveling stations One-side welding stations Stiffener assembly and welding stations Panel handling, transportation parts.
- DOUBLE BOTTOM LINES Web-mounting and welding stations Vertical welding machines Service portals with fitting equipment UHL - transportation trains.

Roller beds of pemamek machine

- MICRO WEB-PANEL LINES Butt-welding Assembly and welding of stiffeners, girders Flexible transportation Curved panel assembly lines, flip-over stations, aluminum handling systems.
- The new PEMA-VWS- Vertical Welding Machine - is assembled on a movable portal and used for the welding of vertical welds of double bottom/bulkhead construction. The machine can weld four vertical welds simultaneously.

4.3 BOILER PRODUCTION AUTOMATION

Pemamek provides turnkey deliveries for membrane wall panel production, tube and fin bar pre-fabrication. Pemamek designs and manufactures production automation for the boiler industry, including efficient moving-tube stationary welding machines and gantry type welding machines, for material handling and prefabrication for membrane wall panel production.

A very good example of this is a basic model of the welding station for membrane wall panels, equipped with six submerged arc welding machines and automatic material handling lines. This model is capable of welding up to 3km of quality seam in one eight-hour shift.

Today the success of power plant (boiler) and wind turbine tower manufacturers is based on their core technologies, backed up with the high utilization rate of advanced automation solutions. With its long experience of supplying technically-advanced equipment to well-known boiler manufacturers, Pemamek has the right solutions, and has recently developed some more new techniques for wind turbine tower suppliers to support this growing environmentally friendly and alternative energy sector.

4.4 PARTS OF PEMAMEK MACHINE

- Pema flip over arms
- Cross transport conveyor
- Tube buffer storage
- Tube and fin bar infeeding line
- Conveyors
- Panel buffer storage
- Welding jig
- Torches
- Carbon di oxide gas nozzle
- Feed rollers
- Wire feeders

4.5 FLIP OVER ARMS

- 7 pcs of hydraulically operated flip over arms.
- Own hydraulic aggregate, max. Pressure 200 bar.
- Each unit has a frame which is bolted to the basement. With the frame there are 2 hydraulic cylinders that will move the arms.
- There are 6 pcs at same time operating units.
- Automatic flipping is operated by operator.

4.6 PEMA CROSS TRANSPORT CONVEYOR

- There are 6 pcs chain conveyor for transporting the membrane wall panel sideways. They are manually controlled by operator.
- Each conveyor has a traveling beam, transport carriage and a roller chain.
- Load capacity is 1700KG/lifting unit.
- Transport speed is 0.6 to 6m/min, motorized by inverter controlled A.C. motor.
- Conveyor has been mechanically connected together.
- Transport carriage has a hydraulic movement (up & down).
- Machine has been bolted to basement.
- Main supply 400V-3ph-50Hz.

4.7 PEMA TUBE AND FIN BAR INFEEDING LINE

- The length of the line is about 25m
- There are 18 pcs chain conveyor in one line.
- Each conveyor has roller chain traction.
- The line has 3 pcs A.C. gear motor (0.18KW) controlled by inverter.
- Tension of roller chain is performed by moving the gear motor.
- There are 12 pcs pneumatic tube loading devices, which are mechanically connected together.
- There are 3 pcs fin bar pulling device and each of them has one A.C. gear motor and gripper for fin bar.
- There are 12 pcs so called “solid frame” tube buffer storage for the tube keeping.

4.8 PEMA ROLLER CONVEYORS

- Mechanical construction is so called “solid frame”.
- Each conveyor has 3 rollers supplied with chain wheels.
- Each roller has A.C. gear motor (0.55KW) controlled by inverter.
- Each conveyor has a roller chain with tension wheel.
- Tension between gear motor and roller is performed by moving the gear motor.
- Main supply 400V-3ph-50Hz.

Fig 4.1Rework through manual welding

4.9 PANEL BUFFER STORAGE

- ✓ There are 6 pcs up and down movable buffer storage for keeping half-welded and finished sub panels.
- ✓ The machine is equipped with 4 pcs of holding arms, loading capacity for each is 700Kg.
- ✓ Buffer storages are installed beside the out-feeding conveyors after pema 2600/6 welding machine.
- ✓ Each storage has a ball screw and up and down moving carriage with arm.
- ✓ Frames are mounted to the base plate.
- ✓ Each storage has worm gear and A.C. motor(1.5KW).

4.9 PEMA WELDING JIG

- ✓ Pneumatically operated (manual ventil) tube aligning and pressing unit.
- ✓ Fastening to the staging table is made by rails.

4.10 DIMENSES OF TUBES AND FLAT

- ➢ Dia of tubes =25.4- 76.1mm.
- ➢ Feeding speed of tubes=0.6- 15m/min.
- ➢ Width of fin bars=10 - 110mm
- ➢ Thickness of fin bar=5 - 12mm
- ➢ Panel length =4000 - 25000mm
- ➢ Max. Width of panels =2500mm
- ➢ Max. Length of panels =4-25m
- ➢ Distance between conveyor=1450 mm

4.11. OPERATOR-FRIENDLY WORKING ENVIRONMENT

Normally, two operators can operate a PEMA panel welding line. The operator working area is open, and welding torch adjustment is easy. Compared with MIG/MAG welding, submerged arc welding ensures good working conditions without welding fumes, welding spatters or arc radiation.

Fig 4.2PEMA Panel Welding Line

4.12 FLUX CORED ARC WELDING

The flux cored arc welding process introduced in early 1950 is a modification of MIG/CO_2 welding process, in which solid wire is replaced by a flux cored electrode wire i.e., a tubular wire filled inside with flux and alloys.This process is growing in popularity. It is being used for more than 20% of arc welding. Some FCAW still uses CO_2 shielding, but the use of flux cored wire alone is increasing. In many cases, the flux-cored wire alone produces welds equal to or better than the original metal and its use eliminates the need for the gas shield equipment and cost.

4.13 Definition and concept

The FCAW is a process in which coalescence is produced by heating with an electric arc between a continuous tubular consumable electrode and the work. The electrode is flux cored i.e. the flux is contained within the electrode which is hollow. In addition to flux, mineral and ferro alloys in the core can provide additional protection and composition control.

4.14 Principle of Operation

As explained above, FCAW utilizes the heat of an arc between a continuously fed consumable flux cored electrode and the work, The heat of the arc melts the surface of the base metal and the end of the electrode. The metal melted off the electrode is transferred through the arc to the work piece where it becomes the deposited weld metal.

4.15 Welding Equipment:

1. A variable speed motor and motor control to power feed rolls which drive the electrode at a preset and uniform rate.
2. (a) A gun which houses a trigger to initiate and stop the electrode feed and flow of gas, electrical current to the arc, and, if used, water for cooling the torch,

   (b) a nozzle which directs the shielding gas to the arc and weld pool (except for self shielded FCAW),

   (c) a contact tube at the axis of the nozzle to transfer welding current to the electrode and

(d) a system of cables, hoses, electrical connections, and casings to direct the gas, electrode, power and water if used.

3. A mount for the spooled or coiled electrode.
4. A control station containing the relays, solenoids and timers needed to integrate the system.
5. A source of shielding gas, if needed, and a device for metering the flow rates of the gas.
6. A power supply to provide an appropriate amount and type of current.
7. A water supply for cooling if necessary. The equipment described above can be adapted for use in semi automatic welding or mounted on fixtures for automatic or machine welding. As compared to GMAW, in FCAW higher current power sources and larger welding guns or torches are used.
8. When FCAW without additional shielding is employed, the entire gas supply system is eliminated. This removes the gas cylinders, the regulator and flow meter, the hoses, the solenoid valve (shown dotted) and the nozzle on the welding gun.
9. In view of the amount of smoke produced by FCAW, it is becoming necessary to include smoke suction nozzles surrounding the gun nozzle to reduce smoke and fumes in the shop atmosphere.

4.16Weldable Metals:

1. Low to medium carbon steels.
2. Low alloy high strength steels.
3. Quenched and tempered steels.
4. Cast iron.
5. (Certain) Stainless steels.

4.17 Joint design

With edge preparation, welds can be made with a single pass on materials from 6 mm through 19 mm. With multi pass technique and with joint preparation the maximum thickness is practically unlimited. Horizontal fillets can be made up to 9.5 mm in a single pass, and in the flat position fillet welds can be made to 19mm.

4.18 Welding Parameters

The FCAW process normally uses direct current with electrode positive i.e., DCEP or DCRP. Direct current with constant voltage power is normally employed. When AC type specially formulated flux cored electrodes are used, the drooping characteristic type power source and voltage sensing feeders are employed. The welding current for flux cored arc welding can vary from as low as 50 amperes to as high as 750 amperes. Most flux cored arc welding is done in the range of 350-500 amperes when the 2.4 mm electrode wire is used.

Table 4.1 Welding Parameters

Electrode size (mm)	Flat Position (1)		Horizontal position (1)		Vertical Position (1)	
	Ampere DC (2)	Voltage EP (3)	Ampere DC (2)	Voltage EP (3)	Ampere DC (2)	Voltage EP (3)
1.2	150 – 225	22-27	150 - 225	22-26	125-200	22-25
1.6	175 – 300	24-29	175 - 275	25-28	150-200	24-27
2.0	200 – 400	25-30	200 - 375	26-30	175-225	25-29
2.4	300 – 500	25-32	300 - 450	25-30	-	-
2.8	400 – 525	26-33	-	-	-	-
3.2	450 - 650	28-34	-	-	-	-

4.19Advantages of Flux Cored Electrode Wires

1. FCAW provides high quality weld metal at lower cost with less effort on the part of the welder than SMAW. It is more forgiving than gas metal arc welding and is more flexible and adaptable than submerged arc welding.
2. Excellent weld appearance smooth and uniform welds, less liable to porosity.
3. Excellent contour of horizontal fillet welds
4. FCAW welds a variety of steels over a wide thickness range.
5. High operating factor can is easily mechanized.
6. High deposition rate high current density.
7. Relatively high travel speeds and considerably reduced spatter.
8. Economical engineering joint designs.
9. Visible arc easy to weld.
10. Less pre cleaning required than gas metal arc welding.
11. Reduced distortion over shielded metal arc welding (SMAW)

4.20Limitations of FCAW:

1. Used only to weld ferrous metals, primarily steels
2. FCAW produces a slag covering which has to be removed.
3. Electrode wire is more expensive on a weight basis than solid electrode wires.
4. Equipment is more expensive and complex than required for shielded metal arc welding; however the increased productivity compensates for this.
5. Earlier, self shielding wires, because of their limited mechanical properties and their inability to operate in vertical and overhead positions could not become popular. These inadequacies have now been overcome and today FCAW is widely used for all position welding.

5. CO_2 WELDING

MIG CO_2 (carbon-dioxide), MAG (Metal Active Gas) or CO_2 welding is a variation of the standard MIG process. In MIG process, generally, argon, helium or their mixtures are used for shielding the molten weld pool whereas in CO_2 welding process, carbon-di-oxide is used as the shielding gas.

5.1Welding Equipment

(1) A constant potential DC power source and controls. It may be either welding generator or transformer rectifier of constant voltage type such as used in submerged arc welding, which gives direct current. DCRP (electrode positive) is always used to obtain stable arc and smooth metal transfer with least spatter.DCSP and AC are unsuited as the arc becomes erratic and unsteady. A constant voltage power source along with a constant speed wire feeder provides a self correctingarc length system

(2) A wire feeder that pulls the wire electrode from a spool and pushes it through the welding gun at required speed. A wire feed contains a (i) DC motor (ii) speed reducing gear box, (iii) 2/4 roll drive, (iv) gas solenoid valve and (v) potentiometer for adjustment of wire feed speed.

(3) The welding gun is shaped like a pistol and is of goose neck design with a gun head angle of 45°. The gun head is connected to a cable hose assembly, whose other end has a coupler for connection to the wire feeder.

5.2WELDING

Welding is defined by American welding society (AWS) as a "a localized coalesance (the fusion or growing together of grain structure of the materials being welded) of metals or non-metals produced by heating the materials to required welding temperature with or without application of pressure alone and with or without the use of filler metals".

The application of welding are so varied and extensive that it would be no exaggeration to say that there is no metal industry and no branch of engineering that does not make use of welding in one form or another. The use of welding in today's technology is extensive. It had a phenomenal rise since about 1930; this growth has been faster than the general industrial growth. Many common everyday-use items, e.g., automobile cars, aircraft, ships, electronic equipment, machinery, household appliances, etc., depend upon welding for their economical construction. At present time, welding practice is divided into about 70% arc welding with balance divided between resistance welding and oxyacetylene welding. In fact, the future of any new metal may depend on how far it would lend itself to fabrication by welding.

5.3FLUX CORED ARC WELDING

Flux cored arc welding (FCAW) is similar to GMAW as far as operation and equipment are concerned. The major difference is that FCAW utilizes an electrode that is very different from the solid electrode used in GMAW. The flux cored electrode is a fabricated electrode and as the name implies, flux material is deposited into its core. The flux cored electrode begins as a flat metal strip that is formed first into a "U" shape. Flux and alloying elements are deposited into the "U" and then the shape is closed into a tubular configuration by a series of forming rolls.

1. The deposition rate is around four times higher than that of stick electrode welding
2. It produces crack free welds in medium carbon steels, using normal welding procedures.
3. Mechanized welding is made easy
4. It eliminates stub losses & the time required for electrode changes
5. The process is adaptable to a variety of products.

5.4COMPARISON BETWEEN FCAW AND MIG

Flux cored welding is a commonly used high deposition rate welding process that adds the benefits of flux to the welding simplicity of MIG welding. As in MIG welding wire is continuously fed from a spool. Flux cored welding is therefore referred to as a semiautomatic welding process.Flux cored welding produces a flux that must be removed. Flux cored welding has good weld appearance (smooth, uniform welds having good contour).

5.5Flux Cored Welding Benefits

- All position capability
- Good quality weld metal deposit

- Higher deposition rates than SMAW
- Low operator skill required
- Metallurgical benefits that can be gained from a flux

5.6Advantages

- The Self-Shielded electrodes are optimal for outdoor procedures since the flux is built into the wire for positive shielding even in windy conditions. An external shielding gas and additional equipment are not needed, so setting up is simpler, faster and easier.
- The flux-cored process is most suited for applications with thicker materials as it is less prone to cold lapping.

5.7 Disadvantages

- It is not recommended for very thin materials (less than 20 gauge).
- When flux-cored welding, machine settings need to be precise. A slight change in a knob position can make a big difference in the arc. In addition, the gun position is more critical in that it must be held consistently, and at the proper angle, to create a good weld.
- This process creates spatter and slag that may need to be cleaned for painting or finishing.

5.8 SELF SHIELDED PROCESS

The main advantage of the self shielding method is that its operation is somewhat simplified because of the absence of external shielding equipment. Although shielding electrodes have been developed for welding low alloy and stainless steels, they are most widely used on mild steels.

The self shielding method generally uses a long electrical stick-out (distance between the contact tube and the end of the unmelted electrode) commonly from 1 to 4 inches. Electrical resistance is increased with the long extension, preheating the electrode before it is fed into the arc. This enables the electrode to burn off at a faster rate and increases deposition. The preheating also decreases the heat available for melting the base metal, resulting in a more shallow penetration than the gas shielded process.

5.9 SHIELDING GASES

Carbon-di-oxide is the most widely used gas for auxiliary shielding of the flux cored electrode. The other commonly used gas is a mixture of 75% argon and 25% carbon-di-oxide.A carbon-di-oxide shield reduces deep penetration and the transfer is globular. As previously discussed co_2 will dissociate in the heat of the arc. To counteract this characteristic, deoxidizing elements are added to the core ingredients of the electrode. The deoxidizers react to form solid oxide compounds that float to the surface as part of the slag covering.

5.10 FLUX CORED ARC WELDING ELECTRODES

Gas shielded flux cored electrode for welding carbon steels were developed this 1950s and were made commercially available in 1957. This process was developed to combine the best features of submerged arc welding and CO_2 welding. The combination of the fluxing ingredients in the core and the external CO_2 gas shield produce high quality welds and a stable arc with a low spatter level. Initially these electrodes were available only in the larger diameters (5/64”-5/32”) and were for use in the flat or horizontal positions on heavy weldments. In 1972, small diameter gas shielded flux cored electrodes for welding in all positions were developed, and this greatly expanded the flux cored arc welding field.

5.11 MANUFACTURING FLUX CORED ELECTRODES

Manufacturing flux cored electrodes requires close controls. Since the weld metal is a combination of the metal sheath and the flux ingredients, both must be closely checked for size and chemical composition before fabrication begins.Since the space within the wire is limited, particle size of the ingredients becomes very important, so that the particles will “nest” together. Flux ingredients must be totally mixed or blended and measures taken to prevent segregation of the elements before fabrication.

5.12 FEATURES OF FLUX CORED ELECTRODES

Flux cored electrodes combine advantages of several of the welding processes we have discussed earlier. As with coated electrodes, the flux improves the weld metal chemical composition and mechanical properties. As in gas metal arc welding and submerged arc welding, productivity is increased because the electrode is continuous

5.13 FUNCTIONS OF THE FLUX INGREDIENTS

As with coated ingredients, each manufacturer has his own formulas for the flux ingredients. The composition of the flux core can be varied to provide electrodes for specific applications.

The basic functions of the flux ingredients are

Deoxidizers and Denitrifies: since nitrogen and oxygen can cause porosity or brittleness, deoxidizers such as manganese and silicon are added. In the case of self shielded electrode, denitrifies such as aluminum are added. Both help to purify the weld metal.

5.14 REWORK

Correcting of defective, Failed or non-conforming item during or after inspection. Rework includes all follow on efforts such as disassembly, repair, replacement, reassembly, etc. Actual or standard cost of correcting defective work.All panel reworks are done by the maintenance engineers in the panel fabrication industries.

5.15 BOW CORRECTION

Before the marking process in panel, check the panel should be straight. If the panel for tubes is not in straight, the bow correction process is applied.The panel is formed during concerned machine. Some of panel is occurring for slight bents. This bents is rectified by using the Bow Correction method.After the bow corrected panel for the following figure.

5.16 MARKING

Marking is the process of transferring a design or pattern to a work piece. It is performed in many industries. In the repetition industries the marking initial setup is designed to remove the need to mark out the every individual piece.The marking is the process of marked the panel for required specification for before or after panel formation by using the other process for cutting, champering ,welding and joining, etc.

5.17 JOINT PREPARATION

The joint preparation is the process for completing the panel and aftering the marking for the cutting purposes. So, the metal is cutting for required specification and are prepared to the joint preparation.

5.18 TIG JOINTS

Tig welding can be work as well or better than mig welding in the right hands but takes more skills to control or reduce wraping.

5.19 RADIOGRAPHY

The radiography is the process for any defect is occurred for welding in panel for completing the process for joints and welding.

5.20 BAR CHART:PANEL FABRICATION TIME DURATION CHART

A bar chart is diagram in which the numerical values of variables are represented by the height or length of lines or rectangular barsof equal width.A bar chart is a chart that presents grouped data with rectangular bars with length proportional to the values that they represents. The bars can be plotted vertically or horizontally. A vertical bar chart is sometimes called as column bar chart.

This chart shows that the time taken for fabricating the roof panels. By using this existing method of panel fabrication the processes such as panel formation process takes 3 shifts (1 shift = 8 hours) , rework process takes 4 shifts , bow correction process takes 1 shift , marking process taking 1 shift , gas cutting process takes 2 shifts but the joint process takes 35 shifts.

This joint process makes the panel formation process more time consumable, money, and more worker usage makes the industry to spend more time and money for this panel formation process.

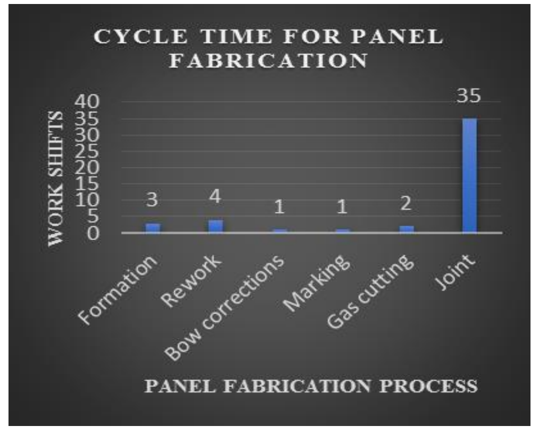

Fig 5.3 Cycle Time For Panel Fabrication

5.21 DIFFICULTIES WHILE PREFERRING NEW METHOD:

We tried to fabricate the roof panel with bends in the pemamek welding machine, but while tried with bend the tool mark occurs in the line bend panel forming due to fin support block by insufficient down stroke. This tool mark damages the line bend in the roof panel. The fin support block down stroke is only 13 mm.

Thus this is eliminating the some manufacturing process are following:

1. Radiography test
2. Tig joint welding
3. Joint preparation
4. Chamfering
5. Gas cutting

Fig 5.1 Panel welded with pre bended tubes made by PEMAMEK panel welding machine

5.22 COMPARISON

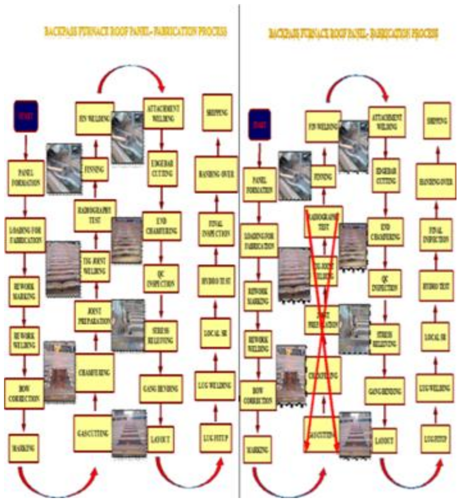

Fig 5.2 Comparison of new method over existing method in panel formation

Thus this new trail method eliminates the some manufacturing process are following:

1. Radiography test
2. Tig joint welding
3. Joint preparation
4. Chamfering
5. Gas cutting

And reduces the cycle time for panel fabrication and also improves the productivity of second pass roof panels in such a manner.

6. ESTIMATION-SCRAP REDUCTION

Table 6.1 Scrap Reduction

	Quantity	Cost/Unit	Savings(Rs)
JOINT	1440	500	720000
FIN in m	360	900	324000
TUBE in m	360	650	234000
Gross Savings			**1278000**

MAN HOURS SAVINGS

In TIG Welding,

Table 6.2 Man Hours Savings

	No	Days	Daily wage	Total(Rs)
Fitters	1	28	600	16800
Welders	1	28	800	22400
				39200

7. CONCLUSION

By this new method of formation (line bend) drastically reduced the cycle time of second pass roof panels of OTSC boilers by 48%. And alsomtrs of material and flat fin saved by this project. Also it improves quality by elimination of manual TIG joints, increases customer satisfaction. In this new method we eliminated 6 operation processes.

1. Cycle time reduced
2. Man,Material,Energy saved
3. Customer satisfaction increases
4. Quality improved
5. Employee fatigue reduced

The our new method checked and verified successfully and the panel fabrication timing is reduced and thus the industry has the more profit.

REFERENCES

[1] DrSukhwinder Singh Jolly, (2013) "A Review on Lean Manufacturing: A feasible solution to Industrial objectives", International Journal of Engineering and Management Research, Vol. 3, No. 2, pp. 13-16.

[2] Denish B. Modi&HemantThakkar, (2014) " Lean Thinking: Reduction of Waste, Lead time, cost through Lean manufacturing tools and techniques",International Journal of Emerging Technology and Advanced Engineering, Vol. 4, No. 3, pp. 339-344.

[3] William G. Sullivan, Thomas N. McDonald & Eileen M. Van Aken, (2002)"Equipment Replacement Decisions and Lean Manufacturing", Journal of Robotics and Computer Integrated Manufacturing, Vol. 18, pp. 255-265.

[4] Rajenthirakumar, Moharam. PV &Harikarthik. S.G, (2011) "Process cycle efficiency improvement through lean: A case study", International Journal of Lean Thinking, Vol.2, No. 1, pp. 46-58.

[5] Praveen Tandon, Dr. Ajay Tiwari&ShashikantTamrakar, (2014)"Implementation of Lean in Foundries", International Journal of Modern Engineering Research, Vol. 4, No. 2, pp. 46-50.

[6] Avinash PV & Ramesh L, (2013) "Enhancing Productivity through Lean",International Journal of Engineering Trends and Technology, Vol. 4, No. 5, pp. 1576-1580.

[7] Mandar M. Sumant&Pritesh R Patel, (2014) "Importance of Lean and Techniques in Industrial sector: A Literature review", International Journal of Applied Engineering Research, Vol. 9, pp. 765–771.

[8] Palak P. Sheth&Vivek A. Deshpande, (2014) "A Review and Methodology of Value Stream Mapping"International Journal of Engineering Development and Research, Vol.2, pp. 1130-1133.

[9] Ram Mohan Rao.O, DrVenkataSubbaiah, DrNarayanaRao&SrinivasaRao.T (2011) "Enhancing Productivity of Hot Metal in Blast Furnace- A case study in an Integrated Steel Plant ", International Journal of Engineering Science and Technology, Vol. 3, No.4, pp. 3518-3525.

[10] Praveen Saraswat, Manoj Kumar Sain& Deepak Kumar, (2014) " A Review of Waste Reduction through Value Stream Mapping analysis", International Journal of Research, Vol. 1, No. 6, pp. 200-207.