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Productivity Improvement in Pipe Butt Joint Fit-up In a Boiler Manufacturing Industry

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***Abstract* - This paper presents a work undertaken in a pipe line manufacturing company which welds (butt joints) different diameter of pipes which are used for manufacturing of boiler. In order to weld two separate pipes, initially both of them has to be aligned and dimensionally checked to reproduce the data in the Engineering drawing. It takes up a lots of time and man power. And also, to make sure that the pipes do not lose its orientation, after the aligning bridge pieces are tag welded with the pipes to arrest all the degrees of freedom of the pipes and thereby immobilizing it. Our project gives the alternative for welding of bridge pieces in pipes for butt joints. By implementing the suggestion of carrying out the process by using fixture, we can reduce the total welding and fit-up time to 75% of the actual time. It also neglect other major problems such as, welding of brittle materials like P91, unnecessary reworks, human efforts, reduction of defects on parent material.**

Keywords: bridge piece, butt joint, alignment, fixture, cycle time.

I. INTRODUCTION

A Pipeline is an essential component which transports hot medium namely water, steam and mixture of steam and water in power plants. These pipelines are designed and tailor-made to suit site matching of different components of steam and water circuit of power plants, connecting various heat transfer, storage medium and distributor systems. The word piping refers to an assembly of pipes and fittings which provides a hollow tubular passage for transportation of a fluid from one place to another. In a thermal power plant, petroleum refinery, petro chemical or any other industrial plant many fluids are used such as water, steam, air, gas, oil, chemical etc. are required to be moved from one equipment or place to another equipment or place at various pressures ranging from sub atmosphere to very high pressure and various temperature ranging from sub-zero to very high temperature. For welding the pipes, bridge piece is used, which results in material consumption, increase in cycle time, man power, it damages the parent material and change the crystal structure in brittle material like P91.

This paper presents the implementation of a fixture to avoid the usage of bridge pieces in a pipe line manufacturing company which is located in the city of Trichy, state of TamilNadu. This paper represents the work done in the company to find out the bottle neck operation and to improve the productivity of those stations by eliminating the bridge piece. Initially time study was conducted at every station and later the layout was reconfigured to suite the production and quality tools were implemented to create a better organized work place. The main objective was to decrease the operating cycle time thereby increase the productivity.

II. LITERATURE SURVEY

E.W. McAllister [1] E.W. McAllister, It explains that for clearing and grading right-of way, labour crew and equipment spread must be considered. H.F.Tremlett [2] it explains about welding process. K.G. Swift, J.D.Peter [3] this chapter discusses joining processes'. Marshall [4] it tells about connections for welded tubular structures. M.A. Wahab [5] it explains Manual Metal Arc Welding and Gas Metal Arc Welding. John Hicks [6] it explains about weld defects. S J Maddox [7] it explains typical service failures, Fatigue Strength of Welded Structures. Clarence E. Jackson [8] it explains welding materials. GJ tahash [9] provides a shop floor report on exploiting automated gas metal arc roll welding technology inpipe spool prefabrication. B. Messer, C. Patrick, S. Seitza [10] it gives information of Achieving cost savings with innovative welding and examination techniques Gunther Eggeler, Ashok Ramteke [11] it explains the Analysis of creep in a welded 'P91' pressure vessel. G.M. Gray, A.B.L. Croker [12] it discuss about reduced ductility of in-service 9Cr1Mo piping revealed during welding procedure qualification.

III. CASE STUDY

The selected boiler pipeline manufacturing company is the leading manufacturer of boiler pipeline in India and one of largest manufacturer of boiler pipeline in Asia. The company

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was established in 1964 at Trichy. It is an ISO 9001: 2000 certified company and also holds a BS OHSAS 18001:2007 certification. This company manufactures different varieties of piping component. The boiler pipes are classified based on diameter, flow, size and mode of operation. The basic piping component are Pipes (for straight line flow), Bend or elbow (for changes in direction of flow), Tees, Stub (for branching of flow), Reducers, Reducing coupling (for joining pipe with another unequal diameter pipe or fitting) Unions, flanges (for providing joints for maintenance requirements), Valves (An elements by which flow can be stopped or regulated).

A. Sequence of pipe butt joint

The sequence of the pipe butt joint in existing method consists of eleven different operations. In the pipe butt welding process the various operation carried out are gas-cutting (The pipes from the shop are cut to required dimensions), Edge Preparation (According to the requirement J or V groove are made on the edges of the pipes), Alignment (Pipes to be welded are positioned to achieve straightness), collect the bridge piece, tag weld for bridge piece, full welding for bridge piece.

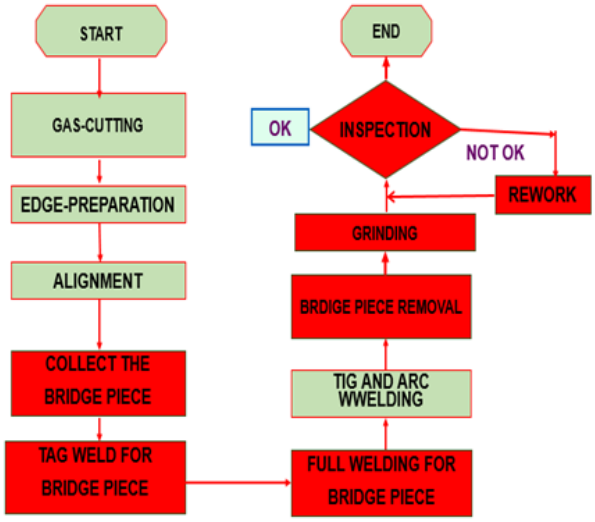

Figure 1: Flow chart of pipe butt joint welding (existing method)

(Both pipes are welded using bridge pieces to arrest relative motion between pipes), TIG and Arc welding (The root gap is welded with one layer of TIG welding and then two layers of arc welding), Bridge piece removal (After welding process the bridge pieces are removed by cutting and hammering action), Grinding (Due to removal of bridge piece the parent material is damaged and pits are formed, more parent material is added in the damaged area, and grinding is done), inspection and the final stage is rework. And then shipping is done to specified customer.

B. Identification of Bottle neck operation

Initially time study was performed at every station to find out the cycle time. Time study was performed for the pipe ranges from diameter.

Table 1: Process data of existing method

S.No	Work Order	Gas Cutting	Edge Preparation	Alignment	Bridge piece set up	TIG and ARC	Bridge piece removal and grinding	Inspection and rework
1.	2342	1	2	1	0.5	3.5	0.5	1.5
2.	2332	1.25	1.5	1	0.75	4	0.75	1.75
3.	2344	1	2	1	0.5	3.5	0.5	1.25
4.	2434	0.75	2.5	1	0.25	3	0.25	1.25
AVERAGE		1	2	1	0.5	3.5	0.5	1.5
TOTAL		4	8	4	2	4	2	6
PERCENTAGE		10%	20%	10%	5%	35%	5%	15%
							Time in hours	

Based on the data obtained from the time study process, it was found that the process bridge piece setup, bridge piece removal, alignment, inspection and rework to be the bottleneck process.

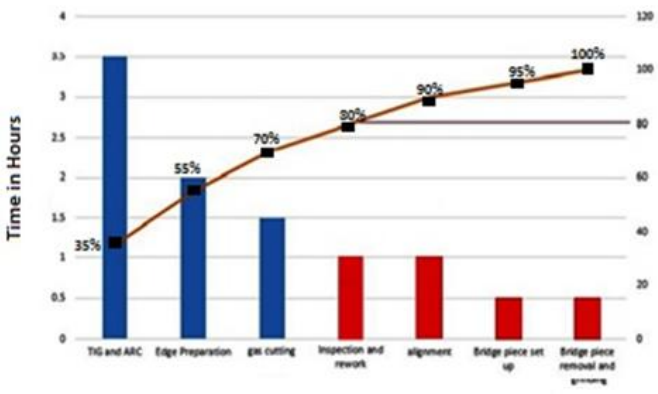

Figure 2: Pareto chart of operating cycle time vs workstations

The net available time per shift is 480 minutes, and the company plans for two to three shift for completing target .But the ultimate aim of firm is to complete the process within the

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first shift and also the P91 material is brittle, so this welding with bridge pieces is affect the material properties and cracks may form. Now after identifying the bottle neck operation, various studies and analysis were done to minimize the bottle neck.

C. Tools used to find solution

(i) Cause and effect diagram

The causes for more cycle time of pipe butt joint were identified and represented using the cause and effect diagram.

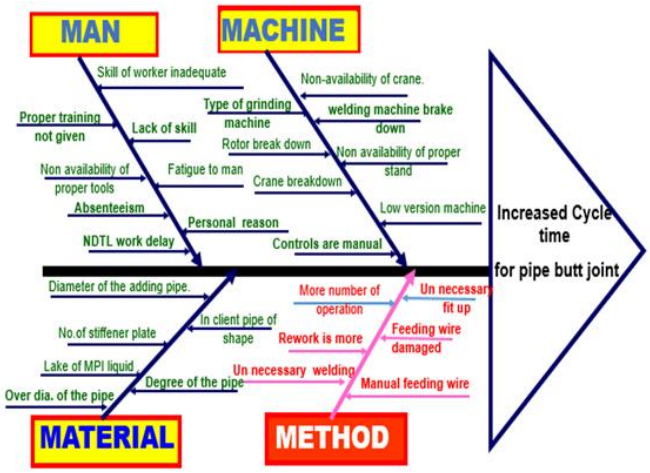

Figure 3: Cause and effect diagram

In this cause and effect diagram the invalid causes are man, machine, material and which will not affect the cycle time more. But the valid cause is the method (unnecessary welding and unnecessary fit-up only) remaining are invalid causes. So these two are the valid causes for sub causes. After analysis of sub causes the root causes are identified. They are fit-up (adding of bridge piece, heat treatment, grinding) and welding (tag weld, gouging).

(ii) Why-Why analysis

The why-why analysis is used to find the solution of the possible causes for the increase in cycle time.

Table 2: Why-Why analysis

Why?	cycle time is high
Why?	Bridge pieces are added
Why?	Heat treatment is done
Why?	Grinding operation is required
Why?	Tag weld is done
Why?	More inspection
Why?	Development of new fixture for butt welding

D. Process improvement

Based on the cause and effect diagram and why-why analysis, the new fixture for pipe butt joint was created by altering the bridge piece welding method.

Bridge pieces are welded manually in existing method which consumes more time and fatigue to the operators. In order to overcome these problems, a new fixture has been designed, fabricated and implemented. The various components of the fixtures are given below.

Table 3: Various components used in fixture

S. No	Component name	No. of components
1	V-block	4
2	Screw rod	1
3	Hinge	2
4	Bolt &nuts	2

(i) V Block

The V block is fabricated from a plate of 20mmthick by CNC operated Gas cutting machine.

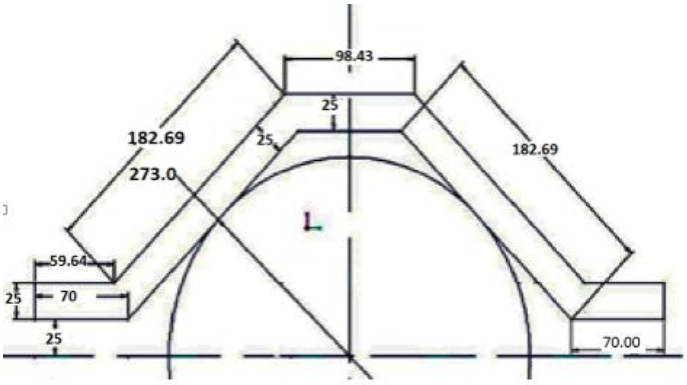

Figure 4: 2D diagram of V-block

(ii) Screw rod

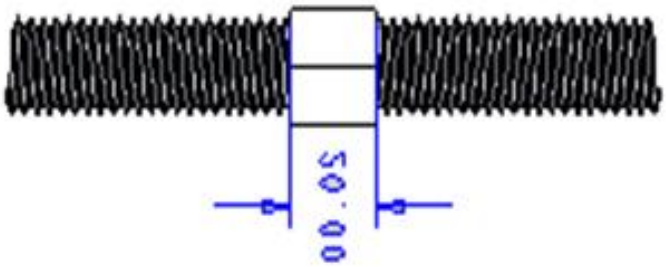

Figure 5: 2D diagram of screw rod

Lathe is used to fabricate a Screw rod from the raw material which is a rod of 30mm diameter, turning and threading operation is done on both the rod.

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(iii) Hinge

Two pipes are welded together perpendicularly, one having internal tapping which will be supporting the screw rod and other one having hollow projection which would be supporting the V Block.

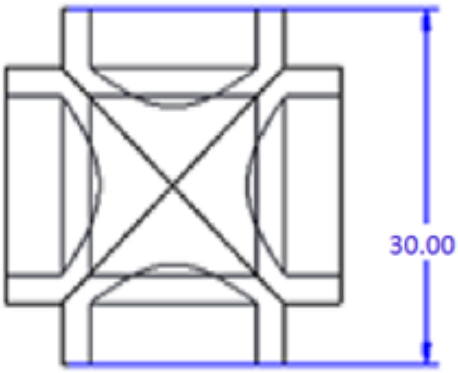

Figure 6: 2D diagram of hinge

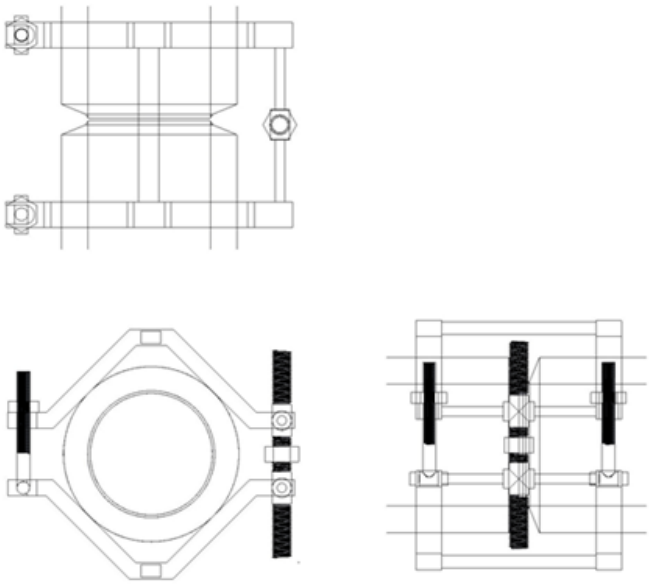

Figure 7: Ortho graphic view of fixture

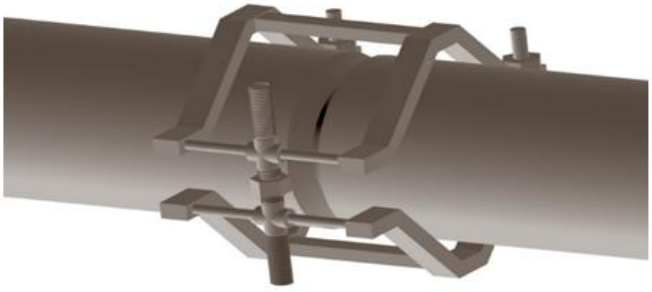

Figure 8: 3D model of fixture

E. Sequence of pipe butt joint in proposed method

The sequence of the pipe butt joint in proposed method consists of five different operations. In the pipe butt welding process the various operation carried out are gas-cutting (The pipes from the shop are cut to required dimensions), Edge Preparation (According to the requirement J or V groove are made on the edges of the pipes), Alignment (Pipes to be welded are positioned to achieve straightness), clamping fixture (Both pipes are clamped using fixture to arrest relative motion between pipes), TIG and Arc welding (The root gap is welded with one layer of TIG welding and then two layers of arc welding).

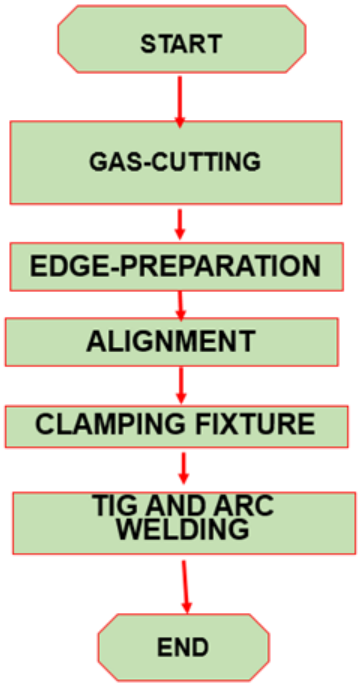

Figure 9: Flow chart of pipe butt joint welding (proposed method)

Table 4: Process data of proposed method

S. No	Work Order	Gas Cutting	Edge Preparation	Alignment	Fixture set up	Bridge piece set up	TIG and ARC	Bridge piece removal and grinding	Inspection and rework
1.	2342	1	2	0.75	0.5	0	3	0	0
2.	2332	1.25	1.5	1	0.5	0	3.5	0	0
3.	2344	1	2	0.75	0.5	0	3	0	0
4.	2434	0.75	2.5	0.5	0.5	0	2.5	0	0
AVERAGE		1	2	0.75	0.5	0	3	0	0
TOTAL		4	8	3	2	0	12	0	0
PERCENTAGE		10%	20%	7.5%	5%	0%	30%	0%	0%
							Time in hours		

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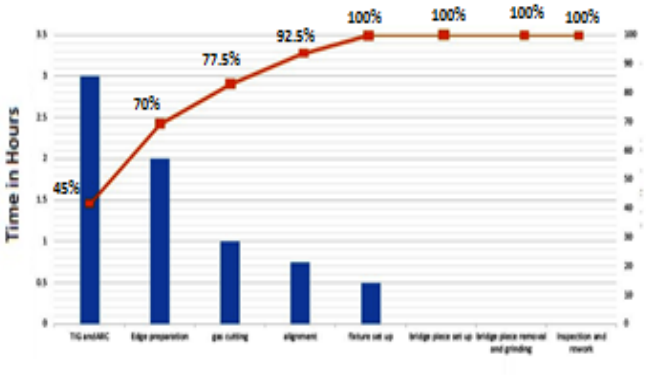

Figure 10: Pareto chart of operating cycle time vs workstations (proposed)

F. Results after successful implementation

A new fixture has been designed, fabricated and implemented and the processing time is reduced from 600 min to 435 min i.e. 27.5% reduction in whole butt welding process.

IV. RESULTS AND DISCUSSION

After the successful implementation of the above concepts and application, the bottleneck stations i.e. butt joint welding cycle time was reduced and also its productivity was improved considerably. The total time has been reduced from 600 min to 435 min i.e. 27.5% reduction in cycle time. A well-organized workplace was achieved by applying this methodology and also the process of dead inventory escalation was performed successfully. It helped the firm to increase the percentage of its adherence level of plan and also it was able to manufacture and deliver the boiler pipes within the mentioned time and minimized the chances of lateness.

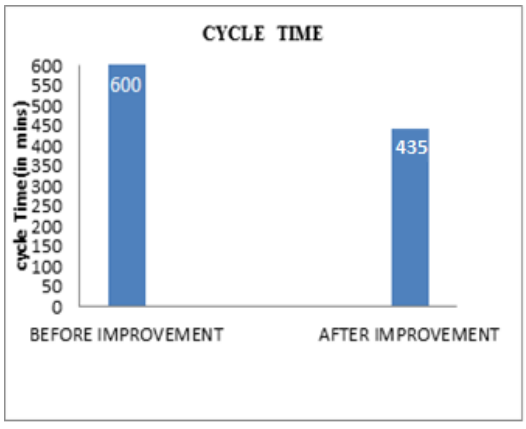

Figure 13: Existing cycle time vs proposed cycle time

V. CONCLUSION

In this project steps were taken to improve the productivity of the pipe butt joint welding unit by creating a better organized system by implementing fixture which reduced the motions and waits and also provided a better working environment. Work standards were defined to improve the efficiency of the manufacturing process by creating a standard operating procedure .All these implementations led to the increase in productivity of welding station and also decreased its cycle time.

REFERENCES

[1] E.W. Mc Allister, "Pipeline Rules of Thumb Handbook (Seventh Edition) Quick and accurate solutions to your everyday pipeline problems", 2009, Pages 39–88.

[2] H.F. TREMLETT, "Mechanical Engineer's Reference Book (Eleventh Edition)" 1973, Pages 6-2–6-76.

[3] K.G. Swift, J.D. Booker, "Process Selection (Second Edition) From Design to Manufacture", 2003, Pages 189–248.

[4] Peter W. Marshall, "Welding of Tubular Structures Proceedings of the Second International Conference" Held in Boston, Massachusetts, USA, 16 – 17 July 1984, Under the Auspices of the International Institute of Welding1984, Pages 1–54, 57–115.

[5] M.A. Wahab "Comprehensive Materials Processing" 2014, Pages 49–76 Volume 6: Welding and Bonding Technologies.

[6] John Hicks, "Welded Design Theory and Practice" 2001, Pages 111–130.

[7] S J MADDOX, "Typical service failures Fatigue Strength of Welded Structures" (Second Edition) Chapter6,A volume in Woodhead Publishing Series in Welding and Other Joining Technologies2002, Pages 156–169.

[8] Clarence E. Jackson, "Modern Materials", Volume 2, 1960, Pages 327–378.

[9] GJ Tahash, "Exploiting Advances in Arc Welding Technology A volume in Wood head Publishing Series in Welding and Other Joining Technologies", 1999, Pages 221–231.

[10] B. Messer, C. Patrick, S. Seitz, "International Journal of Pressure Vessels and Piping", Volume 60, Issue 3, 1994, Pages 237–257.

[11] Gunther Eggeler, Ashok Ramteke, "International Journal of Pressure Vessels and Piping", Volume 83, Issue 5, May 2006, Pages 365–372.

[12] G.M. Graya, A.B.L. Crokerb Reduced ductility of in-service 9Cr1Mo piping revealed during welding procedure qualification.

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