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A Case Study on Demings Principle & Cycle with Just in Time for Manufacturing Mild Steel Pipe and Product Quality Improvement at Project Sites

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Abstract: ***The PDCA Cycle is a systematic series of steps for gaining valuable learning and knowledge for the continual improvement of a product or process. PDCA is an iterative four-step quality improvement and productivity improvement process typically used for the better of the business strategy. PDCA is a successive cycle which starts off small to test potential effects on processes, but then gradually leads to larger and more targeted change. Though the method is applicable to process, business and organization utilized by the industry, but this is an attempt to try and adopt the same at an individual level to bring productivity improvement in individuals which will trigger an improvement in process and quality for the organization at a bigger level. How this method would help an individual to become more accountable which will ultimately enable a group, a product line, and an organization to be able to make a difference in improving the overall quality. The method tries to bring in changes to the traditional ways how an individual does an activity and with few improvements, the overall productivity of mild steel pipes increased that will ultimately benefit the organization.***

Keywords: Continual improvement of a product and process, Mild steel pipe, Hydrostatic pressure, Testing, Water volume, Time and Requirement

1. Introduction

Deming's most popular (and direct) association is with the PDCA cycle. It's a methodology for continuous improvement, problem-solving and one that helps build people, operational and organizational capability in the long term.

The Plan-Do-Check-Act cycle is a model for carrying out change. It is an essential part of the lean manufacturing philosophy and a key prerequisite for continuous improvement of people and processes.

First, proposed by Walter Shewhart and later developed by William Deming, the PDCA cycle became a widespread framework for constant improvements in manufacturing, management, and other areas.

PDCA is a simple four-stage method that enables teams to avoid recurring mistakes and improve processes.

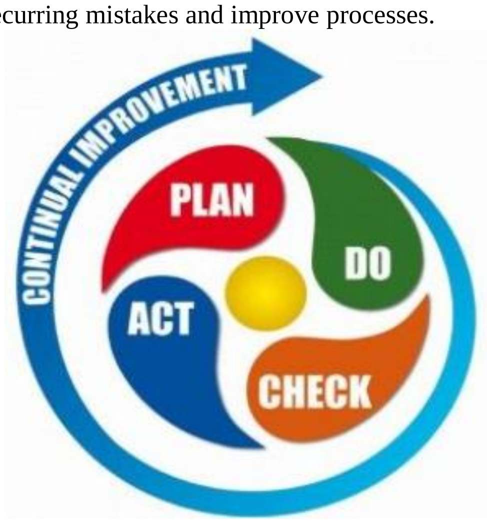

Figure 1: PDCA Cycle

PDCA (plan–do-check-act) is an iterative four-step quality management method used in business for the control and continual improvement of process and products.

2. Procedure

Manufacturing of Longitudinally & Circumferentially Welded Mild Steel Pipes from Plates by Automatic Submerged Arc Welding.

2.1 Scope

This procedure describes the various stages of manufacturing and inspection of pipes manufactured from plates by rolling and welding as per IS 3589.

2.2 Reference Standards

1) IS 3589-2001: Steel Pipe for Water &Sewage.
2) IS 4353-1995: Submerged Arc welding of Mild Steel and Low Alloy Steels.
3) IS 2595-1978: Code of Practice for Radiographic Practice.
4) BS EN 10217-1: 2002: Welded Steel Tubes for Pressure Purposes.

2.3Marking, Cutting & Edge Preparation

Plates received from the Cut to Length Line shall be stacked at one place and checked for identification marks (Unique Coil No).

After identification plates shall be spread for marking & cutting to the exact required length. Diagonals shall be checked for correctiveness in the marking.

Pipe ID shall be marked on the plates near the painted coil mark for easy identification. Correct length and edge preparation shall be made using Oxy-Acetylene/LPG PUG cutting machines. After cutting of the plates all burs and slag shall be removed from the plates by manual chipping and machine grinding. Inspection shall be carried after cutting and grinding for the dimensional correctness and smooth

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edge finish. After the inspection plates shall be transferred to the Rolling Mill Area.

2.4 Rolling of Plates to Shells

Bending is a process of permanently deforming the plate into a particular shape. The plate is deformed due to the force exerted by the rolls. The bending operation shall be carried by the High Performance Three Roll Plate Bending Machine with pre pinching facility. Pre-pinching is the process of bending the edge of the plate to the required radius. The plate is first lightly rolled over its full length. One of the bottom roll is brought near the top roll and plate edge is brought close to the tangent point. By lifting the other bottom roll, plate edge is pre-bent (pre-pinched). Once the pre pinching operation is completed for both the edges, bending shall be carried on the machine by keeping all the three rolls in a pyramid position.

Profile Gauge shall be made available at the rolling machine matching to the inner dia of the pipe to be manufactured. During the rolling process bending profile shall be checked with the gauge for the correct curvature. Once the rolling completed and the plate two ends meet each other, the rolled drum shall be taken out from the machine. After removing from the machine the two edges shall be aligned to straight face and shall be tack welded (E-6013 Electrodes) to retain the shape. Care shall be taken to maintain the gap 0-1 mm as required for Submerged Arc Welding.

Unique Shell number to be given and marked on the shell with Pipe dia and thickness. Inner diameter and ovality shall be checked for each shell rolled and shall be entered in the register. After satisfactory tests rolled shell to be transferred to the fit-up area.

2.5 Pipe Fit up from Shells

Shells shall be placed on a platform having rotating wheels.1 to 2 shells (depending on the length of each shell) shall be assembled to make a 5 to 6 Mtr length pipe. Care to be taken to see the bevelled edge shells to be kept on both ends of the pipe. During fit up and Tack weld of joining the shells care shall be taken to align properly and to maintain the minimum gap (0-1 mm). After fit up pipe straightness and ovality shall be checked and to be marked with pipe number with inner dia and thickness. And the assemble pipe shall be send to the SAW unit.

2.6 Submerged Arc Welding

The assembled pipe shall be placed on the pipe rotators. Pipe rotators rotate the job with controlled speed as required by the welder. Both internal and external joint shall be carried by minimum one run submerged arc welding. Weld current and voltage shall be maintained as per the qualified Weld Procedure Specification. Care shall be taken to maintain the Flux at 3000 C as per the recommendations of the flux manufacturer.

After completion of the welding of longitudinal and circumferential joints pipe shall be released for visual inspection. QA/QC in charge shall check the pipe for any pin holes, under cut, porosity, burn through and other weld defects. Any defects found shall be marked and repaired by SMAW process. Welder number shall be marked on the pipe and entered in the register with the details of pipe number, pipe diameter, welder number and date of welding.

The visually cleared pipe shall be inspected with 100%Ultrasonic testing and 3% Radiography testing. If any defects found shall be repaired and re checked. After getting the NDT clearance pipes shall be released for Hydro Testing.

3. Hydro Testing

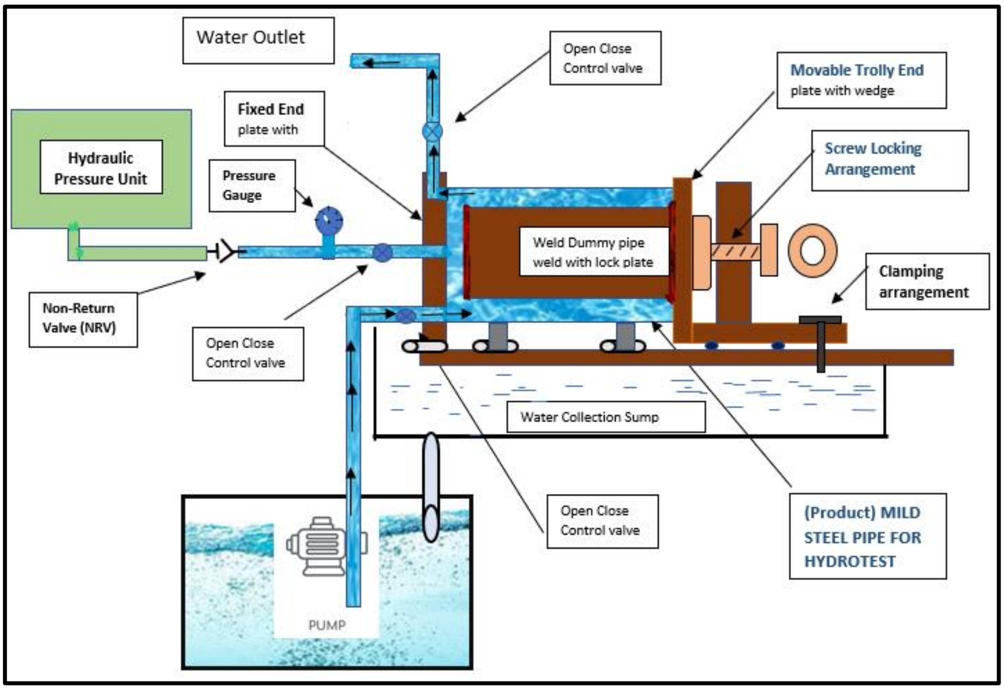

Figure 2: Hydrostatic Pressure Testing

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Each welded pipe shall be hydraulically tested to the required pressure.

Hydro testing unit consists of special pipe end closures to close both ends of the pipe to be tested. The inner portion shall have a dummy pipe to reduce the volume of the water to be filled and load on end plate. Specially designed Hydraulic Jacks hold the end covers while applying the Hydro test pressure on the pipe. Water filling and High-pressure piston pumps are used for filling and pressurizing the pipe. Calibrated pressure gauge mounted in front of the system displays the pressure inside the pipe. The pressure gauge used shall be having a range of 1.5 times the test pressure.

Special trolley arrangements which carry the pipes make the system safer during handling of the pipes.

During pressurizing the pipe all weld portions shall be checked for any sweating/leakage. Light hammering with rubber hammers shall be carried along the weld during the testing period. Any defects found shall be marked, repaired and re hydrotested.

After completion of the hydro testing pipe shall be marked "HT OK"and shall be released for surface cleaning process.

4. Pipe Volume Calculation

Vpipe = A x H
Where,
Vpipe= Volume of Pipe (Cylinder)
A= Area
H=Height (Total Length)

Mild Steel Pipe

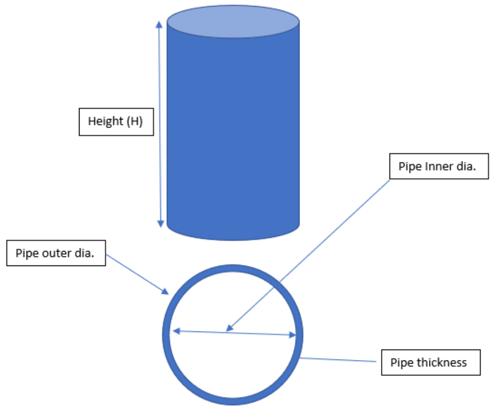


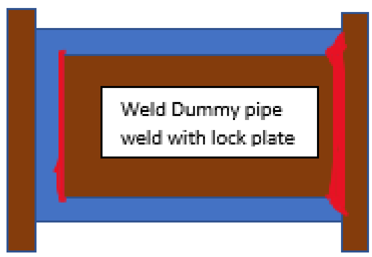
Figure 3: Pipe Volume Calculation

Area of Circle= (π/4) x D^2
Assume D=51 OD
D-thickness = 51-(2x1.2)
=48.6mm
=48.6/1000
=0.0486 mtrs
Assume (H) = 01 mtrs

Pipe volume = ((π/4) x D^2) x H
= ((3.14/4) x $0.0486^{2)}$ x 1
= (0.785 x 0.0972) x 1
= 0.0763 M^3 (cubic meter)

5. Hydrostatic Test Process Comparison

Table 1: In Process Comparison for ID 2000 X11 MM Thickness Pipe

S. No	Comparison Points	BEFORE	AFTER
01	Diagrammatic Difference		
02	Volume of Water	18.840 cubic meter	3.472 cubic meter
03	Time (Pipe Filling Time)	36 min	7 min
04	Rapid progress	More time-consuming process	Less time-consuming process
05	Space (Tank) and Equipment	Large water tank to store water volume	Small water tank to store water volume
06	Productivity	Slow productivity	High productivity
07	Time (to pressurize pipe)	More in compared to volume	Less in compared to volume

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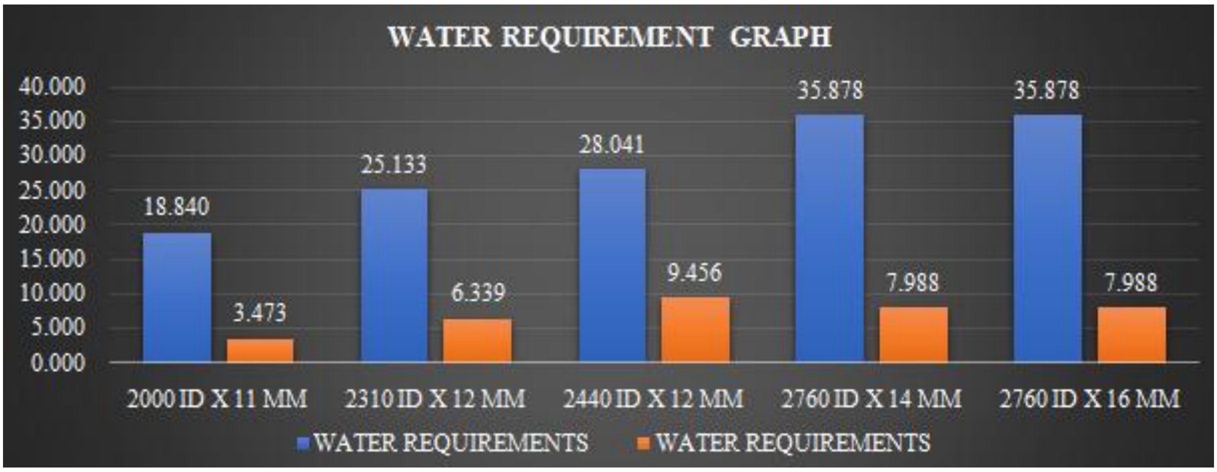
6. Productivity Graph



Graph 1: Water Requirement Before and After Implementation

7. Conclusion

7.1 Hydrostatic Pressure Test Process Improvement

Overall productivity of pipe manufacturing is improved, and water volume quantity and Hydrostatic pressure testing time minimize.

Minimize the testing delay due to 100% each pipe hydraulic delay with IS 3589: 2001 clause-10. As per the below table number-02water volume saving calculated and improve the process efficiency.

As per the below table number-03pipe water filling time saving details explained for 1HP pump and 2-inch discharge line.

7.2 Hydrostatic Test Process Analysis: (below table 02 and 03)

Table 2: Water Requirements for Hydro Testing

1	2	3	4	5	6	7	8
Sr. No	Pipe Identification	Mild Steel Pipe Dimension (Inner Dia. x thk)	Water Requirements		Wedge Dimension (OD x Length) in mtrs	Water Savings/ Wedge Area (cubic meter)	Water filling and Clearance Gap (mtrs)
			Before Implementation (cubic meter)	After Implementation (cubic meter)			
1	AP	2000 ID X 11 MM	18.840	3.473	1.820 x 5.910	15.367	0.090
2	BP	2310 ID X 12 MM	25.133	6.339	2.022 x 5.856	18.794	0.144
3	CP	2440 ID X 12 MM	28.041	9.456	2.022 x 5.791	18.585	0.209
4	DP	2760 ID X 14 MM	35.878	7.988	2.464 x 5.852	27.890	0.148
5	EP	2760 ID X 16 MM	35.878	7.988	2.464 x 5.852	27.890	0.148

Table 3: Water Volume and Time Before and After Implementation

01 HP Pump Outlet (2-inch discharge pipe) Discharge Capacity 500 LPM							
Sr. No	Pipe Identification	Mild Steel Pipe Dimension (INNER Dia)	Water Requirements		Time Requirements		Wedge Dimension (OD x Length) in mtrs
			Before Implementation (cubic meter)	After Implementation (cubic meter)	Before Implementation Pipe Filling Time in (Min)	After Implementation Pipe Filling Time in(Min)	
1	AP	2000 ID X 11 MM	18.840	3.473	36	7	1.820 x 5.910
2	BP	2310 ID X 12 MM	25.133	6.339	50	13	2.022 x 5.856
3	CP	2440 ID X 12 MM	28.041	9.456	56	19	2.022 x 5.791
4	DP	2760 ID X 14 MM	35.878	7.988	70	15	2.464 x 5.852
5	EP	2760 ID X 16 MM	35.878	7.988	70	15	2.464 x 5.852

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