



Fabrication of India's Largest, Welded Titanium Vessel

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Abstract

In this article, the brief about the process of fabrication of India's largest, welded Titanium Vessel is narrated. The challenge faced to make this large capacity vessel and different ways adopted to overcome them are briefed in this article.

Keywords: Welding; fabrication; titanium vessel; largest Ti vessel; made in India.

1.0 INTRODUCTION

This technical paper deals with Welding of heavy walled Titanium Plates. Thickness as high as 100mm thk which involve multiple pass TIG Welding. Yes, TIG / GTA Welding with No other feasible Butt joint Welding process options being Titanium. Challenges faced during forming of 9m Diameter Dished head, Toricone, Site Installation and Welding criticality for handling such a large sized reactive metal and Welding at Site conditions

Welding Multi-layers, True multi layers in terms of GTAW of

100 mm thickness. Effect of properties like Weldmetal hardness and bend ductility studied in this paper

GR Engineering has past experience of handling large vessels, Manufacturing Workshop and Cranes to handle Large diameter jobs in-house & at Site Conditions, Now handling Critical metal like Titanium Alloy has added a feather in manufacturing capabilities

Executing such a large magnitude Exotic Metal need enormous planning and Pre-manufacturing Preparation, foreseeing hurdles and taking appropriate actions to overcome them.

2.0 BASE MATERIAL & WELDING CONSUMABLE DETAILS

Grade	UTS (N/mm ²)	YS (N/mm ²)	% Elongation	ASME P-No.	Filler Wire
SB265 Gr-2	345 (min)	275 - 450	20 (min)	51	ER Ti-2

Grade	Ti	C	Al	V	Fe	O ₂	N ₂	H ₂	Si	Zr	Residual
SB265 Gr-2	Bal	0.08	--	-	0.30	0.25	0.03	0.015	—	—	0.1 / 0.4
ER Ti-2	99.6	0.03	--	-	0.12	0.08-0.16	0.015	0.008	—	—	----

WELD THICKNESS INVOLVED

Shell Butt Joint	42, 38, 34 & 28 mm	Toricone Butt Joint	55 & 46 mm
Base Ring Plate	100 mm	Dishend End	36 mm
Compression Ring	65 mm	Skirt Butt Joint	50 mm
Nozzle Butt Joint	16 mm		

Titanium Welding is the Art of Shielding than the Science of Welding. Recent years has seen many developments in following area which made Titanium welding, A easier task

- Improvement in Digital Welding Power sources
- Precision in Controls Instruments
- Availability of Good Quality Shielding gases, Gas Monitors
- Availability of Custom-made Trailing Shields

3.0 WELDING QUALIFICATION

While qualifying the procedure, Apart from meeting the Code and Specification requirements, we have following consideration / Focus area

1. Simulation of Qualification premises and Site conditions
2. Distortion Control measure / Sequencing
3. Use of Similar Trailing shields for Qualification and on job use

Procedure Qualification conducted for Manual GTAW Process as well as Machine-GTAW Process. Wire spools of Titanium wire (dia 1.2mm, 1.6mm) ordered and using special shielding and Trailing arrangement Welding process is automated. Special focus is given on effectiveness of Trailing shield while welding is carried out in Weave mode

Bend & Hardness Test photographs of PQR Test Coupon



Ben Test Photo



Hardness, HV10 (Weld Cross Section) Photo

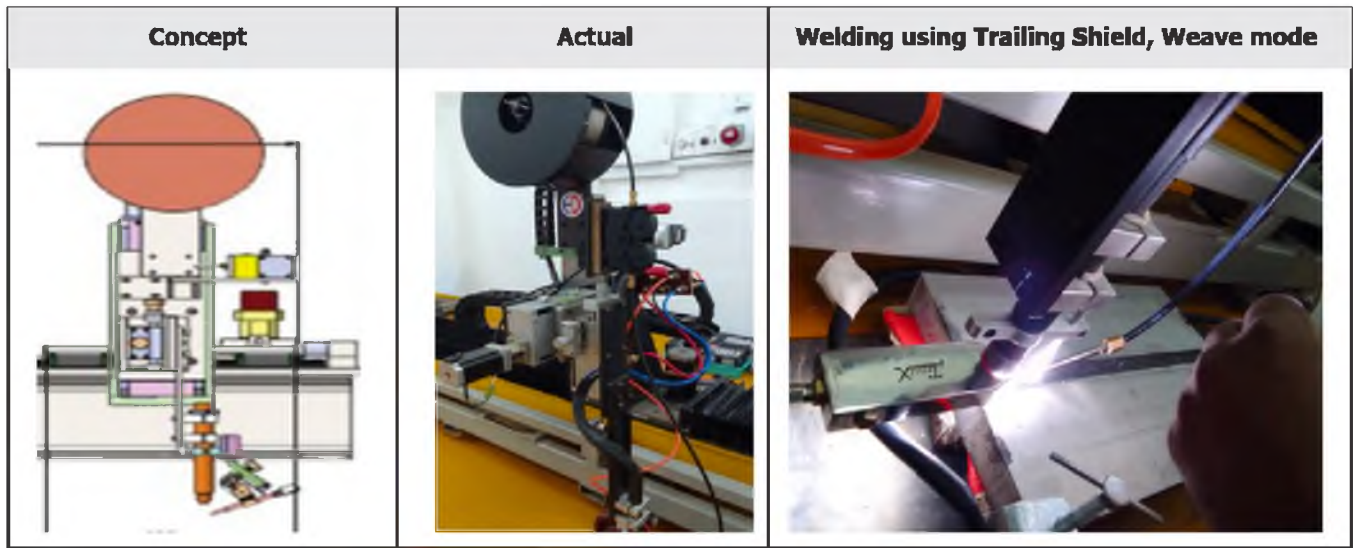
4.0 WELDAUTOMATION

Total welding consumables deposition for the entire Vessel is **4150 Kgs.** To achieve consistency and improve efficiency, Weld Automation is unavoidable. GTAW-Machine process is used. Custom made machine is used for carrying out welding of 100 mm thk Plate. Length of the Weld seam is 8500 mm. Welding machine has Up/Down Slope, Gas Pre-Post Flow,

Pulsing, Weave, Dwell time control, seam tracking,

Proper sequencing of weld bead, turning of the plate to produce balance welds made it possible to weld 100 mm thk plate within 6 mm flatness after welding. Radiography is passed is first attempt

Length of Radiographic Testing carried out in Total job is **561 Meters with Zero/Nil repair.**



5.0 TRAILING SHIELDS / PURGING PADS USED

Trailing shields plays very important role to Protect the weld metal from Atmospheric Oxygen attack when the Weld is hot.. Apart from standard Plate and Pipe type trailing shields, For Corner Weld and for Junction area, different type of customized trailing shields were prepared.

Looking at the High cost of Imported Trailing shields, Local

party developed for Customized trailing shields and Purging Pad preparation. Total 14 types trailing shields and Purging pads used in the project

Each trailing shield will undergo check for Weld Decolouration on similar joint configuration and then only it is issued to Shop for manufacturing. QC Inspector have made plan to check the physical condition of trailing shields and Usability at regular interval and certifying it as "Fit for use".





6.0 WELD EDGE PREPARATION

Preparation of Weld edge is important activity. There shall be minimal heat input during weld preparation / No decolouration. Thickness of the plates were 38 mm, 42 mm, 50mm, 65mm, 100 mm. WEP machines used as shown in picture below. Surface finish is checked after each preparation. First WEP prepared on sides of the plates and then rolling is carried out.

When use of WEP machine is not possible, waterjet cutting machine is being used. VTL also used in some cases.

Shell were rolled using In-house Rolling mill available inside the workshop

Cone Petals were formed using In-house Press of 1000 ton available inside the workshop



7.0 LOCAL ENCLOSURE TO MAINTAIN MICRO-CLIMATIC CONTROLLED CONDITIONS FOR WELDING

Looking at the size of the job (Dia 9 m x 29m Height x 192 MT weight) it is obvious that the job will be fabricated at Site and Trailing shields will be used, it will be out of Chamber Welding.

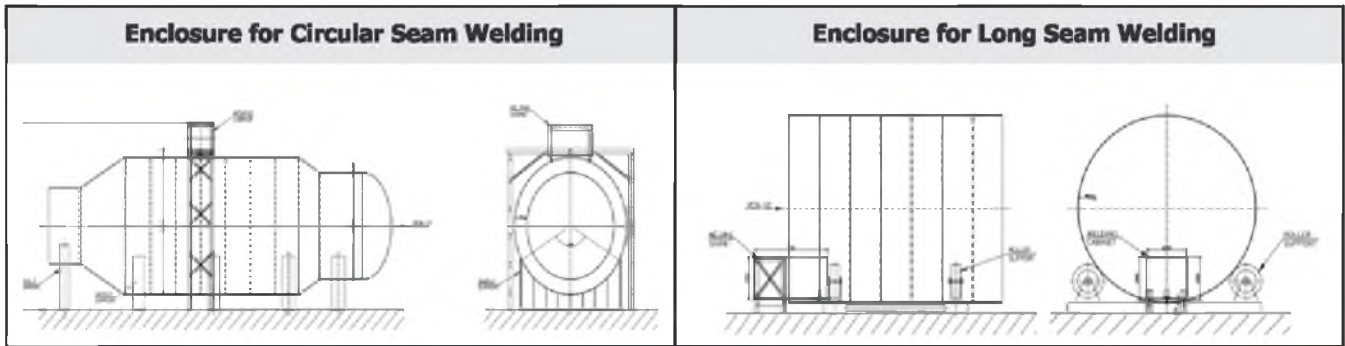
Even after use of best trailing shields, it is important to maintain the cleanliness, humidity in the area of welding. Since welding is carried out in open atmosphere at site, in Rainy time, humidity will be very high. Higher humidity will result in porous welds

Local Welding Enclosures created at the Point of Welding. Enclosures are equipped with

Gas Manifold (High Purity Ar)	Flow meter-3x	3 Nos connection per Welder
Air Conditioner	De-humidifier	Electric Heater
Oxygen Analyzer	Thermo Hygrometer	Trailing Shields, Purging Pads
Acid Cleaning Kit	Welding Machine	Ti Welding Kit

These enclosures are fitted on the job and the gap between Job and Enclosure is sealed with flexible rubber sheet. Inside area

is cleaned thoroughly and checked for cleanliness with "White cloth check"



8.0 ROLE OF QUALITY CONTROL

All Preparation, Planning and Welding Qualification ultimately produce the required result on Shop Floor. Production Monitoring and Quality Control Plays very important role in such critical Fabrication.

Inspection stages like "Release of Set-up for Welding" has a added activity of "Readiness for Titanium Welding for a Specific Joint" for this project. Ensuring Welding Parameters are strictly followed, Only Qualified Welders being used, Proper procedures are employed is well followed by experience QA/QC team lead by Mr. P.V. Ghanekar.

Start from Preparation of Stringent Quality Control Plan (QCP) to Stage wise Monitoring and Till the completion of Pneumatic Test, every activity is well organized by Quality Team. The efforts put in for "First Time Right" by QA/QC team resulted in smooth completion of this project

9.0 CLEAN ROOM FOR WELDING (MICRO-CLIMATIC CONTROLLED CONDITIONS FOR WELDING)

Manufacturing of Vessel is divided in three area

- Clean Room at GR Pvt Engineering Shop, Tarapur
- Enclosed Shop with 100 Ton Crane. GR Engineering Shop, Tarapur
- Identified area at Site, ABRPL Assam, with Crane of 250 Ton

Choice of location is Depending of the size of the job. Final assembly is done at site.

Welding of small size job is carried out in Clean room. Clean room of size 9mtr X 5mtr X 4mtr is made ready with all necessary equipment's used for welding. Every Equipment, Tools, Accessories, Trailing shield is first Trial Welded/ Tested in clean room and then issued to Shop and Site.



10. COMPLETION OF FABRICATION AT SITE

Vessel is installed in Bio Refinery Project, ABRPL, Numaligarh, Assam and Pneumatic Tested successfully completed on 21 Sept 2023.

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