Introduction

Energy Demand is Globally Increasing

Hydrocarbons demand is Also Increasing

Increments in refining & gas processing is a must today

Building up Petrochemical Industry in Energy Rich Countries is Essential

Expanding & Upgrading Existing Process Plants is a Prerequisite

Strong demand for PV with changing specifications
Energy Demand Increase

- Annual Global Energy Growth is @ 2.5%
- Short term “Arab Spring” & Fukushima at the foreground,
- Subsequent closures of Nuclear reactors in Japan & Europe,
- Long term energy demands by China, India, Russia & Brazil
- Production of Basic Petrochemicals are shifting to energy rich ME or fast developing countries (India, China)
Additional Investments

- Additional oil fields are being explored and developed
- Existing plants are being expanded
- Refining capacities are being enhanced and upgraded
- Export-oriented refining, gas processing & petrochemical industries are being built in the Middle East
New Generation of Pressure Vessels

New Generation of Pressure Vessels
Material Enhancement
Maintaining Metallurgy during Manufacture
Manufacture @ Client Site
Material Enhancement

- Intensive R&D,
- Investigate composite materials in heavy walled vessels,
- Varying Modulus of Elasticity through the thickness of material
- Material Testing
- Material Selection for the Process
Maintaining Metallurgy

- Ensuring 100% compliance with material qualifications for WPS/PQR
- Special attention to heat input is within allowable limits
- Weld deposition rates are being maintained
- Clean Welding Environment
For larger size process equipment the like benefits are:

- Eliminate Inland transport permits and bureaucratic confusions of right of way
- Eliminate seaworthy packaging & Preservation
- Eliminate need for cargo shipping dates reliability,
- Eliminate Custom Clearance Issues,
- Reduce fabrication cost and time,

Build products under constant surveillance at jobsite.

Minimize inspection notification durations.

Control over production of equipment.
The Manufacturing Story

1. RFQ’S
2. Engineering
3. Material Purchase
4. Edge Preparation
5. Shell Forming
6. Back Chipping / Grinding
7. Handling
8. Field Fabrication
9. Pre-Heating & Inter pass Temperature
10. Welding Processes
11. Cladding Alloy Overlay
12. NDE
13. Post Weld Heat Treatment (PWHT)
14. Hydro Testing and Foundation
15. Transportation to site
Type of RFQ’S

- Sealed Bids
- Competitive Price Bids
- Novation Bids
- Cost Plus Bids
- Sole Source Bids
Engineering

- NMR Generation
- Material Specification lock
- Settling BOM & BOQs According Material Suborder Specifications
- Fixing of Material Manufacture Schedule
Material Purchase

- Procurement of Material According to RFQ’s
- Procurement from Approved Client Vendors
- Follow Up & Inspection Coordination
- Material Arrival & Release to Production
Edge Preparation

- Methods
- Cutting
- Squaring
Shell Forming

- Transforming a flat plate into a rolled ring by passing it through a series of roll presses
- Methods
Back Chipping/ Grinding

- Essential after first initial several passes ensuring full penetration and sound metal
- Methods
Handling

- Synchronized jacking systems
- Hydraulic Gantries
- EOT Cranes
- Mobile Cranes
- Bogies & Trollies
Field Fabrication

- Size & Location of PV leading to field manufacture,
- Advantages & Disadvantages
- End results
Pre-Heating & Inter pass Temperature

- Reasons & Methods
Welding Processes

- What types of welding processes
- Why we choose one over the other?
- Can we show any calculated methods to prove the chosen welding process is better than the other?
Submerged Arc Welding (SAW) is a high deposition rate process because the weld is deposited in multipasses, the weld metal and the HAZ receives the benefits of grain refinement as position.

Typical SAW narrow gap applications are thick walled components that demand high quality longitudinal or circumferential welding. Narrow gap welding offers two major benefits: it is an economical joint configuration with less weld volume to fill compared to other joint configurations; and the automation friendly joint welded with moderate parameter limits weld defects and gives a high quality weld.

Narrow gap welding becomes attractive with heavy wall thickness sections in repetitive fabrication. The main advantage of narrow gap welding is the greatly reduced weld volume in very thick sections, which results in weld cycle time reduction.

When considering this process, it must be taken into account that it involves a large initial investment, as well as more expensive machining of narrow gap joint preparations.

Narrow gap welding can be single or tandem wire; both requiring specially designed welding head narrow enough to fit into the joint preparation.
Narrow Gap SAW (NGW)

Conventional Submerged Arc Welding (SAW) of ‘V’ and ‘U’ groove weld has proven itself over the years and was most frequently used welding. With constantly increasing wall thickness the Narrow Gap SAW (NGW) with parallel edges gradually replaced the open angle weld shapes and became the standard welding technology for longitudinal and circumferential joints.

Advantages:
- Lower weld joint volume
- Reduce consumable cost
- High weld productivity
- Low angular distortion
**Comparison Based on 150 mm thickness**

<table>
<thead>
<tr>
<th>Joint Type</th>
<th>Weld Joint Area</th>
<th>Weld Deposit/m</th>
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<tbody>
<tr>
<td><strong>Narrow Gap Joint (Joint Gap 20mm)</strong></td>
<td>3967 mm²</td>
<td>31 kg</td>
</tr>
<tr>
<td><strong>Narrow ‘U’ Joint (Joint Gap 16 mm)</strong></td>
<td>4380 mm²</td>
<td>34 kg</td>
</tr>
<tr>
<td><strong>Double ‘V’ Joint 45°</strong></td>
<td>4800 mm²</td>
<td>37 kg</td>
</tr>
<tr>
<td><strong>Single ‘V’ Joint 30°</strong></td>
<td>6030 mm²</td>
<td>47 kg</td>
</tr>
</tbody>
</table>

Note: Weld reinforcement is not included in calculation.
Considering the lead time, Explosion bonded claded plates or Strip cladding options can be adopted to complete the project within scheduled time. A clad plate is manufactured by laminating two metal plates to each other, the explosion bonded process is also known as "cladding by the explosion welding process. The process uses an explosive detonation as the energy source (Vacuum) to produce a metallurgical bond between metal components. Strip cladding can be performed by two methods Submerged Arc strip cladding and Electroslag strip cladding. In SAW strip cladding usually a positive electrode is used to form an electric arc between the strip and the work piece and flux is used to form a molten slag to protect the weld pool from the atmosphere. ESW strip cladding relates to ohmic resistance heating of a molten electrically conductive slag. There is no arc between the strip electrode and the parent metal. The heat generated by molten slag melts the surface of the base metal and the edges of the strip electrode submerged in the slag and flux. The penetration achieved with ESW is less than that with SAW because the molten slag pool is used to melt the strip and some of the parent metal.
Both RT and TOFD techniques to perform NDT on HWPV are being used during the fabrication of Heavy Wall Pressure Vessels. However, TOFD / C-B SCAN / Phase Array are most suitable for very heavy wall thickness and can be performed even during fabrication without evacuating the area. The TOFD technique was first applied in 1985 at the Harwell Center (UK) in response to insistent requests to size cracks in nuclear reactor welds. The TOFD technique is a fully computerized system able to scan, store, and evaluate indications of weld defects in terms of height, length, and position with a grade of accuracy never achieved by other ultrasonic techniques. It is based on diffraction of ultrasonic waves on tips of discontinuities, instead of geometrical reflection on the interface of the discontinuities.

In addition to higher sensitivity, the TOFD technique allows the full examination data to be recorded on hard disk, displaying all discontinuities in C/scan images. TOFD technique is able to detect defects which are normally visible either by radiographic examination or traditional ultrasonic testing (pulse echo). It can be applied with reasonable investment during construction and in service giving good compromise between profit and quality results.
Another consideration for Heavy Wall Pressure Vessel should be the PWHT. If possible, the fabricator should have a furnace large enough to do the stress relieving in one shot.

Depending on the size of the vessel and capacity of the furnace (size and maximum temperature), a full or partial PWHT is performed. In full PWHT, there are two types of firing methods. The most common one is the furnace PWHT wherein the vessel is loaded inside the furnace and heated to the required level in a single firing as per procedure. This is the most desirable type of PWHT because all parameters in the heating, soaking and cooling can be controlled well. However the availability of such furnace are a constraint. Both diesel or gas firing and as well as electrical heating could be used for this. If PWHT in one go is not possible due to the size of the vessel, part-by-part PWHT with sufficient with sufficient overlap of the heated zones can be carried out.

In the second method, the vessel itself is made the furnace by providing burners at appropriate points and by giving insulation all around the vessel. The method is called internal firing and very much dependant on the skill of PWHT Technician. The method of heating adopted is generally diesel or gas firing. For PWHT of weld joint alone localized PWHT can be performed by using electrical resistance heating system.
Hydrostatic Test & Foundation

Usually it is 1.5 times the design pressure with temperature correction as possible. The pressure shall be built up gradually to half the test pressure and allowed to stabilize at that level for few minutes. Thereafter, the pressure may be increased in steps to achieve the final pressure.

Horizontal vessels that are mounted on the saddles can be tested in that position on the saddles itself, provided the vessel is temporarily anchored against any toppling forces that may arise during the course of the test.

In case of large vertical columns, the hydrostatic test is done in a horizontal position on temporary saddles made for this purpose. The requirement of number of saddles needed during the test and the foundations (floor) is decided by the design based on the total hydrostatic test weight and its loading.
Transportation of Heavy weight pressure vessels from workshop to the site is a challenging task and required workout on road surveying and availability of shipping and loading equipments according to project schedule. Transportation of heavy and oversized load consists of specialized and sometimes customized rolling, floating, jacking and lifting equipment. These equipments are operated by skilled and experienced personal aware of consequences and impact on project schedule if not handled correctly.
Thank You