International Journal of Mechanical Engineering (IJME)
ISSN (P): 2319-2240; ISSN (E): 2319-2259
Vol. 9, Issue 5, Jul–Dec 2020; 13–24

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

ANALYSIS OF CYCLE TIME REDUCTION DURING SHROUD HYDRO TEST OF BOILER DRUM OF 500/600MW

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ABSTRACT

Boilers in the power plants and process plants have large drums to house the steam – water mixture, to hold large quantity of water required for steam generation and ensure steam quality. Drums weight anywhere 100 to250 tons with very high thickness depending on the MW rating. Manufacturing of drums need special machines and process. The total cycle time of the drum vary from 100 days to 134 days according the capacity. In the process mapping of drum manufacturing shroud hydro test is a part of cycle taking around 4 – 6 days as of now in 500/600 MW.

Delays in Power Plant Boiler are caused mostly because of leakage during shroud hydro test. By detailed studying the operation involved in carrying out the shroud hydro test and the issues which are causing the leakages during hydro test, an attempt has been made to reduce the cycle time of shroud hydro test.

KEYWORDS: *Time Reduction, Leakages, Shroud Hydro Test*

Article History

Received: *05 Nov 2020* **|** ***Revised:*** *11 Nov 2020* **|** ***Accepted:*** *13 Nov 2020*

INTRODUCTION: BOILERS DRUM

A visual Simultaneous Localization and Mapping (SLAM) have been using as for marker less tracking during in augmented reality implementations. The term SLAM was formerly developed by Hugh Durrant and John J. Leonard which it's concerned with the applications of building a map of unknown environment by a mobile robot while concurrently navigating the environment using the map, [1]. The robotics community also defined the SLAM problem as an agent of map creator of an unknown site using sensor(s) while concurrently localizing itself in the environment. To localize the agent properly, an accurate map is required. To produce a precise map, self-localization has to been done in appropriate way.

Boiler drum is a pressure vessel working at a high pressure and high temperature. It separates the steam and water, the separated steam will go to the super heater and the water remaining in the drum will go to the water wall panels again. To perform such operation the Boiler drum has to be designed in a way that it must withstand high pressure and temperature. The boiler drum consists of a shell closed with dished end covers of hemispherical shapes or semi ellipsoidal shape The shell is generally made of two half shells by hot (or) cold pressing with two longitudinal weld joints called long seams. The joint made by closing the dished end are called circumferential seams.

Process Mapping for Boiler Drum Manufacture

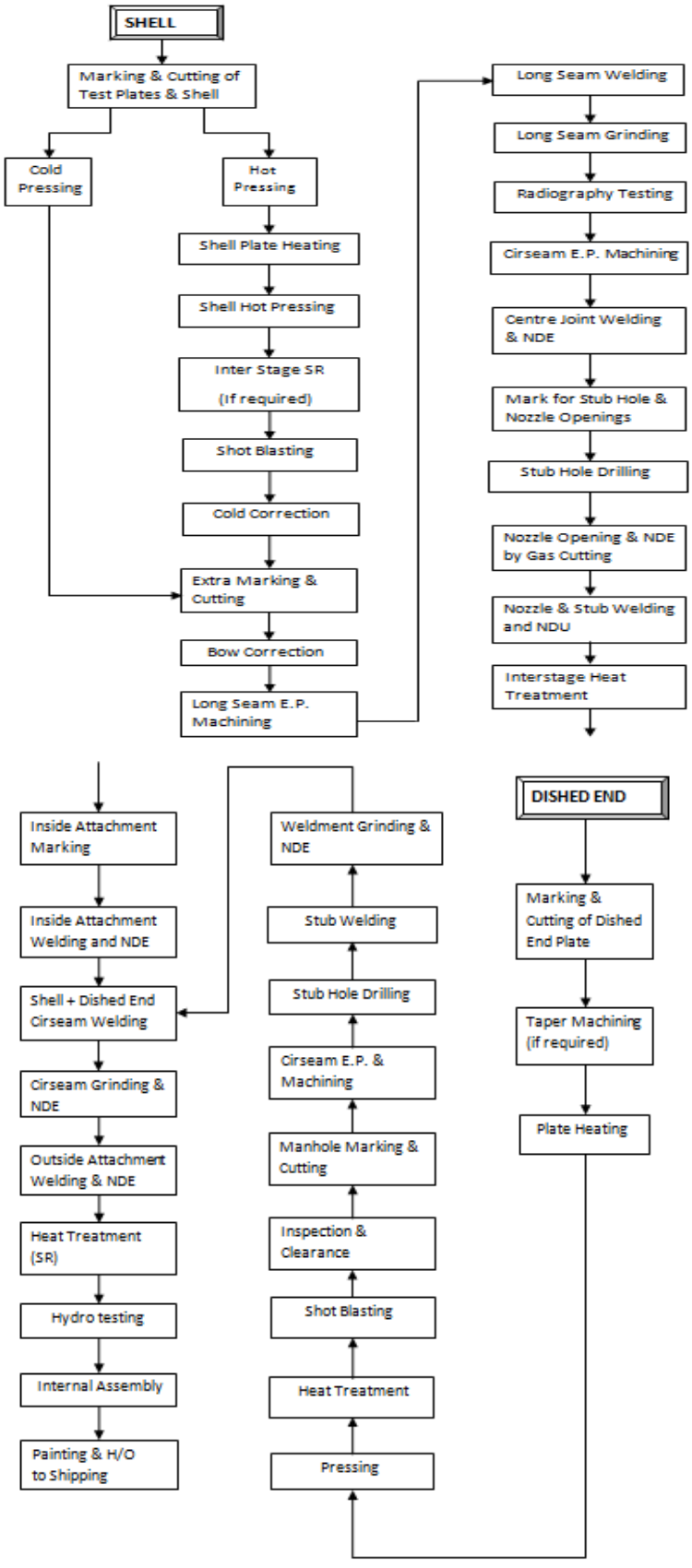

Figure 1: Process of Boiler Drum Manufacture.

Drum

Steam drums are used on re – circulating boilers that operate at subcritical pressures. The primary purpose of the steam drum is to separate the saturated steam from the steam – water mixture that leaves the heat transfer surfaces and enters the drum. The steam – free water is re – circulated within the boiler with the incoming feed water for further steam generation. The saturated steam is removed from the drum through a series of outlet nozzles, where the steam is used as is or flows to a super heater for further heating. (By definition, saturated steam is pure steam that is at the temperature that corresponds to the boiling temperature at a particular pressure. For example, saturated steam at a pressure of 500 psia has a temperature of 467'F.)

The steam drum is used for the following:

- To mix the saturated water that remains after steam separation with the incoming feed water.
- To mix the chemicals that is put into the drum for the purpose of corrosion control and water treatment.
- To purify the steam by removing contaminants and residual moisture.
- To provide the source for a blow down system where a portion of water is rejected as a means of controlling the boiler water chemistry and reducing the solids content.
- To provide storage of water to accommodate any rapid changes in the boiler load.

Figure 2: Inside Arrangement of Boiler Drums.

BOILER HYDROSTATIC TESTING

The equipment should have been hydrostatically tested to a minimum of 1½ times the design pressure, in the factory, and copies of the Manufacturer's Data report, signed by the Authorized Inspector witnessing and evidencing the test forwarded to all jurisdictional bodies as well as to the Client. However, the complete system, along with all interconnecting piping, should be hydrostatically tested before start-up to comply with code requirements and to check for leaks that may have occurred during shipping and handling. This test should be completed under the supervision of and witnessed by an Authorized Inspector who should represent the State or municipality having jurisdiction or the insurance company covering

the installation. At the option of this inspector, the hydrostatic test may be at 1½ times the design pressure of the equipment, or at a pressure slightly less than the setting of the lowest safety valve. The latter test will avoid the necessity of blanking or gagging of safety valves, removing piping and plugging various pipe openings, removing controls and gage glasses, etc

The boiler and process lines must be completely vented in order to fill them with water. The following is a recommended procedure for hydrostatic testing:

- Open the steam drum vent valve and gag the safety valves in accordance with safety valve manufacturer's recommendations. In lieu of gagging, the safety valves may be removed and replaced with test plugs or blind flanges.
- Open the vents on the interconnecting piping. Close steam outlet valve.
- Isolate pressure switches, gauge glasses or control components that are not intended to be subjected to a hydrostatic test.
- Fill the system with treated water in accordance with recommendations from the Clients water treatment consultant. (Refer to section entitled "Water treatment Considerations". The test water temperature range must be 70°F minimum to 120°F maximum (100°F to 120°F water temperature is preferred). Care should be taken so that all air is vented while the equipment is being filled. Fill the equipment until water overflows the vent, then close the vent.
- Apply pressure slowly. The recommended rate of pressure increase is less than 50 psi per minute. Proper control must be maintained so that pressure does not exceed the desired setting of the local steam boiler inspecting agency. Do not subject any pressure part to more than 1½ times the design pressure rating of any component.
- When the proper test pressure is reached, inspection in accordance with the test objective can begin. Examine the system for any leaks. If no leaks are visible, hold the system in a pressurized static condition for a period long enough to satisfy the code requirement.
- Upon completion of the test, release pressure slowly through a small drain valve. Then fully open vents and drains when the pressure drops to 20 psig. Particular Care must be given to make sure that parts not normally containing water during Operations are drained free of water. The system should be drained fully after hydrostatic testing, to prevent freezing, if the unit is installed in a cold weather area, and to minimize corrosion of the metal surfaces.
- If temporary hand hole or man way gaskets were used for the test, they should be replaced with regular service gaskets before readying the unit for operation.
- Gaskets should never be reused. Replace gage glass if necessary and make sure that the gage cocks are open. Remove all blanks or gags from safety valves and install relief valves, if removed.
- Additional inspection at this time by the Authorized inspector will determine whether the installation including piping arrangements, valve gauges and controls and other equipment on the unit meets Code and/or other jurisdictional requirements.

RESULTS AND DISCUSSION

Boiler Drum Shroud Area

The annular gap formed between inner sides of Drum Shell & Separating chamber is called Shroud.

The Shroud area comprises of

- Separating chamber sheets laid on the attachments welded on the shell surface.
- The chamber sheet covers the riser stubs region in the Drum.
- This chamber sheets are further welded with turbo support panel which has turbo support casting welded on it.

Shroud Hydro

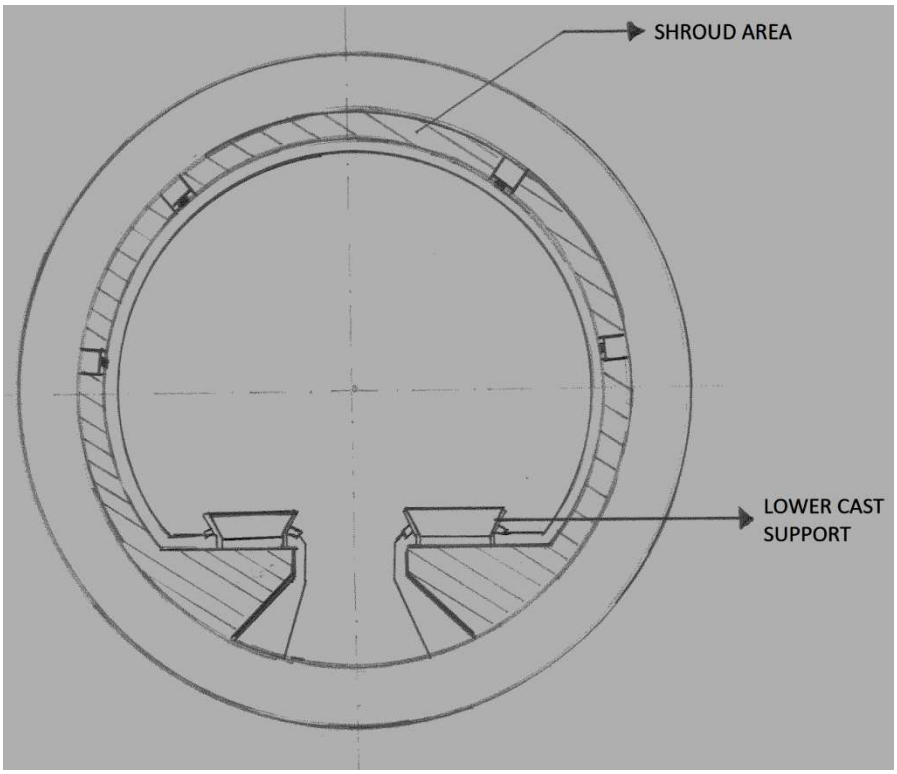

Figure 3: Shroud Area of Drum.

The main purpose of Shroud Hydro is to check the weld strength of chamber plate sheets welded along the length of the Drum with turbo support panel.

During shroud hydro, the chamber area till the turbo support casting is subjected to pressure of 0.35 Kg/Sqcm to 0.5 Kg/Sqcm.

This is because of the necessity of withstanding the differential pressure between the chamber and the drum.

The weldment and the lower support need to with stand the above pressures only during operation.

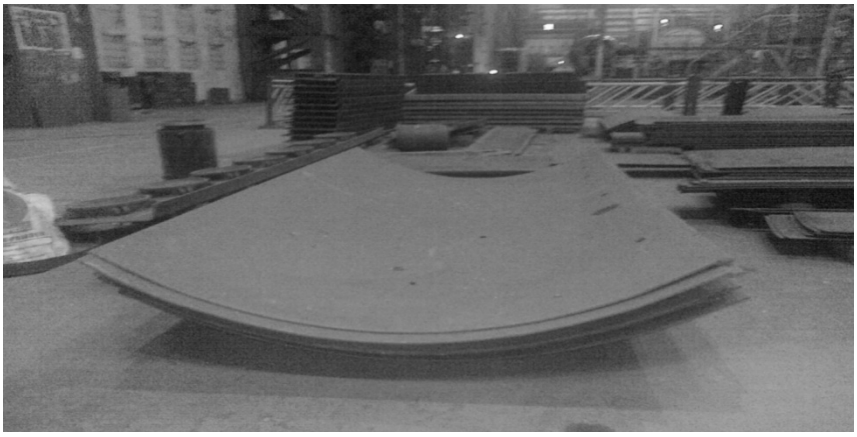

Figure 4: Shroud Plate after Heat Treatment.

Figure 5: Lower Cast Support.

Problems in Conducting Shroud Hydro

The Shroud hydro is carried out inside the Drum (ID 1778 mm) with all the welded attachments & internals.

So in order to conduct shroud hydro one has to enter into the Drum through 16 “Manhole which itself is not a conducive environment.

There upon the fixtures are to be fixed to cover the turbo support opening on the panel to seal the shroud area.

Afterwards the shroud is filled with water and hydro tested. During hydro test often leakages are noticed in the following areas:

- Weldment between the separating chamber sheets.
- Weldment between turbo support panel & turbo support casting.
- The lower support casting.

The above intricacies calls for several repair welding to make the chamber area leak proof.

Each time when a leakage has to be arrested the water in the chamber has to be drained, reworked on the leakage area and then further testing is carried out. This causes delay in successful conductance of hydro test in time.

Existing Process

- It takes 100 days to 134 days for drum production according to MW rating.
- It takes nearly 6 days for full shroud hydro test and curing the problems in that it takes 2 days for checking and curing the problems in the cast lower support
- The shroud hydro test on lower cast support in boiler will mostly be done after been assembled in to the boiler. This process of hydro test on lower cast support after welded in to drum will increase the production cycle time.
- Mostly leakage has been found on the lower cast support after fixing into the drum. The leakage should be closed by manual weld inside the drum by the trained welder.

Shroud Tank with Fixtures

Thus in order to reduce the cycle time of production. We have to do the hydro test on the lower cast support before being fixed in the drum. If any leakage is found on lower cast support, the leakage should be rectified or closed before attaching in the drum.

After the hydro test, the lower cast support is welded in the shroud area of the drum.

This process of hydro testing on the lower cast support before being fixed into the drum will decrease the cycle time required for the production.

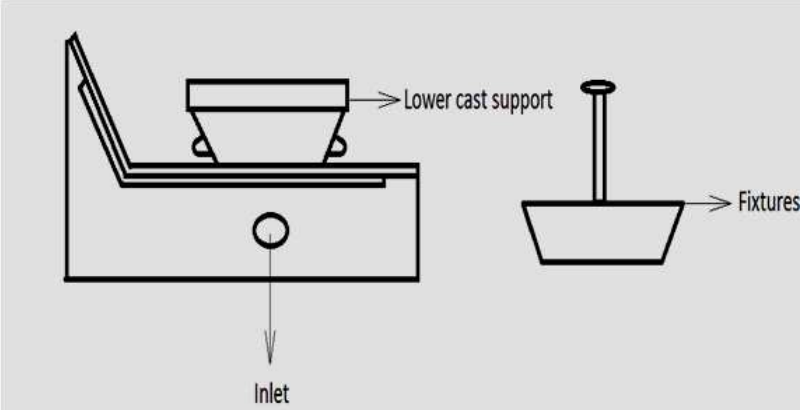

Figure 6: Model of Shroud Tank with Fixtures.

Modified Process of Shroud Tank with Fixture

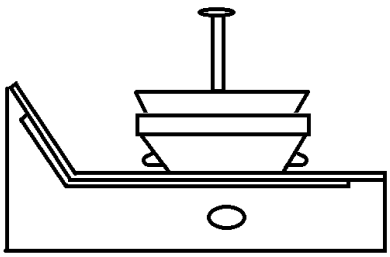

Figure 7: Front View of Cast Lower Support with Fixtures.

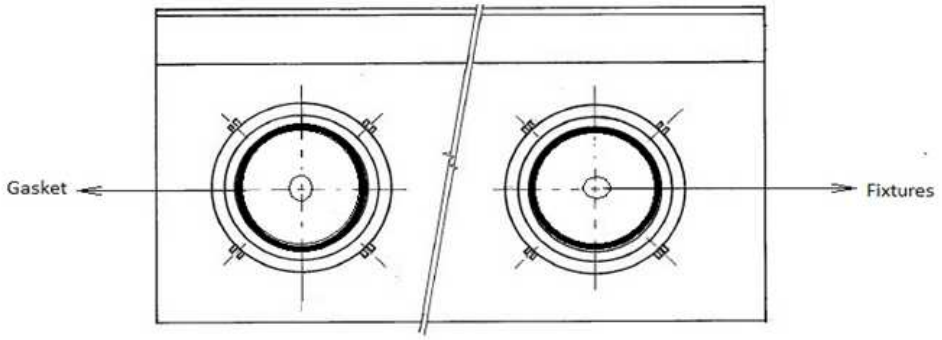

Figure 8: Top View of Cast Lower Support with Fixtures.

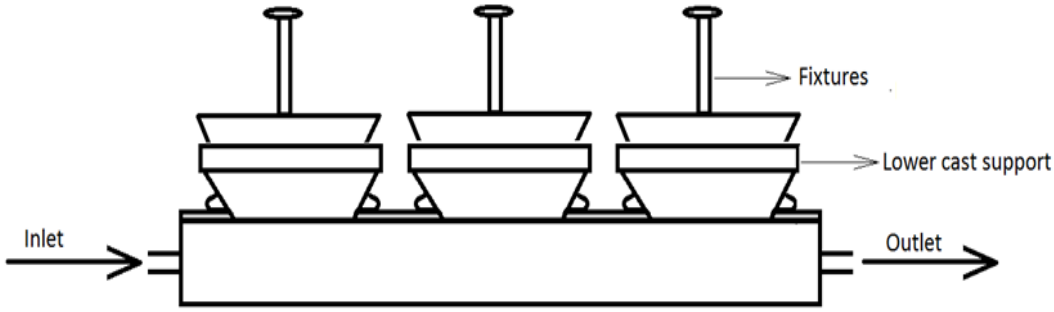

Figure 9: Side View of Cast Lower Support with Fixtures.

Pro-E Model for Shroud Tank and Fixture

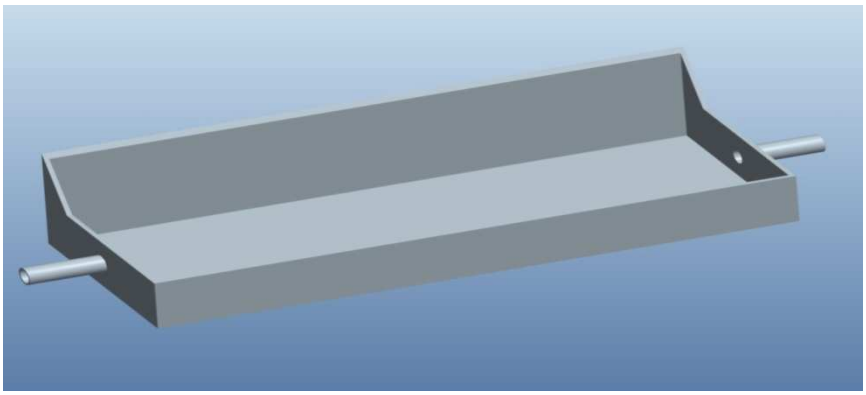

Figure 10: Shroud Tank.

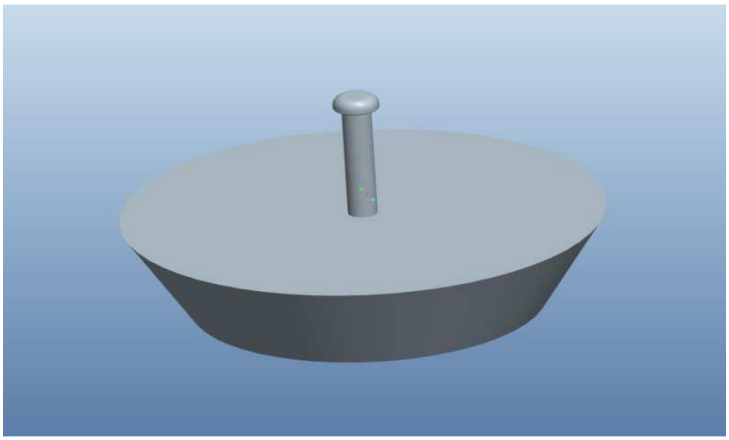

Figure 11: Fixture.

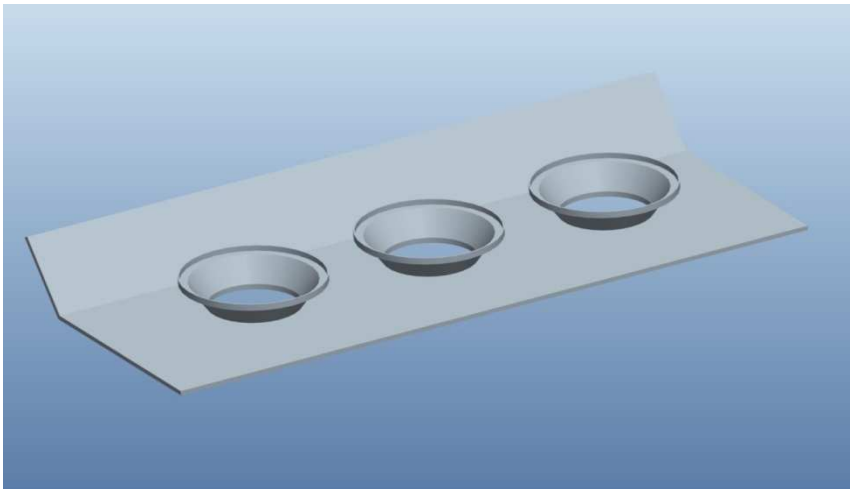

Figure 12: Lower Cast Support.

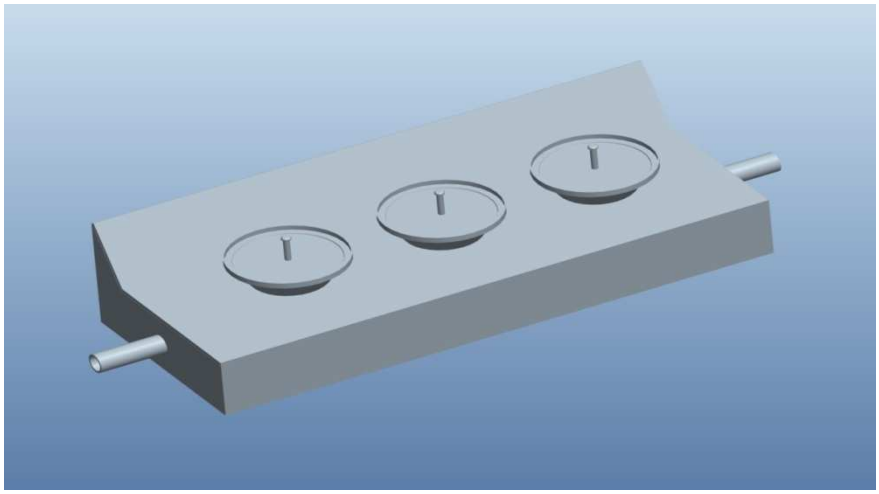

Figure 13: Lower Cast Support Assemble with Shroud Tank.

Before Using Shroud Tank

For 500 MW Boiler Drums

- For 500MW drum manufacture it takes = 120 days
- Total number of cast lower support in drum = 92
- Number of sections of panel in the drum = 4
- Total number of cast lower support in per panel = 23

Time taken for reworking on drum during shroud

- Hydro test per panel = 0.5 shift

Time taken for reworking on drum

- During shroud hydro test = 2 shift
- Shroud hydro pressure should be = 0.5 kg/cm2

For 600 MW Boiler Drums

- For 600MW drum manufacture it takes = 130 days
- Total number of cast lower support in drum = 110
- Number of sections of panel in the drum = 4
- Total number of cast lower support in per panel = 27

Time taken for reworking on drum during shroud

- Hydro Test per Panel = 0.5 shift

Time taken for reworking on drum

- During shroud hydro test = 2 shift
- Shroud hydro pressure should be = 0.5 Kg/cm2

After Using Shroud Tank

For both 500/600MW drum it will reduce 2 days from the total time taken for main shroud hydro test by during the test parallel to any other work.

- For total time taken for main shroud hydro test = 6 days
- We reduce time by doing the test separately parallel to Some other work in drum = 4 days

SUMMARY AND CONCLUSION

Today, in this fast paced world, time management and time reduction are paving way too many achievements and are reducing overall cost of products which is very much necessary in this competitive market to attract customers. According to MW rating it takes 100 days to 134 days for drum production. It takes nearly 6 days for full shroud hydro test and for curing the problems in that it takes 2 days for checking and curing the problems in the cast lower support. The shroud hydro test on lower cast support in boiler will mostly be done after been assembled in to the boiler. This process of hydro test on lower cast support after welded in to drum will increase the production cycle time. Mostly leakage has been found on the lower cast support after fixing into the drum. The leakage should be closed by manual weld inside the drum by a trained welder.

Thus, this project aimed to reduce the cycle time of production. The shroud hydro test on the lower cast support is done before being fixed in the drum. If any leakage is found on lower cast support, the leakage are rectified or closed before attaching in the drum. After the shroud hydro test, the lower cast support is welded in the shroud area of the drum. This process of hydro testing on the lower cast support before being fixed into the drum has decreased the cycle time required for production.

For both 500/600MW drums that are produced in BHEL, this project has reduced the total time taken for main shroud-hydro test from 6days to 4days by carrying out parallel work other than the shroud-hydro test inside the drum; while work is carried out simultaneously in the lower cast support when it is outside the drum before fixing, thus the total production time is successfully reduced.

And also we find some other leakages like Places where the panel is welded to drum attachment, Casting + Panel joint, and in the casting itself, due to its poor quality. And suggestions for close those leakages are by using Lower diameter rod instead of using higher diameter rod, Lap welding should be done during assembly of panel with Drum and Procuring good quality casting. (Casting that has been LPI tested)

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