Manufacture of a Halogen Tested Heat Exchanger

BY H. L. PRABHAKAR*

The Trichy unit of Bharat Heavy Electricals Ltd. is equipped to manufacture a wide range of power boilers, industrial boilers, high pressure valves etc. Very recently this unit faced a challenging job of manufacturing an Ethylene dichloride reactor vessel in which the weld joints were subject to a rigorous halogen leak test. A very sensitive halogen leak detector was used to test the joints. The challenge was met and the reactor was successfully manufactured.

Details of Manufacture

A manufacturer of plastics and chemicals in Madras State had imported an Ethylene dichloride reactor as a part of its original equipment. It was a conventional heat exchanger with Ethylene dichloride as the medium working at 75 psi and 250°F. Due to the nature of fluids handled by this reactor the tubes got corroded and an urgent replacement was required. It was proposed to import a reactor but since this involved considerable foreign exchange, it was decided to investigate the possibility of local manufacture. The tubes of the reactor were not expanded on to the tube plate but welded. Two stringent conditions were stipulated for the manufacture, viz., (a) The weld between the tube and tube plate should be completed in 5 passes only, (b) The weld joint should pass the halogen test after the second and fifth pass.

In order to confirm the quality of the welding, an experimental mock-up heat exchanger was built and all the weld joints were subjected to halogen leak test. The customer was fully satisfied with the high standard of welding and regular manufacture was then taken up.

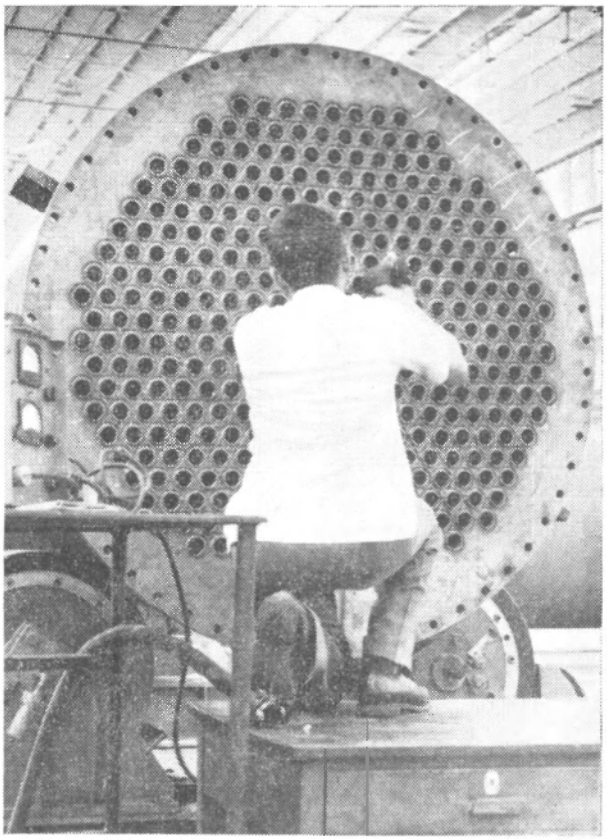

Fig. 1

* At the time this paper was received by the Institute, Mr. H. L. Prabhakar was with Bharat Heavy Electricals Ltd., Tiruchirapalli.

The reactor vessel is about 6000 mm long and 1500 mm in diameter. There are 356 tubes with tube plates on either side of the heat exchanger. The tube assembly is enclosed in a shell. The tubes are spaced by 15 baffle plates. The details of the reactor vessel and the weld joints between tube and tube plate are shown in figures 1 and 2.

All the tubes were subjected to hydraulic test at 115 psi before assembly. The tubes were inserted with the shell in the vertical position. The joint grooves in the tube plate (for welding between tube and tube plate) were so designed that 5 passes of weld would complete the joint. After cleaning the weld joints with acetone, only two passes of weld were deposited on both faces of the heat exchanger. A well known Indian make of rutile electrode was used throughout. A suitable welding sequence was adopted so that the distortion on the tube plate was minimum. Cleanliness was ensured during the entire assembly as this was an extremely important factor to achieve the required quality. The tube ends and the holes in the tube plate were cleaned with acetone. The tube plate holes were wiped with a dry lint-free white cloth. The personnel maintained the working area clear of dust, grease, oil etc.

At this stage the vertical reactor assembly was placed in horizontal position for halogen test. Freon Grade 12 was admitted inside the pressure vessel and then pressurised to 5 atm. with compressed air. Subsequently, the pressure was further raised to 8 atm. with Nitrogen. The probe of halogen leak detector was carefully moved all over the weld joint to detect any possible leak. Out of 712 joints, only 7 joints showed leaks. The defective welds were removed by a special tool and rewelded in two-layers.

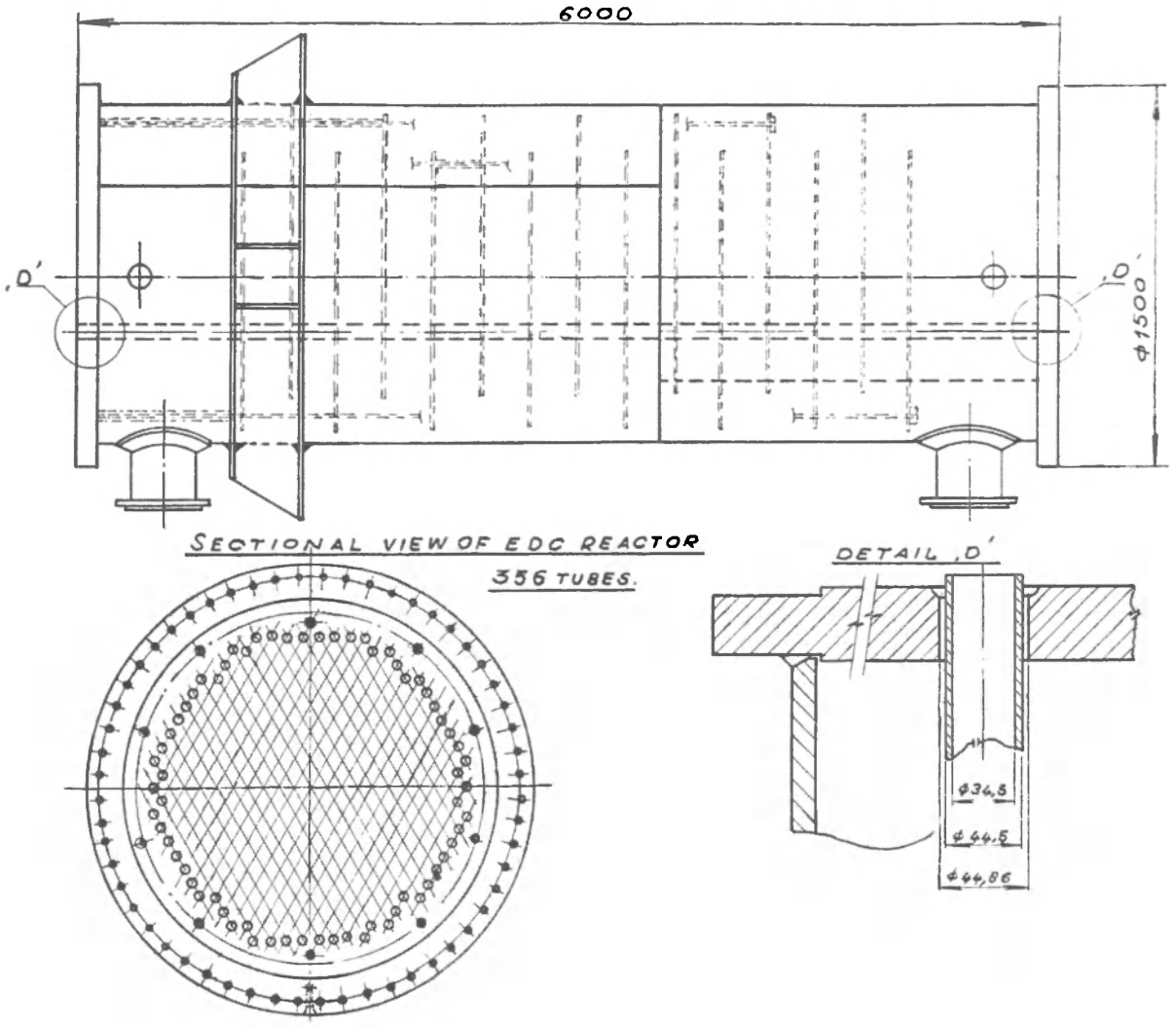

Fig. 2

During the second stage of manufacture, the assembly was placed in the vertical position once again and the remaining three passes were deposited. All the bracket supports and lifting tackles were welded on to the shell and the tube plate joints were once again tested for halogen leak. All the weld joints withstood the severe test perfectly, thus testifying to the high standard of workmanship, electrodes and the shop welders. A routine hydraulic test at 115 psi completed the manufacture of the Ethylene-dichloride reactor vessel.

Testing Procedure

A detailed description of the halogen leak detector testing procedure and equipment seems necessary here since this testing method has been rarely used in India and even elsewhere.

The halogen leak detector testing equipment consists of a suction pump to draw the leaking halogen, and an electronic analysing apparatus. A pump integral with the unit draws off air and leaking halogen through a probe when moved over the leaking joints. The leaking air-gas mixture is drawn and passed between two electrodes. The presence of any leaking halogen increases the inter electrode conductance proportional to the amount of halogen in the medium. The resulting increase in the ion current is amplified electronically and it is indicated by an instrument as well as by an audible alarm.

Before the equipment is used to test the leakage in the weld joint, a careful check of the level of halogen in the background is essential. The equipment has an automatic balancing feature, which will balance out a certain small amount of background halogen. However, air current inside the fabricating shop may give misleading values. One of the easiest methods to overcome wrong reading of halogen leak detector tester is to keep the Freon cylinder atleast 100 metres away.

The probe gun must be switched on at least half-an-hour before its use. All the weld joints and the probe area should be free of oil and dust, as they tend to accumulate halogen leakages. After filling the pressure vessel with Freon gas, it is pressurised to 8 atm. by Nitrogen. The probe is carefully moved along the seam of the weld at about 25 mm per second. Leak is noted by an audible alarm from the control unit. The operator should take care in exposing the instrument to large leaks, as the instrument may be desensitised. In order to check the accuracy of the instrument a standard halogen leak tester should always be carried and instrument checked frequently. This leak tester detects the gas that leaks at the rate of half an ounce per year.

Conclusion

The manufacture of an Ethylene-dichloride reactor was a challenge from the welding point of view. The mock-up which was built to test the welding procedure as well as welders helped in overcoming all the teething troubles. Hand picked welders were further trained on a dummy tube plate joint before they were used on the job. In order to impress the welders about the rigorous testing procedure. halogen leak testing equipment was demonstrated to all the welders who participated in the manufacture of the reactor vessel. This had a very good psychological effect on all the personnel. The successful manufacture of the Ethylene di-chloride reactor vessel resulted in a repeat order for one more unit.