GENERAL REVIEW OF C-WELD IN LPG CYLINDERS

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Abstract : *The C-weld of LPG Cylinders of 33.3 litres water capacity filled with gas at vapour pressure of 16.9 atm at 65° C is considered in this paper. Submerged Arc Welding (SAW) is the process normally adopted. The parameters considered are base metal , electrode/flux combination, current and voltage, post weld heat treatment. etc. Optimum conditions for the process are given, but they may slightly vary from welding machine to welding machine.*

INTRODUCTION

The circumferential weld (C-weld) of Liquefied Petroleum Gas (LPG) cylinders come under the category of pressure vessel welding. The recommended method adopted in making the C-weld is Submerged Arc Welding (SAW) process. In this process, a backing strip is required for the root pass to hold the molten metal before it cools. The major problems encountered in this process are : penetration into the backing strip is not sufficient or absent, the weld strength is less than expected, the bead profile is not good, etc. The SAW method of making C-weld is discussed in this paper.

BASE METAL

The composition of the hot rolled steel plate, Grade B according to IS: 6240: 1989 from which the LPG cylinders are made is C : 0.20 max Mn : 0.90 max Si : 0.025 max S: 0.035 max P : 0.035 max Al: 0.02 min

This is an easy-to-weld carbon steel. Since this is a ferritic steel, great care is required to prevent rusting during heat treatment. Only Grade B steel according to IS: 6240: 1989 is recommended for base metal.

BACKING STRIP

It should be compatible with the parent metal. Generally used steel is IS:1079 Gr 0 or IS: 2062 Gr A. The dimensions of the plate used as backing strip are 2.5 mm thick and 20 mm breadth for the steel plate of 2.9 ± 0.1 mm thick that is bent into a cylinder of 314.4 mm dia (diameter of LPG Cylinders).

The backing strip should fit tightly inside the shell of the cylinder. Otherwise it causes air entrapment between the shell and backing strip at the welded area which can be mistaken for porosity (Fig.1). Short tack welds should be used to hold up the backing strip in place. The backing strip should fuse with the cylinder wall.

ELECTRODE/FLUX COMBINATION

Care should be exercised in the selection of consumables for welds which require heat treating, as the low carbon content of mild steel welds made with most types of flux will give low strength after heat treating. A basic flux with alloyed wire is probably the best.

According to BS 4165: 1984, for pressure vessel quality steels, wires alloyed with Mo, Ni or combination of both be used. (S2M can be used). Only basic fluxes should be used. Electrode/flux combination of IM 300 grade according to BS 4165: 1984, when used for welding from one side has an all weld tensile

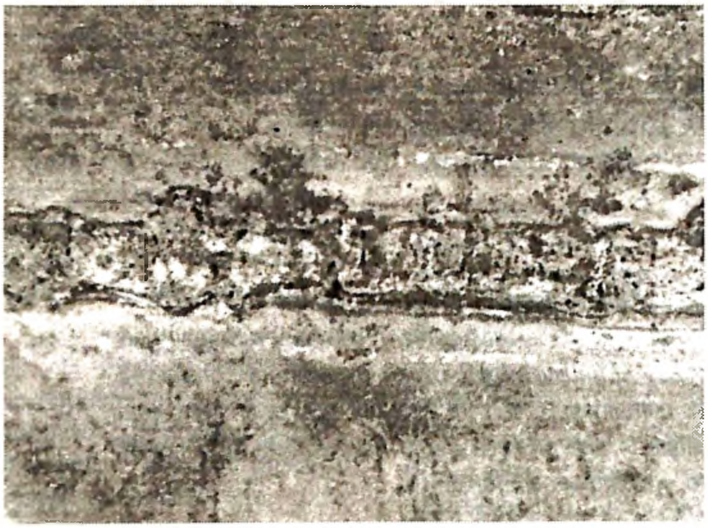

Fig. 1 : Air entrapment below the backing strip.

strength of 40.76 to 61.14 kgf per sq mm at room temperature.

This recommended electrode/flux combination should be favoured instead of thick reinforcement to get a weld strength when copper coated Mild Steel (cc MS) wire is employed. General practice is to use a 3.15 mm dia cc MS wire. Sometimes 2.5 mm dia wire is also used. The reasons for the use of 2.5 mm dia wire are: (1) more depth of penetration and (2) heat input lower for desired penetration.

FLUXES

Sieving of flux before recycling to remove slag particles and dust is necessary. The flux of grain size 0.5 mm to 2.5 mm is the most suitable. Flux size below 0.5 mm is the main cause for the blowholes/pinholes in welding which lead to weld leakages and leakages in subsequent filling. Flux size above 2.5 mm causes irregular weld and slag inclusions and other weld defects which contribute to the percentage of rework in welding. Keeping the flux size between 0.5 mm and 2.5 mm significantly reduces the percentage of weld leaks.

Preheating of flux upto a temperature of 300-350° C is necessary to help in penetration.

WELD REINFORCEMENT

On any bead, the metal extending above the surfaces of the plates is called reinforcement. Reinforcement is to accommodate any defects in welding, hence it is not correct to have reinforcement more than the thickness of the plate. Excessive reinforcement greater than plate thickness increases distortion. On a butt joint, a nominal weld reinforcement of approximately 1.6 mm is all that is necessary. Additional build up serves no useful purpose and will only increase the cost.

WELD PROFILE

The edge of the weld bead should flow into the plate surface with an appearance of perfect fusion. The re-entrant angle should approach 180°.

JOINT DESIGN, JOINT PREPARATION

In the case under study welding is done from one side with a backing strip and the backing strip cannot be removed afterwards. For this a single V-butt weld with root face zero is preferred. The root face should not be present because it provides a solid nose which will fuse and hold up the weld metal thus preventing penetration into the backing strip. This makes the backing strip fall out and produce noise when the cylinder is moved. If possible the root gap should be kept half the thickness of the plate, but welding can also be done successfully without a root gap.

Because of machine constraints, if a square butt joint is used, a root gap of half the thickness of the plate should be used. Otherwise penetration into the backing strip will be difficult to obtain, and the number of rejects will be very high.

If the joint is cleaned by buffing before welding, weld finish and quality of weld is improved.

STICKOUT, ELECTRODE DISPLACEMENT / ALIGNMENT

In developing a procedure, an electrode extension (stickout) of approximately eight times the electrode diameter is a good starting point. This can be changed with amperage to achieve optimum melting rate. The generally used stickout for 3.15 mm dia wire is 28-30 mm. Increasing stickout increases deposition and bead height but decreases welding current, penetration and bead width. Decreasing stickout decreases deposition and bead height but increases welding current, penetration and bead width.

For a cylinder of internal diameter equal to 314.4 mm, the electrode displacement ahead of vertical centre should be 20 to 25 mm.

Centre line of the electrode should align with centre line of joint, that is, torch angle should be 90°. Misalignment makes the bead come to a side, and affects the strength.

TRAVEL SPEED (WELDING SPEED)

General practice is to use a welding speed of 1200 -1400 mm/min or 1400-1600 mm/min for 3.15 mm dia cc MS wire, depending on the welding machine used. This practice seems to give good C-welds.

WIRE FEED RATE

General practice is to use a wire feed rate of 1600-1800 mm/min or 1800-2000 mm/min. for 3.15 mm dia cc MS wire depending on the machine used. This practice appears to be giving good C-welds.

WELDING CURRENT AND VOLTAGE

For a cylinder of 314.4 mm dia welded with 3.15 mm dia cc MS wire with a backing strip by SAW process, welding current of 550-600 A and welding voltage of 28 V seem to give good results.

MAXIMUM INTERPASS TEMPERATURE

Maximum interpass temperature for welding carbon steel is typically limited to 260° to 270°C.

POST WELD HEAT TREATMENT

Heat treatment after welding minimises cracking during or after fabrication, imparts dimensional stability, removes deleterious effects due to cold working and resists stress corrosion. The cylinders should be heated for a sufficiently long period to ensure uniform temperature and then cooled in still air.

Stress relieving is done between 625° to 650°C, with a soaking time of 30 minutes, after completion of all welding according to B5:5045: Part 2: 1978.

Stress relieving is known to improve metallurgical structure of the weld and heat-affected zone by tempering, removal of hydrogen if present, removal of aging effects and reduction of stress corrosion potentialities.

Although normalising and annealing may be helpful metallurgically under certain conditions, they are seldom used because scaling and warping increase rapidly with temperatures above 650°C.

CONCLUSIONS

This paper brings out the important parameters employed in making a good C-weld in LPG Cylinders. The parameters studied are : Base metal, backing strip, Electrode/Flux Combination. etc.

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