

Development of Single Side Single Pass Submerged Arc Welding Procedure for C-Mn Steel Plates using Reusable Backing Strip

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ABSTRACT

A major portion of fabrication activity in a shipyard comprises of welding of which butt welding takes a substantial share. All the decks, side shells, double bottoms, platforms are made of flat stiffened panels. The conventional method of welding of such panels consists of several operations like welding from top, turning over of the panel, gouging of root followed by final welding. Usually these panels have very large overall dimensions making it difficult for such operations. Where turning over is physically not possible, overhead welding becomes the only alternative. This results in an uneven weld bead and a slower rate of production. The uneven bead shape calls for additional operation of grinding resulting in further man-hour requirement. The genesis of this investigation is based on the requirement of improving productivity by cutting down total welding time. Arc welding being a thermal process, it may lead to very complex physical and metallurgical changes in the work piece. It is practically impossible to establish an exact mathematical model of the same. An attempt therefore has been made in this study to establish a submerged arc welding procedure, which will enable producing sound welded butt joints. The combined effect of the basic welding parameters, i.e. voltage, current, speed along with the effect of thickness, on weld penetration, bead formation, HAZ hardness and tensile strength of welded joint has been studied. An attempt has been made to develop a flux filled reusable backing strip. In the present investigation submerged arc welding flux in its powdered form has been used without application of any external pressure and also without any additives. The study also aims at investigating the effect of flux on the formation of the bottom reinforcement. Experiments have been carried out extensively on C-Mn steel plates of thickness 10mm and 12mm. The welds achieved in this single side single pass welding process indicate the feasibility of the process to achieve quality welds to meet relevant industry standards.

KEY WORDS: SAW; HAZ; Flux; Heat input rate; Microstructure; Tensile strength; Impact strength

INTRODUCTION

Single sided single pass submerged arc welding procedure has been established for joining comparatively thin steel plates [Mandal-Maiti, 2004]. With these encouraging results and due to its huge application

potential in shipyards, thicker section mild steel plates have been considered in this investigation. The purpose is to study the feasibility and to establish the procedure for carrying out single sided single pass SAW for a range of plate thickness satisfying the desired mechanical properties and microstructural characteristics.

The process will certainly help in shortening the schedule in subassembly stage and erection phase of a ship. This will also reduce the possibility of weld induced distortions.

The prime focus of the present investigation is to develop a welding procedure to achieve sound welded joints having desired mechanical properties and microstructural characteristics. With the goal of achieving defect free welds with minimum residual stress substantial work [Gianetto-Smith-McGrath-Bowker, 1992; Joarder-Saha-Ghosh, 1991; Smith-McGrath-Gianetto-Orr, 1992a; Dixon-Hakansson, 1995; Drayton, 1972; Doherty-Mcglone, 1977; Yang-Chandel-Bibby, 1993] has been done to study the effects of process variables on welding. In the present investigation heat input per unit volume [Mandal-Maiti, 2004] has been taken to incorporate the effect of plate thickness in cooling rate and its corresponding microstructures. Arc efficiency has been taken as 0.9 [Jang-Kim-Kang, 2001; Bonifaz, 2000a; Goldak-Chakravarty-Bilby, 1984; Kasuya-Yurioka, 1993a]. Lienert et al [2003] studied the feasibility of conventional frictional stir welding on mild steel. Basu et al [2002] used submerged arc welding on high strength structural steels. He studied the variations of bead morphology and microstructure under iso-heat input conditions. Zhang et al [2000] focused on the microstructures and properties of 6061 aluminium alloy weldments using double sided arc welding. Malin developed modified refractory flux for single side welding and discussed the effects of joint geometry on root welds [2001a]. Jang et al discussed only the effect of root opening on mechanical properties, deformations and residual stresses using finite element method [2001].

All the above mentioned studies certainly contributed substantially towards better understanding of welding processes; however they primarily dealt with only conventional welding processes of SAW, FSW, GMAW, SMAW etc. Very few literatures are available focusing