



Magnetically Impelled Arc Butt Welding of alloy steel tubes in boilers – Establishment of parameter window

S. Arungalai Vendan^{a,*}, S. Manoharan^b, G. Buvanashekaran^b, C. Nagamani^a

^a Department of Electrical and Electronics Engineering, National Institute of Technology, Tiruchirappalli 620 015, India

^b Welding Research Institute, BHEL, Tiruchirappalli 620 014, India

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ABSTRACT

Magnetically Impelled Arc Butt Welding (MIAB) is a hybrid solid-state welding process suitable for butt joining hollow cylindrical sections such as pipes and tubes. This process uses an rotating electric arc for heating the extremes of two tubes, which is impelled due to the electromagnetic force created by the interaction of arc current and magnetic field generated by external magnetic system. This paper presents the attempts made to design and develop a laboratory MIAB welding module operated pneumatically to realize the principle of the process. Trials are conducted with alloy steel tubes (48 mm diameter and 6 mm thickness) by varying the various input parameters and subsequently recording the observations. Based on the basic understanding of the process and its parameters, a pivotal attempt is undertaken to weld alloy steel tubes of boilers with specially made MIAB welding equipment (MD1). Investigations are carried out on MIAB welding machine (MD1) after preliminary experimentation to understand the basic mechanisms involved in MIAB welding process. The experimental procedure involves a series of trials to develop and evaluate the knowledge base for MIAB welding alloy steel tubes. Based on the penetration and bead of the weld (observed through visual inspection), the appropriate ranges of various input process parameters identified are presented.

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1. Introduction

Magnetically Impelled Arc Butt Welding (MIAB) is a advanced welding process which is an alternative to the conventional welding process such as friction, flash, resistance and butt welding.

MIAB welding is a solid-state welding process for tubes and pipes in which heat is generated prior to forging by an electric arc moving along the peripheral edges of the weldments with the aid of an external magnetic field. The schematic diagram depicting the principle of MIAB welding process is shown in Fig. 1.

Two tubes to be welded are clamped with proper alignment. The magnetic systems incorporated in the MIAB welding module produce magnetic flux in the arc gap. The radial component of the magnetic flux density B_r and the axial component of the welding arc current I_a interact with each other leading to the generation of an electromagnetic force which impels the arc along the peripheral edges of the tubes.

MIAB has been reported in the literature as early as 1974. From the available literature the work carried out previously by the researchers on MIAB welding discussed in brief.

Tagaki et al. [1] report the development of rotating arc welding equipment suited for application to town gas pipelines. In this

study, it has been proved that welds of high quality and reliability can be obtained along with high efficiency and that the welding equipment can be used very effectively in pipeline laying. Schlebeck [2] reported the welding with a magnetically moved arc (MBL welding). The technical state of development of MBL-P welding (welding with magnetically moved arc with pressure force), machines and power sources for MBL-P welding quality of the MBL-P weld joints are high lighted. Loebner [3] discussed about the magnet arc welding theory and practice. The historical background on MIAB welding process and the emphasis on the development, establishment of the process laid on the previous literatures are presented. Edson [4] puts forward the idea of incorporating MIAB welding for thick wall tubes. This paper revealed the limitations of MIAB welding process when applied on thick walled tubes and suggested solutions to overcome those drawbacks. Mori and Yasuda [5] describes the MIAB welding process developed for welding non-ferrous metals such as aluminum and copper. Arungalai Vendan et al. [6] reported a two and three dimensional finite element model for the analysis of magnetic flux density distributions in the MIAB welding process. Further, the same group [7] has discussed the attempts made to develop a MAIB welding laboratory equipment for understanding the significance of various process parameters.

Although studies [1–7] had reported MIAB welding, there are no reports pertaining to development or employment of specially

* Corresponding author. Tel.: +91 9994748264.

E-mail address: arungalaisv@yahoo.co.in (S.A. Vendan).