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ZAGAZIG UNIVERSITY
SHOUBRA FACULITY OF ENGINEERING

ASSESSMENT OF MECHANICAL PROPERTIES OF WELDED JOINTS OF DISSIMILAR METALS USING STAINLESS STEELS AND CARBON STEELS.

A THESIS

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ABSTRACT

The purpose of this work is to evaluate the microstructure and mechanical properties of dissimilar weld joints, using austentic stainless steel electrodes types E308L& E309L, to join C-Mn Steel type 17MN4, DIN 17155. This steel is used in nuclear industries as a boiler tubes plates. Also, a ferritic steel electrode type AWS E7018 has been used in order to compare similar and dissimilar weld joints. Welding of specimens was conducted using shielded metal arc welding process (SMAW).

Tensile and Charpy-V impact properties were determined at ambient temperature for the weld joints in the as-welded condition and after aging at 580^0Cfor 2, 10, 50 and 100hours. Also were measured the ferrite number of weld deposits for E308 and E309 in the as-welded condition. In addition, Vickeres microhardness profiles across the fusion line were measured in as-welded condition, and for 2hr and 100hr at 580^0C. Optical and scanning electron microscopy were used to characterize the microstructure and fracture surface morphology. The results showed that the C-Mn Steel is very sensitive for stress relief and care should be taken to select the proper time of PWHT. Acicular ferrite which is the predominant structure of the 7018 weld metal exhibited higher impact energy after 2hrs PWHT. The tendency of martensite formation at the fusion line between HAZ and weld Metal is higher in E308 than in E309. In addition, long period of PWHT at 580^0C showed that the E309L weld metal is susceptible to form higher carbides than the E308L.

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CHAPTER 1

INTRODUCTION

Dissimilar metal joints are widely used in many applications in nuclear engineering, chemical, petrochemical, and fossil-fired power plants. This type is also used for superheated, reheated tubes, headers, and hot reheat steam pipes. However, the elevated temperature usually makes austenitic stainless steel the necessary choice. The application of the dissimilar metal joints is not only to satisfy the different requirements of various condition, such as heat resistance, and corrosion resistance, but may also to save of novel and expensive materials, used in some application. There are even cases for which there is no choice other than to join dissimilar metals is usually more complex than joining of dissimilar metals together in a single product for meet the design requirements. Welding of dissimilar metals is usually more complex than joining of similar metals. In addition, dissimilar metal weldments are characterized by compositional gradients and microstructure changes, which produce large variation in physical, and mechanical properties across the weldment.

When welding austentic-ferritic dissimilar steel joints, the major problems encountered are:

1-Due to different in the chemical composition of base metal and filler metal, their alloying elements will diffuse intensily during welding. The structures near the fusion line are very complex. A hard martensite layer will be formed at the weld interface, which could cause the heterogeneity of mechanical properties of the joints.

2-The mismatch of physical properties, such as the heat transfer coefficient and the thermal expansion coefficient, could induce thermal stresses at the weld interface.

3-Dilution of the weld metal, carbon migration near the fusion lines, formation of martensitic transition zone across the fusion line between the weld metal and the ferritic steel.

4-When the joints are used at elevated temperature, carbonized and decarbonized zones will occurs, which could affect the high temperature properties.

In the present work these previous problems of the dissimilar, similar metal welds using the simple welding technique (SMAW) have been investigated. The mechanical properties and microstructure of dissimilar and similar metal welds for stainless steel electrodes E308, E309, and ferritic steels electrode E7018 to welded carbon manganese steels have been studied.

The present work contains 6 chapters, introduction, literature survey, experimental, results, discussions, and conclusions.

CHAPTER 2

LITERATURE SURVEY

2-1 General

2-1-1 Carbon Manganese Steel

Carbon manganese steel is a term applied for steel containing up to 1.70-% max. carbon, 2% manganese and 0.60% max. silicon. The carbon range for most of the structural grades of steel is 0.15-0.29 %C (mild steel) with Mn up to 1.65%. As rolled plates of this steel provide yield strengths in the range of (256-462MPa), and are defined in appropriate ASTM specifications (such as ASTM A36, A441 and A572). Steel in this carbon range can also be furnished in the heat-treated condition to provide yield strengths up to 710 MPa along with excellent notch toughness [1]. These steels are generally produced as plates with arc welding being the primary method of fabrication. Manganese is added to all commercial steels in the range of 0.025 to 1.00 percent to deoxidize it and combine with the sulfur present in the steel to produce manganese sulfide (MnS) which exists as soft gray inclusions in the steel. The MnS inclusions are scattered at the grain boundaries and are elongated in the direction of working. MnS is preferable to iron sulfide (FeS) in the steel since (FeS) is a brittle, low-melting temperature compound which forms at grain boundaries. The effect of manganese in strengthening plain-carbon steels can be divided into the following three parts: solid-solution hardening, grains size