THE Effect Of Current On Characteristic For Welded Joint Between 316 And 316L Stainless Steel Including Microstructure And Mechanical Properties

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A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Materials Engineering)

Faculty of Mechanical Engineering
Universiti Teknologi Malaysia

JANUARY 2014

TO MY BELOVED PARENTS FOR

THEIR ENDLESS LOVE AND SUPPORT

ACKNOWLEDGEMENT

Firstly, I am thankful to God for completing this master project report successfully. This project could not be written without the help of my supervisor, Dr. Norizah Bt Hj. Redzuan and my co supervisor Dr. Norhayati Ahmad who encouraged and challenged me through my academic program.

I would like to express my special gratitude to my parents, my brother, my brother-in-law and my sister. Without all of you, I will not be able to stand where I am today.

Thanks to my friends for their help and view at various occasions. In addition, I would like to express my appreciation to those who have given me either direct or indirect assistance in this project.

Eventually, I hope that this report will be advantageous in future.

ABSTRACT

Arc welding is a method that is widely used for fixed joining process. TIG is most commonly used to weld thin sections of stainless steel and light metals such as aluminum, magnesium, and copper alloys. The process grants the operator greater control over the weld than competing procedures. For this study, the influences of parameters of tungsten inert gas arc welding on the morphology, microstructure, hardness and tensile property, and fracture of welded joints of two kind of material including 316 stainless steel pipe and 316L stainless steel plate have been studied. Results show that the increase of welding current bring about the large amount of heat input in the welding pool, the enlargement of width and deepness of the welding pool, cumulative sigma phase in the matrix of both materials and reducing the chromium carbide percentage in 316 stainless steel welded joint. Arc current of 100A has also been identified as the most suitable arc current used to weld the two and half inches 316 stainless steel pipe. Since it gives the lowest defects and brings the highest value of hardness compared to others. For welding 316L stainless steel plate joint, the most suitable current was identified by 110A since it give the lowest defects and highest value of tensile strength compared to others. However, the value of Hardness is slightly lower than130A.

ABSTRAK

Kimpalan Arc adalah kaedah yang digunakan secara meluas untuk tetap proses penyambungan . TIG adalah yang paling biasa digunakan untuk mengimpal bahagian nipis daripada keluli tahan karat dan logam ringan seperti aluminium, magnesium, dan aloi tembaga. Proses ini memberi pengendali kawalan yang lebih besar ke atas kimpalan daripada prosedur yang bersaing. Untuk kajian ini, Pengaruh parameter tungsten lengai kimpalan arka gas morfologi , struktur mikro , harta tanah tegangan dan patah sendi dikimpal daripada dua jenis bahan termasuk 316 paip keluli tahan karat dan 316L plat keluli tahan karat telah dikaji. Keputusan menunjukkan peningkatan kimpalan membawa semasa kira-kira jumlah yang besar input haba dalam kolam kimpalan, pembesaran lebar dan deepness kolam kimpalan, sigma fasa terkumpul dalam matriks kedua-dua bahan dan mengurangkan peratusan karbida dalam 316 keluli tahan karat bersama dikimpal. Arc semasa 100A juga telah dikenal pasti sebagai semasa arka yang paling sesuai digunakan untuk mengimpal dua setengah inci 316 paip keluli tahan karat. Sejak ia memberikan kecacatan paling rendah dan membawa nilai tertinggi kekerasan berbanding dengan orang lain . Untuk kimpalan keluli tahan karat 316L plat bersama, semasa yang paling sesuai telah dikenal pasti oleh 110A kerana ia memberi kecacatan paling rendah dan nilai tertinggi kekuatan tegangan berbanding dengan orang lain . Walau bagaimanapun , nilai kekerasan adalah than130A rendah sedikit.

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GMAW	GAS metal arc welding
GTAW	Gas tungsten arc welding
MIG	Metal inert gas
UTS	Ultimate tensile strength
TIG	Tungsten inert gas
SMAW	Shielded metal arc welding
SS	Stainless steel
WPS	Welding Procedure Specifications

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Welded components and structures are widely used in almost all industries. Current engineering industry relies heavily on welded components and structures. Therefore, weld integrity becomes important for adequate and reliable performance of components, structures, and plants. Weld integrity is dependent on the base material, specifications, and welding processes. With the ever-increasing sophistication of processes, materials, and specifications, one must have a broad, comprehensive knowledge of the metallurgy and welding processes. Tungsten Arc Welding (GTAW) also known as Tungsten Inner Gas (TIG) involves striking an arc between a non-consumable tungsten electrode and the work piece. The weld pool and the electrode are protected by an inert gas, usually argon, supplied through a gas cup at the end of the welding gun, in which the electrode is centrally positioned. TIG welding can also be used for welding with filler material, which is applied in rod form by hand similar to gas welding. Tools for mechanized TIG welding are used for applications such as joining pipes and welding tubes into the end plates of heat exchangers. Such automatic welding tools can incorporate many advanced features, including mechanized supply of filler wire. The advantages of the process are stable arc and excellent control of the welding result. The main application for TIG welding is welding of stainless steel, welding of light metals, such as aluminum and magnesium alloys, and the welding of copper. It is also suitable for welding all weldable materials, apart from lead and zinc, with all types of joints and in all welding positions.

However, TIG welding is best suited to thin materials, from about 0.5 mm up to about 3 mm thick. (For more thickness must use multi passes welding) (Blondeau, 2013; Storjohann *et al.*, 2005).

Austenitic stainless steel type 316 is an austenitic chromium nickel stainless steel containing molybdenum. This addition of Mo increases general corrosion resistance, improves resistance to pitting from chloride ion solutions, and provides increased strength at elevated temperatures. Type 316L is an extra-low carbon version of type 316 that minimizes harmful carbide precipitation due to welding. Typical uses include exhaust manifolds, furnace parts, heat exchangers, jet engine parts, pharmaceutical and photographic equipment, digesters, tanks and parts exposed to marine atmospheres. This type is used extensively for weldments where its immunity to carbide precipitation due to welding assures optimum corrosion resistance. The weld microstructure of this alloy is mainly composed of delta ferrite and austenite as a dominant phase(Silva *et al.*, 2009). It is well known that the cycle of rapid heating and cooling occurring during welding affects the microstructure, mechanical properties and surface composition of welds (Yong, A, 2009).

The influences of parameters of tungsten inert gas (TIG) arc welding, such as welding current, welding speed, impulse frequency, weld remelting number and grooves are so important on the morphology, microstructure, tensile property and fracture of welded joints of 316 and 316L stainless steel. Arc current as a one of welding parameters plays an important role on morphology and mechanical properties of welded joint (Blondeau, 2013).

1.2 Problem statement

Welding current of tungsten inert gas (TIG) arc welding effects on the morphology, microstructure, tensile property and fracture of welded joints of austenite stainless steel due to heat input, optimized processing Arc current are significant , which provide experimental guidance for the application of stainless steel (Juncai, 2007; Wang *et al.*, 2011).

At present, there exist some processing problems, which affect the quality and property of welded joint, in the welding of grade 316 and 316L structural components. The problems like hot cracking, carbide precipitation phase and sigma phase can reduce significantly the mechanical property of this welded joint. Therefore, selection suitable welding parameters (arc current) and proper material is so important to control the mentioned problems (Lothongkum *et al.*, 2001; Minghui, 2006; Zhang *et al.*, 2005).

Therefore, that needs to find the optimization current as a one of welding parameters for TIG welding on 316L stainless steel to reduce welding effect and to achieve best mechanical properties.

1.3 Research objective

To investigate the effect of current on characteristic for welded joint between 316 and 316L stainless steel: microstructure and mechanical properties.

1.4 Scope of the study

The scopes of this research consist of:

- Literature review on the 316L and 316 stainless steel.
- Literature review on TIG welding principle and the welding parameters of the method chosen.
- Perform TIG welding on 316L stainless steel plate 316 stainless steel pipe with different Arc current as a variable value.
- Specimen preparation.
- Microstructure and metallurgical fractography analysis of welded 316L stainless steel plate 316 stainless steel pipe stainless steel by using Optical, XRD, FESEM-EDX and SEM microscopes.

- The mechanical properties test conducted are tensile and Vickers hardness tests.
- Evaluate the effect of Arc current shift and type of material on welded 316L stainless steel plate and welded 316 stainless steel pipe in terms of microstructure and mechanical properties of the welded joints.

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