UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Mechanical Engineering

INVESTIGATION OF MODIFIED SHIELDED METAL ARC WELDING (MOSMAW) FOR WELD PENETRATION PERFORMANCE

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INVESTIGATION OF MODIFIED SHIELDED METAL ARC WELDING (MOSMAW) FOR WELD PENETRATION PERFORMANCE

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A thesis submitted
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DECLARATION

I declare that this thesis entitle "Investigation of Modified Shielded Metal Arc Welding (MOSMAW) for Welding Penetration Performance" is the result of my own research except as cited in the references. This thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……………………………..….

Name : MANIMARAN A/L SELVAM

Date : 1st October 2017

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Mechanical Engineering.

Signature	: …………………………………….
Supervisor Name	: …………………………………….
Date	: …………………………………….

DEDICATION

To my beloved Mother Lecthumy Monian , Father Selvam Gangan and my Wife Thevimalar

ABSTRACT

This study is about an investigation of modified shielded metal arc welding (MOSMAW) with tubular welding electrode. The existing shielded metal arc welding process (SMAW) was modified into MOSMAW to investigate the weld ability and performance of tubular welding electrode. In the preliminary investigation it was found that heat content and interaction of Helium (He) produced a deeper penetration depth (*PD*) and penetration area (*PA*) as compared with Argon gas (AR) with gas volume flow rate range (0 -2.5 L/min). Secondly from the weld microstructure investigation it was found that there were four weld phases that include ferrite (α) , pearlite (*P*) , widmanstatten ferrite (α_w) and the acicular ferrite (α_a) on three types of flux covered electrode (E6010,E6013 and E7018). Meanwhile hardness range was evident on the weld regions within the SMAW process. Based on , the nondestructive testing, PT and RT method the impact of moisture effect was found with the usage of E7018 tubular electrode which had weld surface defects compared to the use of E6013 tubular electrode. As for the tensile tests, E7018 had higher ultimate tensile strength (UTS) compared to E6013 electrode. The fracture mode found was ductile fracture and the guided bend test found E6013 and E7018 with fed orifice gases to have uniform face bend without the initiation of any crack. As for the weld region element analysis it was found that it had the usual element composition of carbon steel and electrode flux material in weld metal, HAZ and base metal. Moreover, the weld arc temperature measurement in the MOSMAW process with E6013 with Helium fed gases produced higher arc temperature compared to the process without gas provision. The DOE results indicated that the weld variables welding current (*I*), electrode travel speed (*S*), electrode travel feed rate (*F*) and volume flow rate (*Q*) interacted significantly with the responses bead width *W*, penetration depth *PD*, penetration area *PA* and dilution *%D*. Further investigation on the DOE samples of weld penetration depth (*PD*) and penetration area (*PA*) indicated that the interaction were proportional to welding current (*I*) and volume flow rate (*Q*).The micro hardness test result hardness rate region was found to be within the SMAW carbon steel hardness range.

ABSTRAK

Kajian ini adalah mengenai penyiasatan kimpalan arka logam yang dikenali sebagai (MOSMAW) yang diubahsuai dengan menggunakan elektrod kimpalan jenis tubular. Kaedah kimpalan arka logam yang sedia ada dikenali sebagai (SMAW) telah diubahsuai ke MOSMAW untuk menyiasat keupayaan kimpalan dan prestasi elektrod kimpalan tubular. Dalam penyiasatan awal mendapati kandungan haba dan interaksi gas Helium (He) menghasilkan kedalaman penembusan yang lebih mendalam (PD) dan keluasan penembusan (PA) berbanding dengan gas Argon (AR) pada kadar isipadu gas antara (0 - 2.5 L / min). Lain daripada itu , pada penyiasatan mikrostruktur mendapati terdapat empat fasa struktur iaitu ferrite (α), pearlite (P), widmanstatten ferrite (α_w) dan acicular ferrite (α_a) pada elektrod fluks bersalut (E6010, E6013 dan E7018). Seterusnya,bagi keputusan ujian kekerasan mendapati tahap kekerasan pada fasa kimpalan memadahi dengan tahap kekerasan SMAW . Sementara itu , keputusan ujian tanpa musnah dengan kaedah PT and RT mendapati faktor kelembapan pada elektrod besalut E7018 menghasilkan kecacatan pada permukaan kimpalan berbanding dengan penggunaan elektrod besalut E6013.Seterusnya , bagi ujian tegangan mendapati electrode E7018 mempunyai kekuatan tegangan yang lebih tinggi (UTS) berbanding dengan elektrod E6013. Dalam pada itu , semasa ujian tegangan mendapati kesemua sampel ujikaji patah mengikut mod patah mulur. Manakala pada ujian kelenturan mendapati untuk elektrod bersalut E6013 dan E7018 lentur pada muka kimpalan tanpa sebarang keretakan pada permukaan kimpalan. Selain itu, bagi analisa elemen pada fasa kimpalan mendapati kesemua komposisi kimpalan memadahi komposisi elemen pada kawasan keluli kimpalan , HAZ dan karbon keluli asas .Lain daripada itu , untuk ujian pengukuran suhu pada kimpalan MOSMAW dengan elektrod E6013 dan E7018 mendapati proses MOSMAW dengan saluran gas Helium menghasilkan suhu arka tertinggi berbanding dengan kimpalan MOSMAW tanpa saluran gas. Pada ujian DOE mendapati mendapati pembolehubah kimpalan seperti arus elektrik (I) , kelajuan pergerakan elektrod (S), kadar pergerakan elektrod (F) dan kadar aliran isipadu gas (Q) berinteraksi dengan ketara dengan nilai R^2 pada lebar kimpalan (W) , kedalaman penembusan kimpalan (PD), keluasan penembusan (PA) dan kesebatian kimpalan (%D).Keputusan ujian lanjutan DOE mendapati pemboleh ubah kedalaman penembusan kimpalan (PD) dan keluasan penembusan (PA)berinteraksi berkala pada pemboleh ubah arus elektrik (I) and kadar aliran isipadu gas (Q) . Akhir sekali , untuk ujian kekerasan pada permukaan kimpalan mendapati tahap kekerasan pada sampel pilihan memadahi dengan tahap kekerasan keluli karbon kimpalan SMAW.

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