

**UNIVERSITI MALAYSIA PAHANG**

**BORANG PENGESAHAN STATUS TESIS\***

**JUDUL:** INVESTIGATION OF HEAT TREATMENT ON WELD  
JOINT OF STEEL AND ALUMINUM  
**SESI PENGAJIAN:** 2011/2012

Saya AIDA SYAMSIAH BINTI MOHD YUSOF (880229065768)  
(HURUF BESAR)

mengaku membenarkan tesis (Sarjana Muda/Sarjana /Doktor Falsafah)\* ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hak milik Universiti Malaysia Pahang (UMP).
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. \*\*Sila tandakan ( ✓ )

**SULIT**

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

**TERHAD**

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

**TIDAK TERHAD**

Disahkan oleh:

\_\_\_\_\_  
(TANDATANGAN PENULIS)

\_\_\_\_\_  
(TANDATANGAN PENYELIA)

Alamat Tetap:

NO 16 LORONG TMJ 7,  
TAMAN MARAN JAYA, 26500  
MARAN PAHANG

LUQMAN HAKIM B.AHMAD SHAH  
(Nama Penyelia)

Tarikh: 25 JUNE 2012

Tarikh: : 25 JUNE 2012

- CATATAN: \* Potong yang tidak berkenaan.  
 \*\* Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh tesis ini perlu dikelaskan sebagai atau TERHAD.  
 ♦ Tesis dimaksudkan sebagai tesis bagi Ijazah doktor Falsafah dan Sarjana secara Penyelidikan, atau disertasi bagi pengajian secara kerja kursus dan

INVESTIGATION OF HEAT TREATMENT ON WELD JOINT OF STEEL AND  
ALUMINUM

AIDA SYAMSIAH BINTI MOHD YUSOF

Report submitted in partial fulfillment of the requirements for the award  
of Bachelor of Mechanical Engineering with Manufacturing Engineering

Faculty Of Mechanical Engineering  
UNIVERSITI MALAYSIA PAHANG

JUNE 2012

“I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor Degree of Electrical Engineering (Power System)”

Signature : \_\_\_\_\_

Name : LUQMAN HAKIM BIN AHMAD SHAH

Date : 25 JUNE 2012

“All the trademark and copyrights use herein are property of their respective owner. References of information from other sources are quoted accordingly; otherwise the information presented in this report is solely work of the author.”

Signature : \_\_\_\_\_

Author : AIDA SYAMSIAH BINTI MOHD YUSOF

Date : 25 JUNE 2012

## TABLE OF CONTENT

	<b>Page</b>
<b>SUPERVISOR'S DECLARATION</b>	ii
<b>STUDENT'S DECLARATION</b>	iii
<b>ACKNOWLEDGEMENTS</b>	iv
<b>ABSTRACT</b>	v
<b>ABSTRAK</b>	vi
<b>TABLE OF CONTENTS</b>	vii
<b>LIST OF TABLES</b>	x
<b>LIST OF FIGURES</b>	xi
<b>LIST OF SYMBOLS</b>	xiii
<b>LIST OF ABBREVIATIONS</b>	xiv

### **CHAPTER 1        INTRODUCTION**

1.1	Background	1
1.2	Problem Statement	1
1.3	Objective	2
1.4	Scope	2

### **CHAPTER 2        LITERATURE REVIEW**

2.1	Introduction	3
2.2	Welding	3
2.3	Tungsten inert gas (TIG) welding	5
2.3.1	GTAW welding torch	6
2.3.2	Zirconium Tungsten Electrode, EWZr	7
2.4	Welding Method	8
2.4.1	History of TWBs	9

2.4.2 Benefits of Tailor Welded Blanks (TWBs)	10
2.4.2.1 Reduction of Final Car Weight	10
2.4.2.2 Reduction of Automobile Parts Number	11
2.4.2.3 Improved Raw Material Utilization and Reduction of Scrap.	12
2.5 Materials	12
2.5.1 Aluminum	12
2.5.2 Stainless Steel	13
2.5.3 Weldability of Steel- Aluminum	13
2.5.4 Preheating of Steel to Improve Weldability	15

## **CHAPTER 3            METHODOLOGY**

3.1 Introduction	16
3.2 Material Selection	16
3.2.1 Aluminum	16
3.2.2 Stainless Steel	18
3.3 Fabrication Process	18
3.3.1 Process Involve	19
3.3.1.1 Measuring and Cutting	19
3.3.1.2 Joining Process	20
3.4 Specimen's Mechanical Properties	21
3.4.1 Tensile Test	21
3.4.1.1 The Tensile Test	
Specimens Dimension	23
3.4.2 Hardness Test	23
3.5 Microstructure and Phase	
Composition analysis	24
3.5.1 Cold Mounting	24
3.5.2 Grinding	25

3.5.3	Polishing	26
3.5.4	Etching	27
3.5.5	Analysis of Microstructure	27
3.6	Flow Chart	28

## **CHAPTER 4 RESULT AND DISCUSSION**

4.1	Introduction	29
4.2	Result	
4.2.1	Appearance and macrostructure	29
	Group 1: Without preheating process	
	Group 2: With preheating process	
4.2.2	Microstructure of the welding joints	33
	Group 1: Without preheating process	
	Group 2: With preheating process	
4.2.3	Hardness distribution test	36
	Group 1: Without preheating process	
	Group 2: With preheating process	
4.2.4	Mechanical properties	38
	Group 1: Without preheating process	
	Group 2: With preheating process	

## **CHAPTER 5 CONCLUSION AND RECOMMENDATION**

5.1	Introduction	43
5.2	Conclusion	43
5.3	Recommendation	44
5.3.1	Cracks	44
5.3.2	Cold cracking	44
5.3.3	Pre-heating	45

<b>REFERENCES</b>	46
<b>APPENDIX</b>	

## LIST OF TABLES

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
1	Nominal chemical composition of aluminum wrought alloys	17
2	Mechanical properties of aluminum	17
3	Physical properties of aluminum alloy	17
4	Mechanical properties of stainless steel	18
5	Physical properties of stainless steel	18
6	Welding parameters without preheating temperature	21
7	Welding parameters with preheating temperature	21
8	Mechanical properties of specimen 85A	38
9	Mechanical properties of specimen 95A	39
10	Mechanical properties of specimen 85°C 85A	41
11	Mechanical properties of specimen 85°C 95A	42

## LIST OF FIGURES

<b>FIGURE</b>	<b>TITLE</b>	<b>PAGES</b>
1	Cross section of a typical fusion welded joint	4
2	Tungsten Inert Gas (TIG) Welding	5
3	Zirconium Tungsten, EWZr	7
4	Micro-geometrical parameters for seam assessment	8
5	The change of stamping procedure	9
6	The first application example of tailor welded blanks,(TWBs)	10
7	present application of tailor welded blanks, (TWBs)	10
8	Exploded view of current or potential tailor welded blanks body component	11
9	Appearances of the joint with different base metal	14
10	The cross-section of lap joint	14
11	Shearing machine	18
12	TIG welding machine and process	20
13	Tensile test machine	22
14	Geometry of rectangular tensile test specimens (ASTM D1002)	23
15	Vickers hardness test machine	24
16	Cold mounting	25
17	Grinding machine	25
18	Polishing machine	26
19	(a) The solution for etching (b) fume hood	27
20	Optical microscope	27

21	Flowchart of overall methodology.	28
22	(Sample A) Cross section of welding for 65A	30
23	(Sample B) Cross section of welding for 85A	30
24	(Sample C) Cross section of welding for 95A	30
25	(Sample D) Cross section of welding for 85°C 65A	31
26	(Sample E) Cross section of welding for 85°C 85A	31
27	(Sample F) Cross section of welding for 85°C 95A	32
28	Dendrite structure of the weldament area for Group 1	33
29	Intermetallic compound structure of the HAZ area for Group 2	33
30	Dendrite structure of the weldament area for Group 1	34
31	Intermetallic compound structure of the HAZ area for Group 2	34
32	Hardness distribution for Group 1	36
33	Hardness distribution for Group 2	37
34	Graph of specimen 85A	38
35	Graph of specimen 95A	39
36	Graph of specimen 85°C 85A	40
37	Graph of specimen 85°C 95A	41

**LIST OF SYMBOLS**

$\varepsilon$	Strain
$\sigma_c$	Stress
A	Area
F	Force
Kg	Kilogramme
mm	millimeter
MPa	Mega Pascal
N	Newton
$l_0$	initial length
L	final length
HV	Vickers hardness
A	ampere
°C	Celsius