A Study on Welding Defects of Pressure Vessel

This report submitted in accordance with requirements of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Management) with Honours.

By

MOHD SHAH FAHMI BIN ZAINUDDIN

FACULTY OF MANUFACTURING ENGINEERING
2009
BORANG PENGESEHAN STATUS LAPORAN PSM

JUDUL: A STUDY ON WELDING DEFECTS OF PRESSURE VESSEL


Saya MOHD SHAH FAHMI BIN ZAINUDDIN

mengaku membenarkan tesis (PSM/Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. *Sila tandakan (✓)

☐ SULIT (Mengandungi maklumat yang berdasar keselamatan atau kepentingan Malaysia yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐ TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
✓ TIDAK TERHAD

(TANDATANGAN PENULIS)

Alamat Tetap:
NO 8 JALAN BELANGKAS,
55100 KAMPUNG PANDAN,
KUALA LUMPUR.

Tarikh: 21/5/09

(TANDATANGAN PENYELIA)

Cop Rasm:
NIK MOHD FARID BIN CHE ZAINAL ABIDIN
Pensyarah
Fakulti Kejururan Pembuatan
Universiti Teknikal Malaysia Melaka

Tarikh: 21/5/09

* Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.
DECLARATION

I hereby, declare this thesis entitled “A Study on Welding Defects of Pressure Vessel.” is the result of my own research except as cited in references.

Signature : ...........................................
Author’s Name : Mohd Shah Fahmi Bin Zainuddin
Date : 21/5/2009
 APPROVAL  

This Bachelor’s report submitted to the senate of UTeM and has been accepted as fulfillment of the requirement for the Degree of Bachelor of Manufacturing Engineering major in Manufacturing Management with honors. The member of the supervisory committee is as follow:

[Signature]

Mr. Nik Mohd Farid Bin Che Zainal Abidin  
Project Supervisor  
Faculty of Manufacturing Engineering
ABSTRACT

A pressure vessel is a closed container designed to hold gases or liquids at a pressure different from the ambient pressure. During the fabrication of pressure vessels, it has been discovered that a common problem that always occurs is at the welding joint. This problem occurs because the correct welding process is not used, and this then leads to welding defects. This project was carried out at UMW Advantech Sdn. Bhd as they are the fabricators of pressure vessels. It aims to identify the types of welding defects that occur during the welding process, to determine the type of welding inspection that should be conducted with regards to the fabrication of pressure vessels, and finally, to suggest counter measures and improvements to solve the welding defects of pressure vessels. The types of welding defects will be determined by conducting a welding inspection which consists of non destructive tests such as using a dye penetrant, magnetic particle inspection, ultrasonic testing, and radiographic testing.
Tangki tekanan adalah sebuah kontena yang tertutup direka untuk menampung gas atau cecair di satu tekanan berbeza daripada tekanan persekitaran. Semasa proses pembuatan tangki tekanan, ia telah meneemui beberapa masalah biasa yang sering berlaku adalah pada sendi kimpalan. Masalah ini berlaku kerana proses kimpalan yang digunakan adalah tidak betul dan tidak sesuai. Ini menyebabkan membawa kepada kecacatan pada bahagian kimpalan. Projek ini telah dijalankan di UMW Advantech Sdn Bhd dimana mereka sebagai pembuat tangki tekanan. Ia bertujuan untuk mengkaji jenis-jenis kecacatan kimpalan yang berlaku semasa proses kimpalan dialjalankan, untuk menentukan jenis pemeriksaan keatas kecacatan kimpalan, dan akhir sekali mencari jalan penyelesaian kepada masalah kecacatan kimpalan pada tangki tekanan. Setiap jenis kecacatan kimpalan akan dikaji menggunakan ujian tanpa musnah iaitu seperti penyembur penetrant, ujian zarah magnetik, ujian ultrasonik, dan ujian radiografik.
DEDICATION

For my beloved parents:
Mr. Hj. Zainuddin Bin Mohd Arshad
Mrs Hjh. Fuziah Bte Hj. Tahir

For my cherished sibling
Mohd Shukran Bin Hj. Zainuddin

And my treasured friends
UTeM’s students
ACKNOWLEDGEMENT

All Praise to Allah, the Lord of the Worlds, and prayers and peace be upon Muhammad Rasulullah S.A.W, His servant and Messenger. Alhamdulillah, with Allah blessings and guidance, I have completed this project successfully even though along the way, there are many hardship and obstacles.

First of all, I would like to thank to our Faculty of Manufacturing Engineering Dean, Dr. Mohd Rizal Bin Salleh. I am grateful to my punctilious and highly devoted supervisor Mr Nik Mohd Farid Bin Che Zainal Abidin for excellent supervision and for providing for vision, knowledge and guidance throughout this work. Secondly, not to forget both my parents who always pray for my success all the time particularly during difficult times while carrying out this project.

Finally, I would like to thank all individuals who had given me both technical and spiritual support to make this project a success. May all our good deeds and tranquil be worth for our self development, society and the country.

Mohd Shah Fahmi Bin Zainuddin
TABLE OF CONTENTS

Declaration ii
Approval iii
Abstract iv
Abstrak v
Dedication vi
Acknowledgement vii
Table of Contents viii
List of Figures xiii
List of Tables xvi
List of Abbreviations xvii

1.0 INTRODUCTION 1
1.1 Pressure vessel Background 1
1.2 Company Background 2
1.3 Problem Statement 3
1.4 Objective 4
1.5 Scope 4
1.6 Outline of Report 4

2.0 LITERATURE REVIEW 7
2.1 Pressure vessel 7
2.2 Type of pressure vessel 9
2.2.1 Fired Pressure Vessel 9
2.2.2 Unfired Pressure Vessel 9
2.3 Component Part of Pressure Vessel 10
2.4 Welding 13
2.5 Type of Welding 15
2.5.1 Fusion Welding 15
2.5.1.2 Arc Welding 15
2.5.1.3 Fluxed-Core Arc-Welding 16
2.5.1.4 Gas Metal-Arc Welding 17
2.5.1.5 Gas Tungsten-Arc Welding
2.5.1.6 Shielded-Metal Arc Welding
2.5.1.7 Submerged Arc Welding
2.5.2 Pressure Welding (PW)
2.5.2.2 Resistance Welding (RW)
   (a) Spot Welding
   (b) Projection Welding
   (c) Seam Welding
   (i) Simple lap seam weld
   (ii) Mash seam weld
   (iii) Finish seam welding
   (iv) Butt Welding
2.5.2.3 Flash Welding (FW)
2.5.2.4 Cold Welding (CW)
2.6 Type of Welding Test
2.6.1 Non Destructive Test for Pressure Vessel
   2.6.1.2 Liquid Penetrant (PT)
   2.6.1.3 Magnetic Particle Test (MT)
   2.6.1.4 Radiography Test (RT)
   2.6.1.5 Ultrasonic Test (UT)
2.6.2 Advantages and Disadvantages of Non Destructive Test
   2.6.2.2 Advantages
   2.6.2.3 Disadvantage
2.6.3 Destructive test for Pressure Vessel (DT)
   2.6.3.1 Free-Bend Test
   2.6.3.2 Guided-Bend Test
   2.6.3.3 Impact Test
   2.6.3.4 Fillet-Welded Joint Test
   2.6.3.5 Tensile Strength Test
2.7 Advantages and Disadvantages of Destructive Test
   2.7.1 Advantages
   2.7.2 Disadvantages
2.8 Type of Welding Joint
2.9 Type of Welding Position
2.9.1 Horizontal Position Welding 44
2.9.2 Vertical Position Welding 45
2.9.3 Overhead Position Welding 46
2.10 Welding Defects 47
  2.10.1 Type of Welding Defects 47
    2.10.1.1 Porosity 48
    2.10.1.2 Slag Inclusions 49
    2.10.1.3 Lamellar Tearing 50
    2.10.1.4 Lack of Fusion 50
    2.10.1.5 Incomplete Penetration 51
    2.10.1.6 Undercutting 52
2.11 Example Previous Case Study on Welding Defects 53
  2.11.1 Horizontal Shell Boilers 53
  2.11.2 Chemical Reactor Vessel 54
2.12 Summary 54

3.0 METHODOLOGY 55
3.1 Process Flow Diagram 55
3.2 Research Methodology 59
  3.2.1 Primary Data 59
    3.2.1.1 Observation 59
    3.2.1.2 Data Collection 59
    3.2.1.3 Understanding the Nature of the Process 60
    3.2.1.4 Interviews and Discussion 60
    3.2.1.5 Site Visit 60
  3.2.2 Secondary Data 61
    3.2.2.1 Books 61
    3.2.2.2 Journals 61
3.3 Gantt chart 61
3.4 Phase of the Project 62
  3.4.1 Identification Type and Function of Pressure Vessel and Welding Processes 62
  3.4.2 Study on Fabrication of Pressure Vessel 62
  3.4.3 Identify the Welding Defect Using Non Destructive Test 64
3.4.4 Identify the Problem that Causes Welding Defects 64
3.4.5 Study the Welding Defects at Every Welding Joint of Pressure Vessel 64
3.4.6 Counter Measure and Improvement 64
3.5 Summary 64

4.0  FABRICATION OF PRESSURE VESSEL AT UMW ADVANTECH SDN. BHD. 65
4.1 Organization Background 65
4.2 Introduction to the Pressure Vessel Project in UMW Advantech Sdn. Bhd. 69
  4.2.1 The Type Pressure Vessel of UMW Advantech Sdn. Bhd. 69
4.3 Type of Welding Used in Fabrication 71
4.4 Type of Welding Inspection 71
4.5 Summary 71

5.0  RESULT AND ANALYSIS 72
5.1 Inspection Using the Liquid Penetrant Testing 72
  5.1.1 Result 73
  5.1.2 Analysis 73
5.2 Inspection Using the Magnetic Particle Testing 75
  5.2.1 Result 75
  5.2.2 Analysis 78
5.3 Inspection Using the Ultrasonic Testing 78
  5.3.1 Result 78
  5.3.2 Analysis 85
5.4 Inspection Using the Radiographic Testing 85
  5.4.1 Result 86
  5.4.2 Analysis 90
5.5 Summary 90

6.0  DISCUSSION 91
6.1 Evaluation of Non Destructive Test 91
  6.1.1 Evaluation of Liquid Penetrant Testing 92
  6.1.2 Evaluation of Magnetic Particle Testing 92
  6.1.3 Evaluation of Ultrasonic Testing 93
6.1.4 Evaluation of Radiographic Testing 93
6.3 Weldability 93
6.2 Summary 94

7.0 RECOMMENDATION AND IMPROVEMENT 95
7.1 Welding Preparation 95
7.2 Duties of a Welding Inspector 96
7.3 Welding Defect Prevention 98
7.4 Summary 100

8.0 CONCLUSION 101
8.1 Conclusion 101
8.2 Future Study Recommendation 102

REFERENCES 103

APPENDICES 105
Appendix A: Gantt chart of The Project
Appendix B: Dye penetrant examination report
Appendix C: Magnetic particle testing examination report
Appendix D: Ultrasonic testing examination report
Appendix E: Radiographic testing examination report
### LIST OF FIGURES

1.1 Shows a schematic diagram of a pressure vessel 2

2.1 Steam Boilers 9
2.2 Air Receiver Tank Example of Free Bend Test 10
2.3 Pressure Vessel Component Part 12
2.4 Schematics Illustration of the Flux-Cored Arc-Welding 17
2.5 Gas Metal-Arc Welding Process and Basic Equipment Used in Welding Operations Example of Guided-Bend Test 18
2.6 Gas Metal-Arc Welding Process and Basic Equipment Used in Welding Operations Example of Impact Test 20
2.7 Shielded Metal-Arc Welding Process 21
2.8 Submerged-Arc Welding Process and Equipment 22
2.9 Sequence of Events in Resistance Spot Welding 25
2.10 Cross-Section of a Spot Welding 25
2.11 An Air-Operated Rocker-Arm Spot-Welding Machine 26
2.12 Schematic Illustration of Simple Lap Seam Weld 27
2.13 Schematic Illustration of Mash Seam Welding 28
2.14 Butt Welding 29
2.15 Cold Lap Welding 30
2.16 Liquid Penetrant Inspection 31
2.17 Remover 32
2.18 Penetrant 32
2.19 Developer 33
2.20 Magnetic Particles Inspection 34
2.21 Radiographic Testing 35
2.22 Ultrasonic Testing 36
2.23 Example of Free Bend Test 38
2.24 Example of Guided-Bend Test 39
2.25 Example of Impact Test 40
2.26 Example of Fillet Welded Joint Test 40
2.27 Example of Tensile Strength Test
2.28 Example of Horizontal Position Welding
2.29 Example of Bead Welding in the Vertical Position
2.30 Example of Position of Electrode and Weave Motion in the Overhead Position
2.31 Example of Porosity
2.32 Example of Lack of Fusion
2.33 Example of Undercutting

3.1 Project Methodology
3.2 Process Flow Chart
3.3 Schematic Diagram of a Pressure Vessel with four Different Categories of Welds

4.1 UMW Advantech Site Layout
4.2 Company under UMW Corporation Sdn. Bhd.
4.3 Organisation Chart UMW Advantech Sdn. Bhd
4.4 Titan Petchem Pressure Vessel
4.5 Technotest Engineering Pressure Vessels
4.6 Calidad Pressure Vessels

5.1 Liquid Penetrant Testing Examination Report
5.2 Inspection at the platform bracket
5.3 Nozzle joint
5.4 Inspection at the Nozzle 1
5.5 Magnetic Particle Testing Examination Report
5.6 Ultrasonic Testing Examination Report 1
5.7 Defects Schematic Drawing 1 on Pressure Vessel
5.8 Ultrasonic Testing Examination Report 2
5.9 Defects Schematic Drawing 2 on Pressure Vessel
5.10 Ultrasonic Testing Examination Report 3
5.11 Defects Schematic Drawing 3 on Pressure Vessel
5.12 Radiographic Testing Examination Report 1
5.13 Radiographic Testing Examination Report 2
5.14 Radiographic Testing Examination Report 3 89

7.1 Grinding process 95
7.2 Preheat weldment area 97
LIST OF TABLES

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Pressure Vessel Component Part</td>
<td>10</td>
</tr>
<tr>
<td>2.2</td>
<td>Classification of Pressure Welding Process</td>
<td>13</td>
</tr>
<tr>
<td>2.3</td>
<td>Classification of Fusion Welding Process</td>
<td>14</td>
</tr>
<tr>
<td>2.4</td>
<td>Type of Welding Joints</td>
<td>42</td>
</tr>
</tbody>
</table>
## LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Ampere</td>
</tr>
<tr>
<td>AC</td>
<td>Alternating Current</td>
</tr>
<tr>
<td>API</td>
<td>American Petroleum Institute</td>
</tr>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
</tr>
<tr>
<td>CW</td>
<td>Cold Welding</td>
</tr>
<tr>
<td>DC</td>
<td>Directing Current</td>
</tr>
<tr>
<td>DT</td>
<td>Destructive Test</td>
</tr>
<tr>
<td>FCAW</td>
<td>Fluxed-Core Arc-Welding</td>
</tr>
<tr>
<td>FW</td>
<td>Flash Welding</td>
</tr>
<tr>
<td>GMAW</td>
<td>Gas Metal-Arc Welding</td>
</tr>
<tr>
<td>GTAW</td>
<td>Gas Tungsten-Arc Welding</td>
</tr>
<tr>
<td>JIS</td>
<td>Japanese Industrial Standard</td>
</tr>
<tr>
<td>kPa</td>
<td>Kilo Pascal</td>
</tr>
<tr>
<td>MMA</td>
<td>Manual Metal Arc Welding</td>
</tr>
<tr>
<td>MPa</td>
<td>Mega Pascal</td>
</tr>
<tr>
<td>MT</td>
<td>Magnetic Particle Test</td>
</tr>
<tr>
<td>NDT</td>
<td>Non Destructive Test</td>
</tr>
<tr>
<td>PED</td>
<td>Pressure Equipment Directive</td>
</tr>
<tr>
<td>Psig</td>
<td>Pounds per square inch gage</td>
</tr>
<tr>
<td>PT</td>
<td>Liquid Penetrant</td>
</tr>
<tr>
<td>PW</td>
<td>Pressure Welding</td>
</tr>
<tr>
<td>RT</td>
<td>Radiography Test</td>
</tr>
<tr>
<td>RW</td>
<td>Resistance Welding</td>
</tr>
<tr>
<td>SAW</td>
<td>Submerged Arc Welding</td>
</tr>
<tr>
<td>SMAW</td>
<td>Shielded-Metal Arc Welding</td>
</tr>
<tr>
<td>TIG</td>
<td>Tungsten Inert Gas</td>
</tr>
<tr>
<td>UT</td>
<td>Ultrasonic Test</td>
</tr>
<tr>
<td>V</td>
<td>Volt</td>
</tr>
</tbody>
</table>
CHAPTER 1
INTRODUCTION

This project aims to provide some improvements and suggestions on how to solve problems related to pressure vessel fabrication. This chapter defines the pressure vessel specifications and tests followed by the objectives and scope of study of the thesis. Furthermore, the methodology used will also be explained.

1.1 Pressure Vessel Background

A pressure vessel is a closed container designed to hold gases or liquids at a pressure different from the ambient pressure. This vessel is categorized as Unfired Pressure Vessel. The end caps fitted to the cylindrical body are called heads. In addition to industrial compressed air receivers and domestic hot water storage tanks, other examples of pressure vessels are diving cylinders, distillation towers, other vessels in mining or oil refineries and petrochemical plants, nuclear reactor vessels, pneumatic reservoirs, hydraulic reservoirs under pressure, storage vessels for liquefied gases such as ammonia, chlorine, propane, butane and LPG.

In the industrial sector, pressure vessels are designed to operate safely at a specific pressure and temperature technically referred to as the ‘Design Pressure’ and ‘Design Temperature’. A vessel that is inadequately designed to handle high pressures constitutes a very significant safety hazard. Because of that, the design and certification of pressure vessels is governed by design codes such as the ASME Boiler and Pressure Vessel Code in North America, the Pressure Equipment Directive of the EU (PED), and the Japanese Industrial Standard (JIS). From here, we can make comparisons between pressure vessel, boiler and tank. A boiler is a
closed vessel in which water or other fluids are heated. The heated or vaporised fluid exits the boiler for use in various processes or heating applications. This vessel is categorised as Fired Pressure Vessel. A boiler has:

1. Safety valve: used to relieve pressure and prevent possible explosion of a boiler.
2. Water level indicators: a water gauge or water column to show the operator the level of fluid in the boiler.
4. Surface blow down line.
5. Feed water check valve or clack valve: a non-return stop valve in the feed water line.

![Figure 1.1: Shows a schematic diagram of a pressure vessel](image)

1.2 Company background

The case study was conducted at UMW Advantech Sdn Bhd. It was incorporated in 1917 by Chia Yee Soh who is the founder of UMW Group. UMW Group’s main business activity ranges from automotive, heavy and industrial equipment,
manufacturing and engineering, automotive parts, and oil & gas. UMW Advantech Sdn Bhd is a wholly owned subsidiary of UMW Holdings Berhad. The company has two divisions, Auto Component and Specialty Equipment. Equipped with talents, state of the art design and comprehensive facilities and system, they provide innovative engineering solutions for Automotive, Oil & Gas, Petrochemical, Oleochemical, Environment Control and Transportation.

UMW Advantech Sdn Bhd was formerly known as UMW Engineering Sdn Bhd. The company has been ISO 9001:2000 certified since 2002. The company is also a registered member of ASME, U2 and R, for which R stands for the approval to repair welding works. The main customers of the company are Titan Petchem (M) Sdn Bhd and Calidad Sdn Bhd. The main product that UMW Advantech Sdn Bhd produces for the customer is the pressure vessel.

1.3 Problem statement

Nowadays, a pressure vessel is a closed container designed to hold gases or liquids at a different pressure from the surrounding pressure. Besides that, a pressure vessel is to operate safely at a specific pressure and temperature technically referred to as the ‘Design Pressure’ and ‘Design Temperature’. The problem that always occurs during the fabrication in the welding process for pressure vessel is the occurrence of welding defects at the pressure vessel welding joint. This welding defect occurs after the welding processes have been done at the welding joint of the pressure vessel. This welding defect can be determined using Non Destructive Test (NDT). These NDTs consist of die penetrate inspection, magnetic particles inspection, ultrasonic inspection, and radiography inspection. Welding inspection has been designed to provide a general description of welding specifications for new pressure vessels.

Basically, this project will focus more on determining the welding defects at the pressure vessel after the welding process. This is because; at the UMW Advantech Sdn. Bhd. they never revise, the causes on the welding defects that always occur after the welding inspection has been done of pressure pessel. UMW Advantech Sdn Bhd has been selected as the pressure vessel fabricator in order to reduce the welding
defects of the pressure vessel. Currently, the company faces a problem in preventing the welding defects that always occur after the welding process. Therefore, this project aims to find the best solution to improve the welding process to prevent welding defects by focusing on the factors that cause the welding defects.

1.4 Objective

The objectives of this project are as follows:

a) To identify the welding defects encountered during the welding process using the Non Destructive Test.

b) To suggest counter measures and improvements to solve the welding defects of pressure vessels.

1.5 Scope

This project was conducted at UMW Advantech Sdn Bhd who is a fabricator of the pressure vessel. The scope for the project is to mainly focus on:

1. The defects of welding on the pressure vessel joints.
2. The types of welding inspection and the factors that cause the welding defects.
3. The improvements that could be made to avoid welding defects.

1.6 Outline of Report

This report outline illustrates the process flow of completion for this project. This project is divided into four (4) chapters. The chapters are as follows
Chapter 1: Introduction
The first chapter of the report describes the introduction of the project, background, objective and scope. In this chapter, the focus of the study is classified.

Chapter 2: Literature Review
The second chapter is the literature review of the pressure vessel. In this chapter, aspects of the pressure vessel and the various welding processes are discussed. The specifications of the pressure vessel in the ASME code are also discussed. The chapter then goes on to describe the types of welding inspection that are used to detect welding defects.

Chapter 3: Methodology
The third chapter discusses the methodology of the project. It consists of the information from the primary and secondary data sources for analysing the welding defects of pressure vessel. The chapter starts by identifying the company used as the case study. This is followed by understanding the nature of the process, identifying the type and function of pressure vessels and welding process, and studying the fabrication of pressure vessels. Then, it goes on to discuss the welding inspections used to detect the welding defects. This chapter also includes details on the project planning, flowcharts and Gantt charts. Data collection in this project utilises the Non Destructive Test (NDT) method.

Chapter 4: Fabrication of pressure vessel at UMW Advantech Sdn Bhd
This chapter discusses the pressure vessels fabricated by UMW Advantech Sdn Bhd. This includes the welding process and the welding inspection that have been used to detect the welding defects utilised by UMW Advantech Sdn Bhd.
Chapter 5: Result and Analysis
This chapter discusses the result and analysis based from the experiments that have been done. This includes the type welding defects that occur on pressure vessel.

Chapter 6: Discussion
This chapter is about the discussion of the project. It will discuss the advantage and disadvantage of the Non Destructive Test (NDT) in term to identify the welding defect. It also will discuss about the welding ability.

Chapter 7: Recommendation and Improvement
This chapter discusses the recommendation and improvement for the welding defects. It also includes the method to prevent the welding defects.

Chapter 8: Conclusion
This chapter discusses the conclusion overall of the project that a study of welding defects on pressure vessel.