SUPERVISOR DECLARATION

"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 the Bachelor of Mechanical Engineering (Design and Innovation)

Signature :……..

Name Of Supervisor :……

Date :……

Signature :……..

Name Of Supervisor :……

Date :……

INTEGRATED PRODUCT DESIGN AND OPTIMIZATION OF MULTIPLEX ELECTRODE HOLDER FOR ARC WELDING PROCESS

CHEW LAI HUAT

This report is used to fulfill
part of the requirement in order to be awarded with
Bachelor Degree of Mechanical Engineering (DESIGN AND INNOVATION)

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

APRIL 2011

PENGAKUAN

"Saya akui laporan ini adalah hasil kerja saya sendiri
kecuali ringkasan dan petikan
yang setiap satunya saya telah jelaskan sumbernya."

Tandatangan :…….

Nama penulis :…….

Tarikh :…….

DECLARATION

"I hereby confirm that this report is solely written by me
except those paragraphs and summaries
that have been stated with citation"

Signature : …….

Writer : …….

Date : …….

DEDICATION

To my family and friends whose encouragement helped me to complete it and who have supported me.

ACKNOWLEDGEMENTS

I would like to express our gratitude to a lot of people who helped me to finish this report successfully.

Firstly, I would like to thanks my PSM supervisor, Dr S.Thiru Chitrambalam. He has given me the right amount of advice that helped me to solve my PSM problems successfully.

I would like to thanks Mr. Kharil and Mr Zunaidi in welding lab who helped me a lot in my literature review and welding experiment.

Next I would like to appreciate our university. University Teknikal Malaysia Melaka, have provided a lot of services like Welding workshop and Fabrication workshop. It has made my work much easier to find information. On top of that the friendly staffs have made my work a lot easier when finding information.

I would also like to thanks the internet up loaders who upload a lot of information regarding CAD and experimental setup.

Lastly, I would like to thank my classmates, and my parents who give us a lot of support and encouragement.

Thanks once again.

ABSTRAK

Cabaran utama bagi Projek Sarjana Muda ini adalah untuk merancang Multiplex Electrode Holder (MEH) dengan kombinasi antara Sheilded Metal Arc Welding (SMAW) dan Gas Metal Arc Welding (GMAW) Projek ini merupakan pemegang elektrod las busur yang dapat melakukan dua proses pengelasan busur utama iaitu. , konvensional Sheilded Metal Arc Welding dan semi-automatik Gas Metal Arc Welding (GMAW) dengan mengintegrasikan ciri-ciri pengelasan kedua proses bersama dalam satu operasi tunggal. Dalam projek ini juga merangkumi mengembangkan prestasi kecekapan pengelasan untuk MEH. Mencari penyelesaian untuk mengendalikan kelajuan-elektrod, untuk menjaga kestabilan busur selama proses pengelasan SMAW pada MEH. Selain itu, projek ini juga merangkumi percubaan MEH, dalam percubaan ini adalah untuk menaikan taraf operasi diantara SMAW dan GMAW. Setelah percubaan, pengoptimuman rekabentuk dari MEH dengan menganalisa prestasi dari hasil eksperimen dengan meningkatkan kestabilan busur semasa proses GMAW. Meningkatkan prestasi pengelasan SMAW dengan pengubahsuaian rekabentuk yang sesuai di pemegang elektrod. Lukisan 8 rekabentuk konseptual pemegang Elektrod Multiplex menggunakan software 3D CAD untuk digunakan dalam papan Morfologi. Projek ini melibatkan suatu rekabentuk model konseptual, terperinci Multiplex Electrode Holder dan penyelidikan eksperimental untuk meningkatkan prestasi dari kedua-dua proses pengelasan SMAW dan GMAW. 3D CAD perisian digunakan untuk melukis konseptual serta model kerja terperinci MEH dan kemudian untuk pengoptimuman rekabentuk. Untuk analisis data, kaedah Regresi akan digunakan untuk menganalisis data. Pada dasarnya perlu menentukan beberapa ukuran untuk percubaan ini. Pengelasan arus, voltan busur, kelajuan pengelasan dan kelajuan-elektrod dipilih sebagai ukuran percubaan. Setelah percubaan selesai, ANOVA digunakan untuk menyiasat ukuran proses secara signifikan. Ini merupakan prestasi dengan memisahkan kepelbagaian jumlah nilai hubungan, yang

diukur dengan jumlah deviasi kuadrat dari jumlah keseluruhan nilai hubungan, menjadi deposit oleh ukuran proses masing-masing

ABSTRACT

The main challenge for this project was to design and fabricate a Multiplex Electrode Holder (MEH) that can perform two fundamentally different welding process such as a manual Shielded Metal Arc welding (SMAW) and Gas Metal Arc Welding (GMAW) by integrating the features of both welding processes together in a single setup. The efficiency welding performance for MEH, also was investigated by develop a solution to control the feed-rate of the electrode, so and to preserve the stability of the arc during the welding process of SMAW in MEH. In order to do that, this project also included four parameter conditions toexperiment MEH, to assess the efficacy on performed both SMAW and GMAW. The optimization of the design of the MEH by analyzing its performance from the experimental results by preserving and improving of the stability of the arc during GMAW processes. Enhancementof the welding performance of SMAW by appropriate design modification in electrode holder was also done by making eight conceptual design of Multiplex Electrode holder using 3D CAD software to develop a Morphology Chart. This project involves a detailed conceptual and working model design of Multiplex Electrode Holder and experimental investigation to improve welding performance of both SMAW and GMAW processes. 3D CAD software's is extensively used to make the conceptual as well as detailed working models of MEH and later for design optimization. For data analysis, Regression method was used to analyze the data. Four welding condition such as the welding current, arc voltage, welding speed and electrode feed-rate were chosen as the experiment parameters. After experiment completed, ANOVA is used investigate which welding process parameters significantly affect the performance characteristic. This is an accomplishment by separating the total variability of the relation grades, which is measured by the sum of the squared deviations from the total mean of the relation grade, into contribution by each welding process parameter and the error.

CONTENTS

LIST OF TABLES

TABLE TITLE PAGE

LIST OF FIGURES

LIST OF FLOW CHART

LIST OF SYMBOLS

1. w/p = ratio of bead width to penetration
2. w/h = reinforcement height
3. %D = percentage dilution
4. W = Bead width
5. P = Bead penetration / Depth of penetration
6. H = Bead height / Crown height / Height of reinforcement
7. α = Angle of convexity
8. β = Angle of entry
9. A_r= Area of reinforcement
10. A_P= Area of penetration
11. A_t = Total bead area, ($A_r + A_p$)
12. I = Arc current
13. V = Arc voltage
14. S = welding speed
15. D = Electrode stick-out
16. E = pre-heat temperature
17. S/N = Signal to noise
18. kg/h = Deposition rate

LIST OF ABBREVIATIONS

1. MEH - Multiplex electrode holder
2. SMAW - Shielded metal arc welding
3. GMAW = Gas Metal Arc welding
4. MIG = Metal inert gas
5. CAD = Computer aided design
6. DOE = Design of experiment
7. MAG = Metal active gas
8. *WPSF* = Weld penetration shape factor
9. *WRFF* = Weld Reinforcement form factor
10. S/N = Signal to noise
11. ANOVA = Analysis of variance

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

This project describes the development design of a combination electrode holder for alternating current gas metal arc welding. The name of the electrode holder is Multiplex electrode holder (MEH). This method could replace the former MIG Torch with only have MIG process but now we have two processes in one torch which are Gas metal arc welding (GMAW) and shielded metal arc welding (SMAW).

Welding machines are widely used in industry. Of the variety of welding processes, stick-electrode welding, more formally known as shielded metal arc welding (SMAW) is the most common and is conventionally performed manually. Although wages continue to rise and more manufacturers move to automate their processes to increase productivity, the SMAW still holds a large share of the total welding filler-metal business, largely due to its advantages which include exceptional versatility, low maintenance costs, durability, relative simplicity of operation, and ease of set-up [1,2,3].

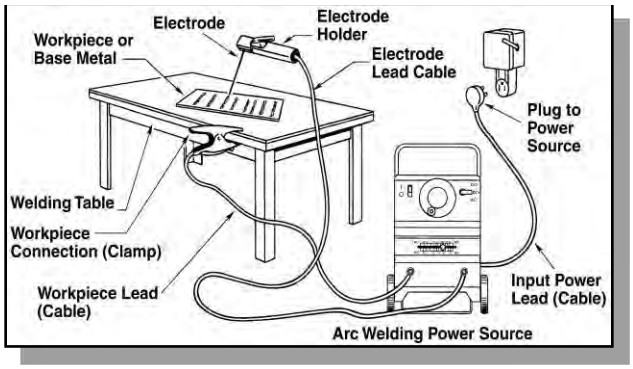

Figure 1- Lincorn electric SMAW Stick Welding.

(Source: Jennifer campbell ABG.Inc)

GMAW is known as "Gas Metal Arc Welding" where it is using a continuously fed consumable electrode and a shielding gas. Gas metal arc welding (GMAW) is widely used in industry due to its high metal deposition and ease of automation with better weld quality [4]. The advantages of the GMAW is the welding can be done in all positions, no slag removal, high welding speeds, high weld quality and less distortion of work piece[5]. There are 3 majors component in GMAW equipment, i) welding torch, ii) Welding