

**DESIGN, OPTIMIZATION AND PROTOTYPING OF MULTIPURPOSE
WELD ELECTRODE HOLDER**

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SUPERVISOR DECLARATION

“I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design & Innovation)”

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DESIGN, OPTIMIZATION AND PROTOTYPING OF MULTIPURPOSE
WELD ELECTRODE HOLDER

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This thesis is submitted to Faculty of Mechanical Engineering in partial fulfilment
of the requirement for the award of Bachelors Degree in
Mechanical Engineering (Design & Innovation)

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DECLARATION

“I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged.”

Signature:

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For my beloved Mum and Dad

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ABSTRAK

Elektrod selulosa kimpalan arka digunakan secara meluas dalam industri pembinaan terutamanya dalam industri paip minyak dan paip gas. Disebabkan elektrod bersalut selulos mempunyai kandungan hidrogen yang tinggi, dimana ia membawa kepada keretakan hidrogen dalam kimpalan. Selain itu, penggunaan elektrod selulosa yang tinggi secara tidak langsung akan menyumbang kemusnahan tumbuhan-tumbuhan dan menyebabkan kemusnahan alam sekitar. Bagi industri talian paip yang berterusan asalah disebabkan oleh keupayaan elektrod selulosa boleh melakukan penembusan yang tinggi dalam kimpalan. Daripada masalah-masalah yang sedia ada, projek ini telah mereka bentuk prototip pemegang elektrod kimpalan serbaguna untuk mencari jalan bagi menggantikan selulosa dalam elektrod lapisan untuk proses kimpalan arka. Reka bentuk konsep telah dibuat dalam apa-apa cara yang ia akan mengurangkan penggunaan selulosa dengan menggunakan gas yang dibekalkan melalui elektrod tiub. Pemegang elektrod kimpalan serbaguna telah dilaksanakan selaras dengan metodologi reka bentuk kejuruteraan dalam pembangunan produk melalui pengenalan masalah, “house of quality”, penjanaan konsep, penilaian konsep, pemilihan konsep, model saiz bahagian, “DFX”, pemilihan bahan, pembuatan proses pemilihan, terperinci reka bentuk dan prototaip.

ABSTRACT

For open root pass weld, commercial cellulose electrode is widely used in pipeline construction industry especially for welding oil or gas pipes. Cellulosic coated electrode, due to its high hydrogen content, will lead to hydrogen cracking in welds. Moreover, the high usage of cellulose electrode will indirectly contribute the destruction of plants and cause environment degradation. In spite of these two major draw backs pipeline industry is keep on using the electrodes mainly due to the ability of cellulose electrodes in making high penetration 'all purpose' welds. An attempt is made hence to design, optimize and prototyping of a Multipurpose Weld Electrode Holder in order to find a way to replace cellulose in electrodes coatings for SMAW process. The concept design was made in such a way that it will minimize the usage of cellulosic, by using a secondary gas supplied through the tubular electrode. The Multipurpose Weld Electrode Holder was made in accordance with the standard engineering design methodologies in product development through problem identification, house of quality, concept generation, concept evaluation, concept selection, modeling sizing of part, DFX, material selection, manufacturing process selection, detail design and prototyping.

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LIST OF ABBREVIATIONS

SMAW	=	Shielded Metal Arc Welding
GMAW	=	Gas Metal Arc Welding
GTAW	=	Gas Tungsten Arc Welding
MIG	=	Metal Inert Gas Welding
TIG	=	Tungsten Inert Gas Welding
HICC	=	Hydrogen Induced Cold Cracking
PRCI	=	Pipeline Research Council International
HOQ	=	House Of Quality
DFX	=	Design for X
DFMA	=	Design For Manufacturing and Assembly
DFA	=	Design For Assembly
DFM	=	Design For Manufacturing
MWEH	=	Multipurpose Weld Electrode Holder

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CHAPTER 1

INTRODUCTION

1.1 Background

Welding is a fabrication process in joining two metal work pieces by melting the metal and adding filler material to form a pool molten material that turn into stronger joint after solidified, sometimes it also used in conjunction with heat. The modern welding method are the metal get heated to melting point, at the same time there are shielding from air or from the nozzle of welding torch became a solidified slag to protect the solidified, well the filler metal is added to joined the work piece (Patyal).

In addition, several welding process that being use in industrial such as Shielded Metal Arc Welding (SMAW) considered Stick welding process, Gas Metal Arc Welding (GMAW) also known as Metal Inert Gas Welding (MIG) and Gas Tungsten Arc Welding (GTAW) is equal to Tungsten Inert Gas Welding (TIG) (VirginiaTech).

Furthermore, the SMAW process is most simple and flexible welding process, SMAW can weld in any position as long as the electrode can reach the location. SMAW can join ferrous and nonferrous material which is cast iron, stainless steels, nickel based alloys, carbon low alloy steels, and copper alloys. But the electrode of SMAW has high hydrogen cellulosic. Regarding to Pipeline Research Council

International (PRCI) and the US Department of Transportation. Found that, by using cellulosic coated electrode will lead to hydrogen cracking in weld metal deposited (Fiore and Boring 2009). Although the GMAW process is no slag after welding but the torch size and nozzle have positioning problem during welding process. For GTAW process, the welding current of GTAW can control from 5 to 300 amps for different thickness of metal, but compared to SMAW the deposition rate is lower (Chevron Corporation 1998).

This project concentrated on redesign and product development of SMAW electrode holder, which by adding new concept to modified the SMAW electrode holder which to instead the cellulose electrode by inert gases. The flow of this project is started from literature review, problem statement finding and survey, the following step will accord the engineering design and product development step to generate the SMAW multipurpose electrode holder prototype.

Finally, the project succeed by applies engineering design methodologies in product development through literature review, problem identification, house of quality, concept generation, concept evaluation, concept selection, modeling sizing of part, DFMA, material selection, manufacturing process selection, detail design and prototype.

1.2 Problem statement

For open root technique weld, commercial cellulose electrode is widely used in pipeline construction industry to weld oil or gas pipes. During welding, the electrode releases gaseous hydrogen and carbon monoxide by the decomposition of organic cellulose, through the shielding gas surrounding the arc (SUPPIAH 1999). Hydrogen is known for HICC failure, and in spite of it, the pipeline industry used the cellulosic electrode to produce high penetration weld requirement and low cost pipe welds (S.Thiruchitrabalam et al. 2011). It is well recognized by the Pipeline Research Council International (PRCI) and the US Department of Transportation that using cellulosic coated electrode will lead to hydrogen cracking in weld. In addition,

cellulose electrode cannot be exposed to bright sunlight in warm because it may damage the cellulose electrode. It is advisable to keep cellulose electrode in cool condition to remain the electrode in good condition (Fiore and Boring 2009). Also the cellulose contents are increasing the environmental pollution because it is extract from the plant.

1.3 Objectives

- i. To conceptualize, select of the design for SMAW multipurpose weld electrode holder.
- ii. To design and fabricate a prototype of SMAW multipurpose weld electrode holder.

1.4 Scope

- i. To study, understand the theory & functioning of SMAW weld electrode holders.
- ii. To study and apply engineering design methodologies in product development by using detail designing, DFX and prototyping

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The literature review is a proof or explanation of the theory and literature relating to the projects implemented. A project would not be complete if only rely on the idea alone. The studies and observations have to be done because it is very important in smoothness and effectiveness of a project. The information of the literature gathers from internet, technical articles, trade journal, book or consultant and etc.

2.2 SMAW welding process

Welding is a process that fixing or creating composition of metal, however welding also a fabrication process in joining metal by melt the metal and add filler material to form a pool molten material become stronger joint after solidified with pressure and heat sometimes both (Patyal).

Modern welding is considered four parts; there are metals, heat supply, filler material, and shield from surrounding. The welding method are apply the heat to the metal until melting point, at the moment there are some kind of shielding from air

will become a solidified slag to protect the solidified weld metal, filler metal are added to joined the metal work piece (Go Welding.org)

There are several common types of welding process are used in industry. Which is shielded metal arc welding (SMAW), Gas tungsten arc welding (GTAW) and Gas metal arc welding (GMAW). The purpose of every welding process is same, is to join two or more pieces of metal from a single piece together, but the type of welding process is base on the material that wanted to joint and whether the project is heavy or light duty. And yet, the different types of welding torch or electrode holder is used for different welding machine.

2.3 Shielded Metal Arc Welding (SMAW)

Shielded metal arc welding (SMAW) considered as arc welding process or stick welding process. Figure 2.1 shows an electrode covered by flux are use to form a shielding around the molten weld pool. The flux is form a protective slag during welding, which is producing a shielding gas to reduce weld pool exposure to oxygen. The slag can remove once it in solidified condition. Filler material is form by the core wire of the consumable electrode (Chevron Corporation 1998). Electrical circuit created by electrical current flow from one power source terminal to another power source terminal of the welding machine during the welding process, the current is the amount of electron that flow through an electrical circuit. The conductor is the work piece and the working table is electricity flows.

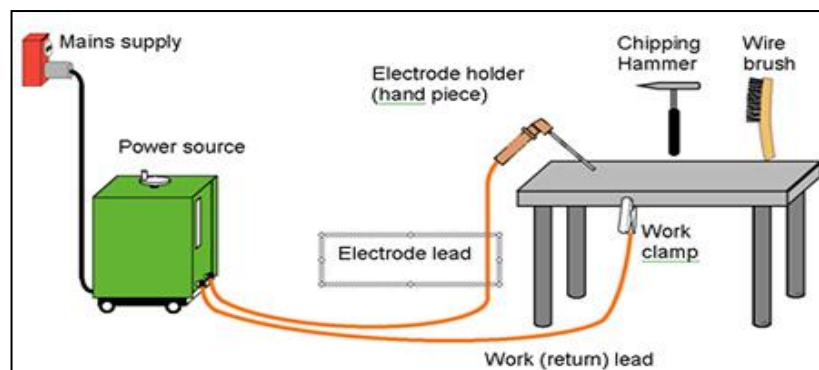


Figure 2.1: Shielded metal arc welding (SMAW)

(Source: http://www.hera.org.nz/Category?Action=View&Category_id=521)

2.4 Input and output power for SMAW

The power source of SMAW must be from high voltage with low current to low voltage with high amperage welding current. There are two type of power source that industrial being used, which is single phase and three phase power at voltage, where the voltage for single phase power usually is 120 and 220 VAC, it is for low power application, and however the voltage for three phase power is 220 to 480 VAC.

The electricity output from welding machine can be either alternating current (AC) where Direct Current Electrode Positive (DCEP) or Direct Current Straight Negative (DCEN) that shows in figure 2.2. The voltage for SMAW is 60 to 80 volts for open circuit, but the voltage is 23 to 27 volts for arc voltage. The voltage increased for long arc gap and decreased for short arc gap. In addition, SMAW processes are using constant current output during welding process (Youngberg 2006).

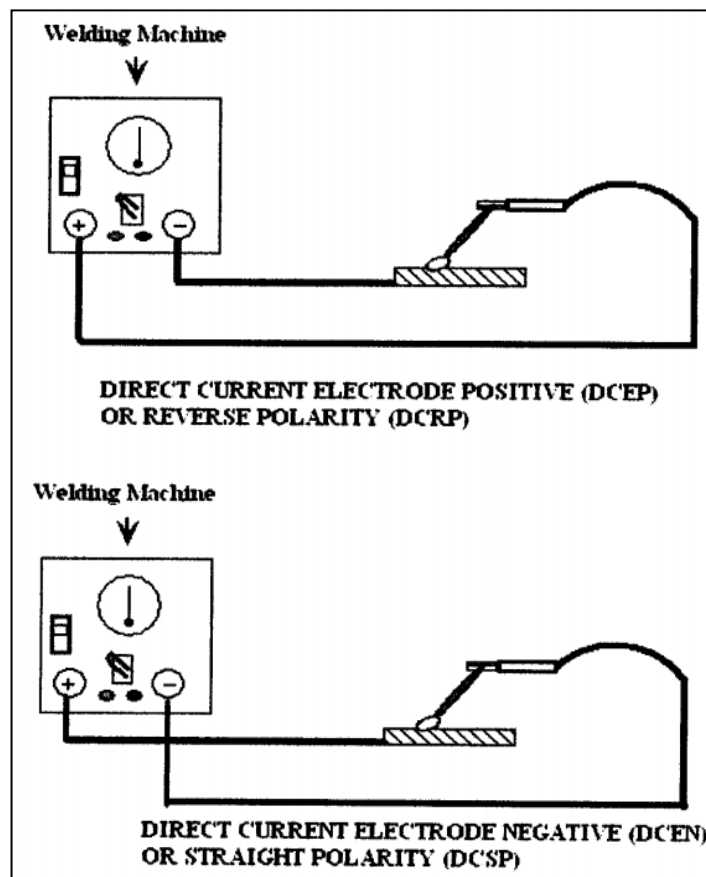


Figure 2.2: Direct current setting

(Source: Mohd Fariz bin Mod Yunoh, May 2004)