OPTIMIZATION OF MIG WELDING PROCESS PARAMETERS ON MECHANICAL PROPERTIES OF Al-MS-SS MATERIALS

NIK NUR FATIHAH BINTI CHE HASSAN

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Optimization Of Mig Welding Process Parameters On Mechanical Properties Of Al-MS-SS Materials

by

NIK NUR FATIHAH BINTI CHE HASSAN
(1332420848)

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Author's full name : NIK NUR FATIHAH BINTI CHE HASSAN

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LIST OF ABBREVIATIONS

C	Carbon
Mn	Manganese
P	Phosphorous
S	Sulphur
O	Oxygen
Si	Silicon
Al	Aluminum
Ti	Titanium
Cr	Chromium
Ni	Nickel
Co	Cobalt
Mo	Molybdenum
N	Nitrogen
Cu	Copper
W	Tungsten

Sn	Tin
Fe	Iron
Zn	Zinc
Mg	Magnesium

Kimpalan Optimum MIG Parameter Ke Atas Sifat-Sifat Mekanikal Bahan Al- MS-SS

ABSTRAK

Aplikasi proses kimpalan dalam industri kebanyakan melibatkan ketahanan sesuatu objek untuk menahan daya yang dikenakan. Oleh yang demikian, daya tegangan dan kekuatan sambungan kimpalan mestilah diambil kira. Kimpalan gas lengai logam digunakan untuk menyambungkan dua kepingan spesimen keluli lembut, keluli tahan karat dan aloi aluminum berdasarkan kapada parameter yang telah dipilih. Spesimen yang digunakan adalah ketebalan 3mm. analisis kekuatan tegangan dan kekerasan telah dijalankan ke atas permukaan kawasan yang telah dikimpal. Analisis daya ketahanan diuji menggunakan Ultimate Tensile Machine dan kekerasan (Vickers Hardness Test) yang paling tinggi dicatatkan. Kaedah Taguchi digunakan untuk menyusun atur eksperimen bagi mendapatkan nilai optimum untuk setiap analisis yang diuji. Keputusan daripada analisis Graf nisbah Signal-to-Noise yang paling tinggi untuk setiap parameter memberi keputusan kepada nilai optimum untuk setiap jenis bahan. Analisis of Variance dilakukan untuk mengenal pasti peratusan parameter yang mempengaruhi kepada daya ketegangan sesuatu bahan. Ujian pengesahan dilakukan berdasarkan parameter optimum yang telah dianalisis dan mendapati terdapat ralat antara ramalan nilai optimum dan nilai eksperimen yang sebenar. Walau bagaimanapun, analisis struktur permukaan telah dilakukan dengan menggunakan Scanning Electron Microstructure untuk menyokong kepada keputusan eksperimen. Imej yang ditunjukkan dalam analisis menunjukkan kesan penembusan logam kimpalan di antara kepingan bahan berbeza untuk setiap bahan yang dikaji. Imej specimen keluli lembut menunjukkan penembusan paling tinggi berbanding yang lain. Penemuan-penemuan nilai optimum dan jadual keputusan yang diperolehi boleh digunakan sebagai rujukan untuk pelbagai aplikasi kimpalan gas lengai dalam industry berkaitan.

Optimization of MIG Welding Process Parameters on Mechanical Properties of Al-MS- SS

ABSTRACT

Applications of welding process in the industry mostly involve the resistance of an object to resist the force applied. As such, the tensile strength and hardness of welding must be considered. The Metal Inert Gas welding is used to joint two plates of Aluminum, Mild Steel and Stainless Steel in butt joint type based on the selected parameters. The specimens used are 3mm thickness. Analysis of tensile strength using Ultimate Tensile Machine and hardness (Vickers Hardness Test) has been carried out on the surface of welding area. The highest values of tensile strength and hardness test were recorded. Taguchi method is used for design of experiment in order to obtain the optimum value for each analysis tested. The highest of Signal-to-Noise ratio graph for each parameter provide results of optimal values for each type of material. Analysis of Variance was carried out to identify the percentage of parameters contributions to the tension of a material. Confirmation tests carried out on the basis of optimum parameter which has been analyzed and found there was an error between predictions of optimal value and the actual experimental values. However, microstructure analysis has been done to support the results of the experiment. The images of penetration shown by Scanning Electron Microscope for Mild steel specimen are the highest penetration than others. The findings of the optimal value and table of results obtained can be used as a reference for various applications for metal inert gas welding in industry.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Welding is a manufacturing process, which is carried out for joining of metals. Modern welding is a technology based on heat sources, in which, there are many methods capable of being used to raise the metal locally to a temperature suitable for welding. Statement by Houldcroft and John (1989), it is a highly efficient, economical and adaptable method of joining compared to late nineteenth century, the only welding process used by blacksmith by heaping and heating coals around the part to make a joint. Metal Inert Gas (MIG) welding is one of the most widely used processes in industry. MIG is the one type of Gas Metal Arc Welding (GMAW) in which Argon or Helium is used as an inert gas. The equipment of MIG welding comprises the power source which is direct current (DC), the wire feed unit, the flexible conduit with a torch and control devices to start and stop the wire feed, welding current and gas flow.

According to research by Sapakal and Telsang (2012), they stated that welding parameters play a very significant role in determining the quality of a weld joint. In reality weld geometry directly affects the complexity of weld structure. Therefore, controlling welding parameters affecting the arc and welding should be carried out and their changing

conditions during the process must be known prior to obtain optimum results. The quality of the joint can be defined in terms of properties such as mechanical properties.

Mechanical testing is an important aspect of weld ability study. A mechanical property is the properties that reveal the reaction, either elastic or plastic, of a metal to an applied stress. For example, mechanical properties testing are tensile strength, yield strength, elongation, reduction of area, hardness, impact strength, and bend ability.

Esme (2009) stated the following:

The weld strength is measured by a number of standardized destructive tests, which subject the weld to dissimilar types of loading. Some of these are tensile, torsion, impact, fatigue and hardness. It is very significant to select welding process parameters for obtaining optimal weld strength. Generally, the welding process parameters are determined based on experience or from a handbook. However, this does not ensure that the selected welding process parameters can give the optimal or near optimal weld strength for that particular welding machine and environment.

Studying the design parameters one at a time of by trial and error is a common approach to design optimization (Phadke, 1989). However, this leads either to a very long and expensive time span for completing the design or to premature termination of design process due to budget or schedule pressures. Taguchi's approach provides a systematic and efficient method to determine near optimum design parameter for performance and cost.

1.2 Problem Statement

Common engineering materials such as aluminum, mild steel, stainless steel, nickel alloy and titanium alloys are known for better-quality resistance to heat and corrosion as well as low thermal expansion properties. These properties make it useful in industries that require parts to retain stability as well as the ability to resist corrosion over a wide range of temperatures (Mitterer, 2000; Rusinek, 2007; Baddoo, 2008). These materials are suitable for aerospace, automotive and electronic industries. These industries depend increasingly on higher geometric accuracies and micro or nano structured surfaces to meet the growing need for improving performance and reliability.

However, it is partially acceptable in industrial application due to difficulties in welding especially when utilizing conventional gas or arc welding. Therefore, for many industries the above requirements is leading to capabilities of conventional welding methods and machine tools being eclipsed by new processes and machine systems which at this time at the research stage. Furthermore, the advances in the field MIG welding have accepted in the application of this technology to the manufacture of those materials.

This research used aluminum, mild steel and stainless steel because there is a limited result that study and compare the tensile strength and hardness for these three materials which are required parts to retain stability. This study is focused on a semi automatic machine operation which applies MIG welding process.

1.3 Objectives

The objectives of this study highlighted below:

i. To analyze quality characteristics of the weld on mechanical properties such as ultimate tensile strength, micro hardness and microstructure for weld butt joint.

ii. To identify optimum setting of the best combination welding parameters for MIG welding through experimental study of soft non-ferrous metal like 1100 Aluminum alloy.

iii. To identify optimum setting of the best combination welding parameters for MIG welding through experimental study of hard ferrous metal like AISI 1017 Mild Steel and AISI 302 Stainless Steel.

1.4 Scopes of the Project

The scopes of the study:

i. The welding method was perpendicular butt joint which is commonly used in industries.

ii. Parameter selection in the MIG welding experiment was based on available data.

iii. Mechanical properties test are used as a quality measurement for tensile strength and micro hardness.

iv. Manual and semi-automatic ways of welding are generally used in small industries to weld three different materials.

1.5 Limitations of the Project

Limitations of the study are as follow:

i. Electrode diameter of MIG welding machine is 0.8 mm.
ii. Plate thickness provided is 3mm for aluminum, mild steel and stainless steel.
iii. The parameter range not used in the high level of machine specification because of the thickness of the plate is too thin. If the high level of range applied, the plate will burn.

1.6 Significant of Findings

The best parameter setting of MIG welding can be acquired from the experimental results. The settings were used to obtain optimal welding performance in order to maximize quality characteristic of the welding area. The result of experiments can give advantage to manufacturing industries which use manual and semi-automatic MIG welding operation.

1.7 Report Structures

Chapter 1 is briefly described about the introduction which consists background of the study, problem statement, objective and scope. This background of study will discuss about the welding process which are the main manufacturing process in this research followed by the problem statement. The objective also mentions earlier in this chapter to make clear what the purpose this research in done and what the outcome of the research. Scopes are listed to make the research become in deeper and more specific.

Chapter 2 is a literature review of the Metal Inert Gas (MIG) process, material selection, parameter selection and design of the experiments Taguchi application. These sections discuss details on the previous process, method and application related to this study. Much information gathered in this chapter and will be used in this study.

Chapter 3 is mainly about the procedure and theory behind the tools. The flowchart of methodology is given in this chapter to show how this study is done from beginning until the end. Besides that, the equipment and method selection for this study are discussed in details. The scheme of investigation is explained in detailed.

Chapter 4 presents the experimental results, analysis and discussion. The calculations, graphs and table of results are shown in this section. Starting with experimental results show in tables, analysis graph Signal-to-Noise (S/N) ratios and Analysis of Variance (ANOVA). The discussions about the results are evaluated and conclude.