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EFFECT OF ARC STUD WELDING PARAMETERS ON MECHANICAL PROPERTIES OF DISSIMILAR METALS

A Thesis Submitted to the Council of College of Engineering, University of Diyala in Partial Fulfillment of the Requirements for the Degree of Master of Science in Mechanical Engineering

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CHAPTER ONE

GENERAL INTRODUCTION

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1.1. Introduction

Arc Stud Welding is widely used in various production area including automotive, ship building, steam boiler and other types of construction industry [1, 2]. It is a well-established operation for attaching studs to different material thickness [3]. Arc welding includes: arc stud, gas metal arc, gas tungsten arc, plasma arc, shielded metal arc, submerged arc. Figure (1-1) shows the process and equipment of all joining methods. Arc stud welding is a form of spot welding for joining a metal stud similar or dissimilar work piece by using stud as an electrode. Welding can be achieved by several welding processes. Stud welding reduces the costs, labor time and materials in addition the weld is typically stronger than the stud and base material [4]. The application of arc stud welding is well done in various industrialization fare prominent stud welding parameters [5]. Especially, the welding of austenitic stainless steel to carbon steel is widely utilized in many applications such as nuclear power plant equipment, fossil fuel boilers, refineries and heat exchanger [6]. The properties of both metals being welded must be taken in consideration. In sometimes, compromise for selecting the metal conditions is necessary due to the some conditions may be optimum for first metal and undesirable for other [7].

Based on the materials selected for joining, a lot of problems are appeared in joining these materials with various kind of welding process. For example, the differences in the thermal expansion coefficients cause differences in residual stresses along the different weldment region. The grain phenomena is a significant issue associated with the austenitic (SS) –

ferritic low carbon steel welding. The main reason behind that is the absence of the phase transformation which affects toughness and ductility [8]. Welding current and welding time must be selected properly to obtain a high-quality performance well jointed [5].

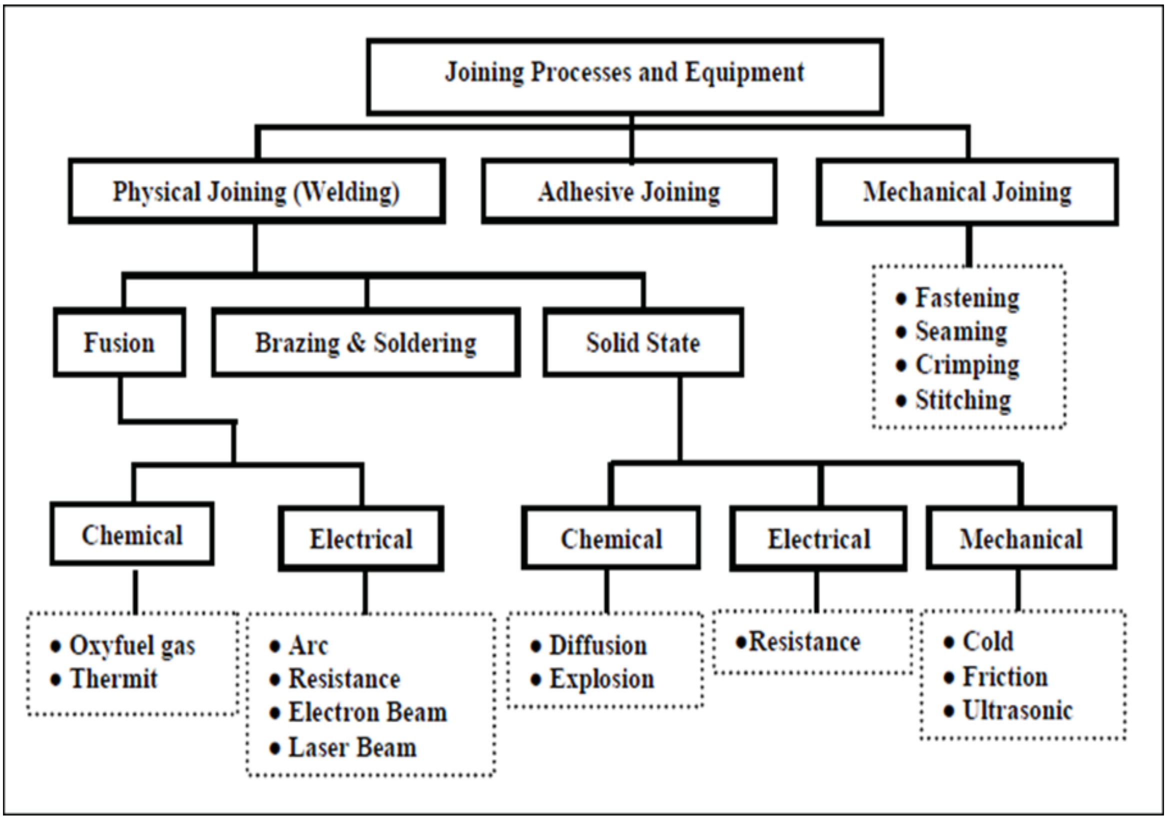

Figure (1-1): Classification of joining methods according to AWS [9].

1.2. Thesis outlines

This thesis is the result of a research work sponsored by University of Diyala/College of Engineering. The significance and objectives of this project are disclosed in the next section of this chapter. Additional information is discussed in the balance of this thesis to achieve its objectives. This thesis is divided into six technical chapters, each of which is devoted to the description of a specific part of the research activities as follows:

Chapter Two describes the literature review of researches that related with the topic of this thesis. Furthermore, some of concluding remarks are deduced from the previous studies of literature review.

Chapter Three presents the methodology of theoretical part including: methods of ASW, advantages-disadvantages of ASW, exemplary metals weld by ASW. This chapter is also concerned with the main parameters of ASW and weld ability. The final part of chapter discusses the art behavior of welds fusions solidification and problem associated with DMW.

Chapter Four deals with the experimental work, materials and test description, which include materials selection, machine of ASW and welding procedures. This chapter also includes the types of tests (Torque, Bending, Tensile and Micro-Hardness).

Chapter Five shows all the results and which divided according to the types of tests.

Chapter Six reviews the main important of conclusions and provides some of suggestions for future studies in this field.

1.3. Problem statement

In Diyala State Company, there are several technical problems in connecting the high voltage bushing electrical transformers production during joining stud type AISI 304 to the plate type AISI 1008 using GMAW. These technical problems can be summarized as: Welding accuracy, distortion in the weld area, the welding efficiency is not good, scatter slag, light flashes, more time, filler material and cost.

1.4. Aims of the research

In order to overcome these problems, ARC stud welding is applied and suggested. The following objectives are thus proposed:

1. Study the effects of arc stud welding parameters on the mechanical properties (Torque, Tensile, Bending strength and microhardness) of dissimilar weldments. Assessment of the microstructure of fusion and heat affected zone of arc stud welding AISI 304 and AISI 303 with low carbon steel AISI 1008.
2. Solving the problem of joining stud AISI 304 with AISI 1008 in tank (reservoir) of electrical transformers produced by Diyala State Company.

ABSTRACT

Arc stud welding (ASW) process is generally used for joining fasteners or studs with the base metal. It is widely used in different industries and production areas such as: steam boiler production, bridge and automotive industry. In this study, arc stud welding of two types materials austenitic stainless steel (AISI 304 and AISI 303) for stud and low carbon steel (AISI 1008) for plate was investigated using DABOTEK machine DT (1000). The welding current and welding time at the constant protrusion are the main welding parameters took into a count to analyze the mechanical properties and microstructure of weldments. The welding current was used in three levels (400, 600 and 800) AMP while, the welding time was used in six levels (0.20, 0.25, 0.30, 0.35, 0.40 and 0.45) seconds. The torque, tensile, bending and micro-hardness is employed as the indicators of weld joint quality. The test results show that the dissimilar welding of AISI 304/AISI 1008 joint record torque strength 90 N.m, tensile strength 487 MPa and pass in bending test at 600 AMP with 0.3 Second. While, welding type AISI 303/AISI 1008 joint record torque strength 62 N.m, tensile strength 515MPa and pass in bending test at 600AMP with 0.25 Second.

On the other side, the higher micro-hardness value was recorded in the fusion zone for both types of weldments. In addition, increasing the welding current leads to increase the extent of HAZ of low carbon steel and grain growth of HAZ of stainless steel. Furthermore, the results observed that the microstructure of the weldment and base metal of fusion zone near the center undergoes considerable changes because of the heating and cooling of the welding process.

The XRD analysis revealed that the phases formed at the fusion zone are ($Cr_{23}C_6$, Cr_7C_3, martensite, FeNi, FeCr). SEM examinations illustrated that two types of weldments contain some porosity; also, EDS illustrated the percentage of chemical composition in the fusion zone. According to the Taguchi approach, the mix. of stud welding parameters which would have an effect on the optimum welding joints, in condition of torque test AISI 304/AISI 1008.