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THE EFFECT OF HEAT TREATMENT ON HARDNESS FOR VARIOUS SUBMERGED ARC WELDED PARTS

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Abstract

In industrial applications, the welding of different materials is widely used for taking advantage of the superior properties and reducing the overall costs. While a wide variety of welding methods are used in joining these different materials, the most widely used welding method in the automotive industry, especially in the use of thin sheet designs, is submerged welding. In this study, the application of submerged welding in joining different metals was discussed in detail. The advantages and limitations of the method compared to other welding methods used in joining different metals are given. Various welding procedures that may be an alternative to the method for joining different materials are also included. As an application, 304 grade austenitic stainless steel and St 37 sheet materials were welded under 3 different currents and 3 different designs by submerged welding, and their effects on the hardness values of the weldments were analyzed.

Keywords: Submerged arc welding, heterogeneous welding, hardness measurement

1. Introduction

The increase in the types of materials used in today's industry, the necessity of joining different metals with different properties, and the increasing importance of economic factors especially in recent years lead to the necessity of using materials with different properties together.

One of the most common manufacturing methods of constructions is welding. Welding is defined as “a localized coalescence of metals or non-metals produced either by heating to suitable temperature, with or without the application of pressure or by the application of pressure alone and with or without the use of filler metals.” [American Welding Society (AWS)]. Welding methods are classified as fusion welding and solid-state welding according to the type of process (Table 1.).

Although welding of different metals (heterogeneous welding) is usually done by solid state welding methods, it can also be done by welding methods such as electron beam, MIG/MAG, TIG. (1,2). Fusion welding method is open to errors and the formation of residual stresses at macro level due to inhomogeneous cooling are important disadvantages of this method and decrease the strength of the welding. In that case, if welding permits joining of materials of different composition by a fusion event or if the size and shape is to be limited, minimum internal source of residual stress can be obtained and the advantage of superiority of fusion can be used (2,3).

Table 1. Classification of Welding Methods (1,2,4)

Fusion Welding	Solid State Welding
1. Arc Welding • Gas tungsten arc welding (TIG) or (GTAW) • Gas metal arc welding (MIG) or (GMAW) • Shielded metal arc welding (SMAW) • Submerged arc welding • Plasma arc welding • Flux cored arc welding (FCAW)	1. Cold Pressure Weld
2. Electric Resistance Welding • Spot welding • Seam welding • Projection welding • Resistance butt welding	2. Ultrasonic Welding
3. **Gas welding** • Oxy-acetylene welding • Oxy-hydrogen welding • Air -acetylene welding • Pressure Gas welding	3. Friction Welding
4. **Radiant energy welding Process** 1) Electron beam welding 2) Laser beam welding.	4. Furnace Weld
5. **Thermo chemical welding Process**	5. Cast Pressure Weld
	6. Gas-Pressure Weld
	7. Electric Resistance Welding
	8. Electric Arc Pressure Welding
	9. Diffusion Welding

Among fusion welding methods, electrical resistance welding forms the most commonly used method in the automotive industry, the white goods and kitchenware manufacturing industry, the manufacturing industry of chemical containers. Resistance welding process in which fusion of facing surfaces of a lap joint is achieved at one location by opposing electrodes. The mating electrodes can be in the form of point or in the shape of disks. The basis of the resistance source is the formation of a fusion with heat caused by the resistance of the workpieces against the electrical current passing through the work parts held together under pressure by the electrodes (5,6,7).

Many different material pairs in the industry have applications for joining with welding. The most important of these are undoubtedly the welding of steel with other metals. Below are examples of different metal combinations.

- Stainless steel-plain carbon or low alloy steels
- Steel-copper alloys
- Steel-aluminum alloys
- Steel-nickel and cobalt alloys
- Copper-nickel alloys
- Titanium alloys - different metals

The physical, mechanical and metallurgical properties of metals must be studied very well when joining different metals. The problem encountered in joining different metallic materials is due to intermetallic components occurring in transition zones between metals.

Therefore, the thermal expansion coefficients and fusion temperatures of the materials to be combined should be known.

The most important factors in determining the connection properties of different metals after welding are the properties of the combined materials and the phase diagrams formed by the materials together.

2. Experimental studies

The experiments performed in this study were recorded with three different welding methods and materials.

Firstly St 37 material is connected by gas welding method and sg2 welding wire. (Figure 1)

Figure 1. St 37 material joining by gas welding method

In another experiment, again St 37 material is welded by hand welding method and sg2 welding wire. (Figure 2)

Figure 2. St 37 material joining by hand welding method

In Figure 3, again, 304L (1.4307) Stainless Steel material is welded with argon welding method and wire rod 308L.

Figure 3. Argon welding of 304L (1.4307) Stainless steel material

Then, the results obtained from these pairs of different materials were compared with the hardness test results of the same type of materials.

In the examination of the results section, the results obtained from the samples obtained by welding methods with the same materials and the results obtained by welding methods performed with different materials were evaluated together.

2.1. Material properties

2.1.1. 304L (1.4307) Stainless steel

304L grade stainless steel, 304 grade stainless steel version with a carbon content of less than 0.03%. This stainless-steel grade, which is almost identical to 304 grade stainless in terms of

its basic properties, is recommended instead of 304 grade where welding is intense. 304 quality instead of 304L, 304 quality stainless steel instead of 304 quality is no problem to use. However, it is preferable to use 304L grade stainless steel where welding is dense, in order to prevent carbon carbide. This low-carbon quality minimizes carbon carburizing by minimizing the extreme heat generated during welding. In short, 304L grade contains less carbon, it is important to make welding more comfortable, but it is no problem to use 304 grade instead.

2.1.2. ST-37

ST-37 is mostly used in construction machinery and construction equipment manufacturing, general construction plates, road and rail vehicles manufacturing, storage tanks, container manufacturing, pressure vessels or boiler manufacturing, LPG manufacturing, shipbuilding and used in the backbone.

ST-37 sheets are produced by hot and subsequent cold rolling. It is the most widely produced and consumed products in the world and in Turkey. Especially in developed and developing countries, production and consumption increase every year. Black sheet metal is widely used.

2.1.3. St-37 Sheet specifications

ST-37 black sheets are produced between 1,50 mm-20,00 mm. S235JR (ST37) Quality is the most made and preferred in the world market and in our country. It is also produced in different thicknesses and qualities. For example, S255 (ST52) this product is hard and has higher strength. Products of this quality are used in different manufactures that require strength.

3. Findings

According to the result obtained from experimental samples with 3 different constructions at an optimum welding current with different materials, all samples were realized by St 37 material. The result obtained here; the hardness of the alloy formed as a result of welding is the highest in 304L stainless sheet material.

The experiments carried out in this study were recorded with three different welding methods and materials.

First, it is connected with the gas welding method and SG 37 welding wire with St 37 material. In another experiment, it was combined with St 37 material by hand welding method and sg2 welding wire. In another study, 304L (1.4307) Stainless Steel material was tied with argon welding method and 308L welding wire.

Then, the results obtained from these different material pairs were compared with the hardness test results of the same type of materials.

In the first sample, welding wire SG2 was used with st37 gas welding method and the hardness measurement was 200 hb.

In the second sample, st37 material was welded with a hand welding method, as b 55 welding wire, and the hardness measurement was 160 hb.

In the third sample, 304L stainless sheet material was used, argon welding method was made and welding wire rod: 308 L was used, and after welding, the hardness measurement was 250 hb.

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