

Study on Techniques of Welding Dissimilar Materials: SS400 Steel and Cooper (99%).

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ABSTRACT: Techniques for joining dissimilar materials: SS400 steel and cooper (99%) is becoming increasingly important in the manufacturing of structures for engineering applications. suitable joining methods are necessary in order to reliably join these dissimilar materials (SS400 steel and cooper (99%) and to integrate them in engineering structures. Understanding of the various joining technologies that exist for for joining dissimilar materials structures is consequently important. The objective of this study is to examine and summarize information and results of study. The findings presented serve to further understanding of the various joining techniques available for dissimilar materials: SS400 steel and cooper (99%).

KEYWORDS: Dissimilar materials, SS400 steel, Cooper

I. GENERAL INTRODUCTION

Welding dissimilar metals can be difficult. Dissimilar metal welding, as compared to traditional welding, is the joining of two separate metals which wouldn't ordinarily weld together as they have different chemical and mechanical qualities, and are from different alloy systems. It is very important for many different industries, whereby there is often a necessity to weld together different parts and components to save on material costs or to use the best material at all times for the best end product.

The complication with welding dissimilar metals is that often very different metals may be getting welded together, which means it is not always as easy as simply melting the two parts together to form a bond. The problems arise in the transition zone between the two metals, where the intermetallic compounds are formed.

For a successful dissimilar metal weld to have taken place, the new forming joint needs to be as strong as the metal with the weaker tensile strength, so that you know the joint will be able to withstand any stresses that it faces; in the example shown above this is the stainless steel. Copper and steel are two other metals which are often welded together, but both possess very different properties and are not mutually soluble. This paper presents of joining techniques for dissimilar materials found in ss400 steel and cooper (99%)

II. ANALYSIS OF WELD-BONDED DISSIMILAR MATERIALS: SS400 STEEL AND COOPER (99%)

2.1. detailed drawings and model

Based on the requirements of the business, the author studied in detail the cooling system and nozzles of the iron and steel smelting plant that were corroded. Require welding to meet and ensure tightness, withstand pressure above 10 bar.

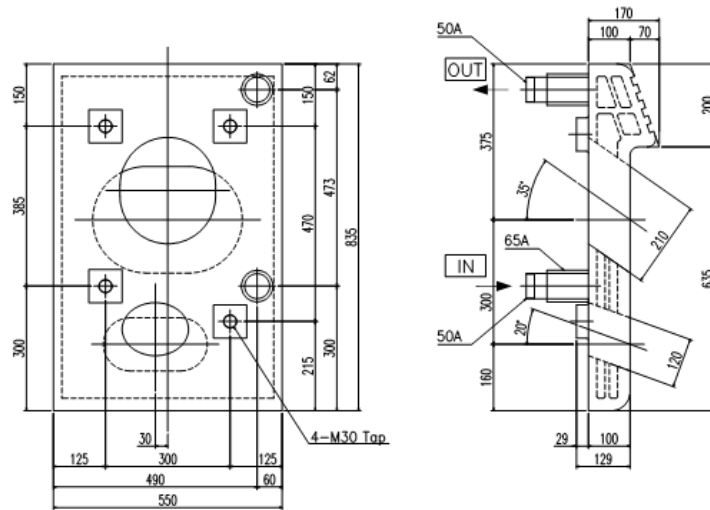


Fig.1 Detailed drawings

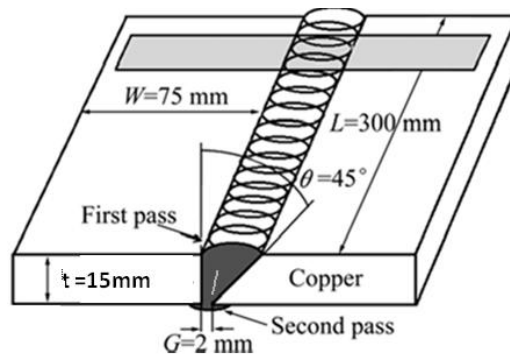


Fig.2 Test sample

2.2. Experimental and determination of base materials

Welding dissimilar materials: SS400 steel and copper (99%) using GTAW welding process, the sheets of the dimensions as shown in Figure 1 were cut from the rolled sheets. Single beveled link design was chosen to focus heat flow on copper plate to compensate for heat loss due to its high thermal conductivity. Figure 1 is the size of the link used in this study. Before welding, the copper plates are preheated to 500 degrees C for 10 minutes. GTAW welding is then performed using three different auxiliary materials.

Copper (99%) and SS400 steel test materials are analyzed to determine the chemical element composition on a spectrophotometer as shown in Table 1.

During the welding process, the first welding line is made on the oblique angle and the second one on the back of the link to fill the lack of penetration of the first weld. To describe the bonding, metal samples of the cross-section of the weld were cut and examined using a scanning electron microscope VEGA / TESCAN.

The chemical composition of the bond is determined by the energy dispersive spectroscopy (EDS) method associated with SEM. The mechanical properties of the welded samples are tested by three different tests including tensile test, stiffness and face bending. The tensile test pieces are cut perpendicular to the connecting line with dimensions of 140mm x 75 mm x 10-15 mm.

This test was performed by INSTRON 4208 tensile testing machine with a movement speed of 1 mm / min. Vickers's micro hardness (HV) test was performed with a applied load of 200 g for 30 seconds. In addition, to test the weldability of the welded area, specimens of similar dimensions to tensile test pieces are prepared from joints. The face bend test is then carried out through specimens that bend around a bar with an outside diameter of 6 cm.

Table 1 Chemical composition of substrate and welding rod materials (%)

Material	C	Mn	Si	P	S	Material	Cr	Ni	Mo	Cu	Fe
SS400	0.04	1.70	0.48	0.016	0.005	SS400	19.55	8.23	0.3	0.70	Bal.
Cu	-	-	-	≤0.001	≤0.002	Cu	-	≤0.002	-	≥99.99	≤0.002
soldering stick ERCu	-	-	-	≤0.001	≤0.002	soldering stick ERCu	-	≤0.002	-	≥99.99	≤0.002
soldering stick Ni - Cu - Fe	0.50	-	-	-	-	soldering stick Ni - Cu - Fe	-	66.50	-	30.00	4.00

2.3. Heating and Cooling Methods

Heating before welding, keeping the temperature unchanged during welding with resistive rods surrounding the part, using glass wool to insulate heat, heat to welding temperature. During the welding process, the temperature is controlled by temperature sensor and infrared heat measuring device HT - 6899 (Taiwan) (Fig 3)



Fig.3 Resistance heat output device and measuring device, temperature monitor

The experimental samples are welded in 3 layers, the welding distance $I = 15$ mm, the width of the welding rod knife g $W = 12$ mm, the angle of the torch tip compared to the welding material 90° . Welding procedure specification shown in table 2.

Table 2: Welding procedure specification

Welding layer	Amperage (A)	Voltage (V)	Speed (cm/s)	Airflow (l/minute)
1	180÷200	23	0,36	08÷10
2	230÷250	26	0,38	10÷12
3	300÷350	26	0,40	10÷12

Heating, keeping heat by the local heating method: When raising the temperature of the substrate from $300^\circ\text{C} \div 400^\circ\text{C}$, the welding rod material is melting, but the metal base material is not melting. Raising the temperature from $450^\circ\text{C} \div 500^\circ\text{C}$ of molten metal material, but the phenomenon of peeling off a thin layer of substrate metal surface. Continue to raise the temperature from $650^\circ\text{C} \div 700^\circ\text{C}$ good welded joints, ensuring the resistance to pressure under the technical requirements $p \geq 10$ bar.



Fig.4 Heating position by resistors when welding and repairing



Fig.5 Details before and after welding recovery

For parts with large welding surfaces, such as cooling tanks, use local heating with Oxy Gas burner when welding is completed, cracked in another position. Multi-layer welding cracks right at the position of the previous welding layer due to the local heating process leading to rapid shrinkage phenomenon due to thermal stress leading to cracking, breaking on the substrate surface.

Heating, keeping heat by whole heating method: Raising the substrate with a resistive furnace, keeping the heat with an experimental insulation layer welded 3 layers according to the above technology parameters and slow cooling with speed From $100^{\circ}\text{C} \div 120^{\circ}\text{C/h}$, the quality of welded joints is good, guaranteeing the penetration, no cracking and withstand under high pressure working conditions.

2.4. Tensile properties and bending properties

For Ni-Cu-Fe filler rods, tensile strength and elongation are 89% and 39% of copper base plate. But, in the best condition, the maximum tensile strength and elongation are 96% and 44% of the copper base plate, respectively, for the copper welding rod material. The lower durability and elongation for Ni-Cu-Fe filler rods is due to the presence of cracks and voids in the fusion area.

In order to study the forming ability of the bonding, the surface bending test is carried out through bending samples. Around a cylindrical bar with an outer diameter of 6 cm. The sample is welded with Cu filler material which is bent to 180 degrees around the bar without any macro defects such as splitting, tearing or breaking as shown in Fig 6. This

indicates that copper stainless steel welding was safely carried out in this study. A tunnel and a large tear were formed in the common area of the samples welded with Ni - Cu - Fe filler material and SS400 steel after bending about 180° and 25° around the bar. This is due to the presence of solidified cracks and voids in the fusion area of Ni-Cu-Fe filler material and defects at the interface of stainless steel filler filler material and copper baseplate.



Fig 6. Curved specimen

III. CONCLUSION

Ni-Cu-Fe and ERCu filler welding materials can be used to weld copper to SS400 steel. In the case of Cu filler welding material, no macroscopic and microscopic cracks form in the fusion area. But the formation of solidification cracks has reduced the tensile strength and elongation of the bond produced by Ni-Cu-Fe filler welding material.

In samples welded with Cu filler rods, the joint tensile strength is 96% weaker. These links are also bent to 180 degrees without macro defects such as splitting, tearing or breaking and showing good formatting ability.

The combined zone has a higher hardness than the base material in all samples. In addition, the formation of Fe-Cu mixture at the interface of steel - Cu filler welding material causes the highest hardness in the fusion area.

With the process of welding and restoring copper materials, the authors have performed on 02 types of fuel nozzles and cooling suits with a base material of 99.9% Cu selected Cooper welding wire (ERCu), welding mode, large-scale resistance heating-tempering method is suitable. The product has a good bond with the base metal, there is no defect between the alloying area of the substrate and the filler material. The filler position withstands pressure $p \geq 10$ bar.

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