Retraction

Retraction: Investigation of Solid State Welding of Copper Nickel Alloy (Cu-Ni 90/10) Using FSW Process (IOP Conf. Ser.: Mater. Sci. Eng. 1145 012112)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Investigation of Solid State Welding of Copper Nickel Alloy (Cu-Ni 90/10) Using FSW Process

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Abstract. In traditional joining process, copper alloys are hard to weld owing to its thermal and electrical properties. Owing to the high melting temperature and large thermal conductivity, excessive heat is needed for the joining operation of copper alloys. With increased heat input, the heat affected region of the welded part increases, the mechanical and thermal properties of the component deteriorate. The objectives of this research are to discover the ideal mechanical performance of FSW of copper alloys. Two main factors such as tool speed and traversing speed has been investigated. A cylindrical profile of tool pin is used for all the experiments. A total of four experiments were conducted with two rotational as well as traversing speed for this investigation. The response such as tensile strength was analysed for accessing the integrity of the welded joints. At a steady load, the joints manufactured are found to have a highest tensile strength of 262 Mpa. Thus the 93.57 percentage of joint efficiency is achieved.

Keywords: Friction Stir Welding; Microstructure; Cu Ni Alloy; Tensile strength;

1. Introduction
Cupro Nickel Alloy (Cu-Ni 90/10) comprises of 90% copper, 10% nickel alloy with minor but significant contributions of iron and manganese for improved overall strength and corrosion resistance [1-4]. It’s a common grade for maritime, structural, and manufacturing applications because of its high flexural strength and durability. Industrial engineers widely prefer the cupro nickel alloy owing to the superior resistance to stress corrosion, degradation especially in seawater and brackish water, as well as its exceptional manufacturing and joining properties, excellent resistance to galvanic corrosion. It is widely used in the marine applications such as struts, ship hulls, naval fixtures, marine equipment’s, salt water valves, fittings, hot water reservoirs, seawater baffles, propeller sleeves, pump components and rudder sleeves.

FSW have been utilized for the joining of many advanced materials [5-8]. Heat is created owing to the friction between the spinning tool & the Cu Ni alloy metal. Thus, a softened region is formed around the rotating tool. As the tool is traversed across the specimens to be joined, the tool physically intermixes the softened metal parts with its tool pressure. In the fusion welding process, porosity and cracks are major problem [9-11]. FSW has many benefits over fusion welding methods owing to its solid-state type of welding. During FSW, many problems in the fusion welding process such as blow holes, cracking in the weldments due to thermal stresses are overcome. Some of the other
advantages are higher mechanical properties, the absence of toxic fumes as in the case of fusion welding process, the non-requirement of filler rods and shielding gases, the possibility of automated process in the CNC milling machines, the possibility of welding in all directions (horizontal, vertical as well as inclined due to absence of molten weld pool), a better weld appearance. However, there are few limitations as well such as the transverse speed is low.

2. Literature survey

Many researches were conducted in the FSW of aluminium alloys. However, the reports on FSW of copper alloys were limited.

Researchers in [12] analysed the FSW of copper alloy C11000. Thermocouples were installed at several locations to determine the temperature ranges during the joining process. They compared the mechanical performance of FSW joints with the base metals and concluded that for defect free joining of copper alloys temperatures in the process to be maintained between 460 C to 550 C.

Researchers in [13] analysed the FSW of pure copper of 3 mm thickness plate. They observed that defect free welds were observed when the tool & traverse speed is at 900 rpm & 25 mm / min respectively. The mechanical strength was also found to be high.

Researchers in [14] analysed the mechanical properties of FSW of aluminium and copper joints. They observed that at tool & traverse speed of 2500 rpm & 30 mm/min respectively, the maximum strength of 105 Mpa is observed.

Researchers in [15] analysed the FSW of Al 5052 alloy with pure copper plates. Preheating of specimens was carried out prior to welding process. The experiments were conducted at 2800 rpm of rotational speed with a tool tilt & traverse speed of 1 degree & 2 mm / sec respectively. They concluded that the tool profile and preheating affected the microstructure and the formation of intermetallic phases. Many researchers attempted to join hardened alloys using friction stir welding process. [16-18]

Based on the literature survey it is found that FSW can be used for the successful joining of Cu Ni (90-10) alloy.

3. Materials and Methods

For the FSW of copper alloys, a milling machine of capacity 15 HP, 4500 rpm is used as shown in figure 1. Four experiments are conducted at varying tool rotational speeds of 800 rpm & 900 rpm as shown in table 1. The welding speed is varied between 25 mm/min and 40 mm/ min. Cu Ni alloy of dimensions (150 mm × 50 mm × 2 mm thickness) is considered in this research work. A cylindrical pin tool profile is preferred in the research work as indicated in figure 2.

|   | FSW Tool speed (rpm) | Traverse speed (mm/min) | Tensile strength (Mpa) |
|---|----------------------|-------------------------|------------------------|
| 1 | 800                  | 25                      | 245                    |
| 2 | 800                  | 40                      | 262                    |
| 3 | 900                  | 25                      | 185                    |
| 4 | 900                  | 40                      | 215                    |
4. Results and discussions

The welding speed and the tool speed are two parameters analysed in the current work. The other parameters such as pressure, angle of tilt of FSW tool and the tool profiles are not varied in the current research work based on the literature survey.

Trial experiments are initially conducted to set the process parameter levels. It is found that a minimum of 800 rpm and 25 mm/ min traverse speed is required for the FSW of selected 2 mm thickness copper nickel alloy sheets. It has been observed that the tool rotational speed controls the total heat generation in the welding process. It is attained through the stirring action on the base metals. It is observed that 800 rpm tool rotational speed produced higher tensile strength than 900 rpm tool rotational speed. The mechanism of metal transfer on the FSW process is observed to be shearing of metallic layers and extrusion. The welding speed influences the time taken for the heat generation in the FSW process. However, the tool & traverse speed of 900 rpm & 25 mm/ min respectively results in the excessive heat generation causing cracks in the specimen 3 as shown in figure 3. Owing to the presence of cracks, the tensile shear strength is found to be the lowest of 185 Mpa. The highest tensile strength of 262 Mpa is achieved at tool speed & traverse speed of 800 rpm & 40 mm/ min respectively, where the heat generation is neither excessive nor insufficient. Figure 4 shows Defect free FSW joint. The microstructures of the specimen 2 which yielded highest tensile strength is shown in figure 5(a) and figure (b). The microstructure comprises of welded zone (WZ) and thermo mechanically affected zone (TMAZ). It is observed that no welding defects such as micro cracks, stress corrosion cracking, intermetallic particles are observed in the welding zone. It is credited to the solid-state welding characteristics of the frictions stir welding process.
5. Conclusions
The copper nickel alloy is successfully joined by FSW process with a cylindrical tool pin of shoulder diameter 18 and D/d ratio 3 using a milling machine.
(i) Excessive heat generation is caused by the high tool and the low traverse speed in specimen 3, resulting in cracks and the tensile shear strength is found to be the lowest of 185 Mpa.
(ii) At tool & traverse speed of 800 rpm & 40 mm/min respectively, the maximum tensile strength of 262 Mpa is reached, indicating that heat generation is neither excessive nor insufficient.
(iii) Based on the microstructural analysis, it is concluded that no welding defects such as micro cracks, stress corrosion cracking or intermetallic particles have been found in the WZ and TMAZ.
(iv) Hence a successful FSW of copper nickel alloy (Cu Ni – 90/10) of 2 mm thickness is achieved at 800 rpm tool speed and 40 mm/min traverse speed. Joint efficiency of 93.57 percentage is achieved with the solid-state friction stir welding process.

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