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Effect of Shot Peening on Submerged Friction Stir Welded AA 6061 T6 Alloy under Various Cooling Media

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Friction stir welding (FSW), a new solid-state joining technique, was invented by The Welding Institute (TWI) of UK. There is no need to take extra concern for the compatibility of chemical composition of the material because the joining does not involves any secondary consumable filler material, which is an issue of conventional fusion welding. The primary functions of the tools are: (a) heating of the workpiece, and (b) movement of material to produce the joint. The weld joint is produced by frictional heat generated between the tool and weld materials, which causes the weld material to plastically deform resulting in the development of fine grains in the weld zone. Factors that affect friction stir welding include rotational speed of tool ,tool depth ,welding speed, heat flow generation have major effect on the material flow pattern and temperature distribution, thereby influencing the microstructural evolution of the material. To produce ultrafine grains and uniform cooling rate, Submerged Friction Stir Welding is employed (SFSW). In order to take full advantage, the whole workpiece is immersed in the liquid during the welding which is called Submerged Friction Stir Welding which facilitates uniform cooling throughout the material. Farzad Heirani et al.. (2017) was proved that in comparison with the air-cooled specimen, the increase in the tensile strength of the water-cooled samples can be due to the increase of hardness in the SZ resulted by an ultrafine-grain structure.

There is a problem of loss in mechanical properties like tensile, hardness and fatigue of friction stir welded samples due to presence of tensile stresses .Shot peening is often introduced for in aircraft defects to mitigate the tensile stresses built up in grinding process and replace them with beneficial compressive residual stresses. Anas M. Atieh1 et al.. (2017) was investigated the effect of surface modifications from high and low intensity shot peening on the mechanical properties of TIG welded Al 6061-T6 specimens. Over all, the mechanical characteristics for all treatments were enhanced as speculated due to the compressive residual stresses introduced by shot peening .The tensile strength has been increased by an amount of 7 to 29% in comparison with the unpeened weld specimen. Hassan Khairia Salman1 et al.. (2015) was investigated the shot peening process contributed in improving mechanical properties for all specimens due to residual stress generation for(11.5% of FSW after shot peening) and (4% of TIG after shot peening) . So there is a need for study in the effect of shot peening on the submerged friction stir welded aluminium alloy 6061-T6 for attaining betterment of properties and microstructure. Shot Peening is a cold working process of materials is to introduce a compressive residual stress layer thereby increasing mechanical properties of the material. Most commonly used materials of peening media are glass, ceramics and steels. In the present study, highly polished smooth and spherical SS304 shots are used because of their properties such as good corrosion resistance and toughness. The hardness of the SS304 shots used is found to be HRC 27.

The aim of this investigation to study the effect of shot peening on the mechanical and microstructural properties of submerged friction welded joints of Al 6061 T6 under three different cooling mediums .Submerged Friction Stir Welding was carried out under various cooling media like water, brine solution, coolant oil by keeping other parameters like rotational speed (1000 rpm), welding speed (60mm/min) constant. The optimum parameter combinations for maximizing the yield strength ,tensile strength and percentage of elongation were identified in the previous research by Senthil kumar et al. (2016) .The optimum condition of the medium, rotational speed, welding speed were found to be coolant oil,1000 rpm,60 mm/min, respectively. Two samples from each cooling media can be welded at constant welding parameters and subjected to metal cutting process for further shot peening process. The shot peening was carried out on the one friction stir welded sample from each cooling condition (water, brine solution, coolant oil) using a steel balls of diameter (6mm), rotational speed (750rpm) and for 45 min. Tensile test, Vickers hardness test , Microstructure evaluation was carried out on the respective weld peened and weld unpeened joints. In added to that the effect of cooling media of welded joints on the mechanical properties, microstructural properties were discussed. Finally the comparison has to be made between the properties of weld peened and weld unpeened of Al 6061 T6 alloy.

Tensile strength of weld peened and unpeened FSW samples were studied and analysed. Tensile strength increasing for the weld peened samples compared to weld unpeened samples. Tensile strength of peened FSW joint under water increased by 17% compared to peened FSW joint under coolant oil. Tensile strength of peened FSW joint under water increased by 14% compared to peened FSW joint under brine solution. Highest tensile strength was achieved in shot peened water condition was 230 N/mm2. Lowest tensile strength was achieved in unopened brine condition was 183.6 N/mm2. The effect of cooling media on the tensile strength of the weld peened and weld unpeened samples are increasing in the following order, Brine < Coolant < Shot peened brine < Shot peened coolant < Water < Shot peened water.

Hardness of weld peened and unpeened FSW samples were studied and analysed. Hardness increasing for the weld peened samples compared to weld unpeened samples. The maximum hardness was achieved in peened weld joint under water condition. The value obtained was 71.11 HV. The minimum hardness was obtained on unpeened weld joint under brine condition. T he value obtained was 61.22 HV. The effects of cooling media on the hardness of the weld peened and weld unpeened samples are increasing in the following order, Brine< Water < Shotpeened brine < Coolant < Shotpeened coolant< Shotpeened water Microstructure of the parent metal, FSW and shot peened FSW joints under water were analysed and compared. It is evident that weld peened grains are finer than weld unpeened grains and the base metal. The average grain diameter of weld nugget region of peened FSW joint under water was 13.5µm. Microstructure comparison also shows that peened weld joints produces more fine grains than unpeened weld joints.