FINDINGS

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TOPIC OF RESEARCH- FRICTION STIR WELDING OF NON FERROUS CURVED SECTION

The present work attempts to study the friction stir welding of AA3003 pipes. To achieve the task, a rigorous study of literature is done. More than 300 research articles are thoroughly studied and an efficient strategy is formulated. In the initial phase, friction stir welding of sheets are studied and effects of various process parameters are analyzed. Further, a filtered and focused study is carried out for AA3003 alloys. It is deduced that Aluminum 3003 alloy pipes are widely used due to their excellent properties, including good corrosion resistance, formability, and moderate strength. Due to its corrosion resistance, 3003 is ideal for transportation and storage tanks for chemicals and food products. Major work for this work is done on friction stir welding of sheets. A few literature has reported friction stir welding of AA3003 pipes. Thus, this work proves useful for industry which are focused on welding of Al- alloy pipes.

The set-up for friction stir welding of pipes has been developed. To perform the FSW process, four process parameters namely tool offset (A), tool rotational speed (B), tool shoulder diameter (C), and pipe diameter (D) are finalized after rigorous experimentation and literature review. Three levels are used for tool rotational speed, tool shoulder diameter and pipe diameter whereas,

two levels are considered for tool offset. The levels used for tool offset are 3 mm and 4 mm; for tool rotational speed the levels are 710 rpm, 900 rpm and 1120 rpm; for tool shoulder diameter the levels are 16 mm, 18 mm and 20 mm; and for pipe diameter the levels are 40 mm, 60 mm and 80 mm. AA3003BM pipes of three different diameters i.e. 40 mm, 60 mm and 80 mm each of 5 mm thickness and length 10 mm are used in the experimental study. FSW tool with a cylindrical shoulder and cylindrical pin and material HSS is designed and developed. The experimentation (pipe welding) is performed on a vertical milling machine using proper set-up according to Taguchi's L_{18} orthogonal array (OA).

The micro hardness profile is traced using micro hardness tester. The micro hardness values are calculated along the length of welds using 48 readings (24mm in each left and right of center of SZ). Micro-hardness values are found maximum at SZ zone and minimum at HAZ zone as expected. The average micro-hardness of BM is found to be 58HV. The maximum hardness in SZ comes out to be 78.4 HV which is around 35 percent more than BM which is an excellent outcome of the process.

The effect of processing parameters, within the considered range, on ultimate tensile strength (UTS) is also analyzed using Taguchi's L_{18} OA. Signal-to-Noise (S/N) ratio of the UTS values are calculated considering larger-the-better criteria for UTS. The analysis of means (ANOM) is performed to obtain optimum setting of process parameters for maximizing UTS and it is found as $A_2B_2C_2D_2$. Analysis of variance (ANOVA) is carried out to determine significance of the process parameters for UTS. ANOVA result reveals that tool offset, tool shoulder diameter and pipe diameter significantly affect UTS. Confirmatory test is carried out to validate the obtained optimal combination result. A joint efficiency of 97.88% is obtained at the optimal combination of the FSW process parameters.