MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures I - Development and Verification (Space Vehicles and Components) (1)

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DEVELOPMENT AND DEMONSTRATION OF FRICTION STIR WELDING PROCESS TOWARDS REALISATION OF PROPELLANT TANKS FOR SPACE PROGRAMME

Abstract

Juxtaposing the proven and potential aluminum alloys with joining processes optimizes the application of aluminum alloys for space applications more effectively.With the adoption of vastly emerging advanced solid state joining process of Friction Stir Welding (FSW), applications of aluminum alloys are widened. The process details of FSW using Fixed Pin Tool (FPT) are fairly matured and reasonably well demonstrated for aluminum alloys. Adopting Retractable Pin Tool (RPT) for FPT exit-hole closure is one of the promising and practically adoptable technical solutions. The RPT system consists of independent shoulder and pin unlike integral shoulder and pin type of FTP. As the overlap welding progresses with RPT, the earlier generated exit-hole will get closed by filling and forging and thereafter the pin is withdrawn in gradual and controlled way. This paper is concerned with the demonstration and implementation of retractable pin tool of FSW process to cylindrical welds of the propellant tanks made of aluminum alloy AA 2219 in T87 temper condition. In the present study a dedicated force and position control capable 100kN FSW facility is employed. Production welds with exit holes generated by Tri-flute fixed pin tool (FPT) on AA 2219 - T 87 are used for the exit-hole closure experiments by retractable pin tool (RPT). Technical paper further delineates the various RPT process parameters of tool dwelling time, the tool rotation direction, down force, shoulder and pin rotation, transverse weld speed and pin withdrawal rate. The generation of flash and depth of indentation and the additional temperature increase in the overlap region are investigated. Temperature is monitored using K type cemented thermocouples at 250ms time interval using 12 -channel temperature acquisition system. The residual stresses generated by RPT process are evaluated using non-destructive X-ray diffraction method. The weld nugget characterization using the non-destructive test evaluation radiography supplemented by phased array ultrasonic (PAU) testing, mechanical properties evaluation both at room temperature (300K) and cryo temperature (77K) along with the metallographic analysis carried out using optical microscopy, micro hardness and scanning electron microscope (SEM) are discussed. The morphology of onion rings and deformation pattern in the weld nugget are elaborated.Assured ultimate tensile strength (UTS) of 310 MPa, proof strength (0.2PS) of 175 MPa with minimum 6.0 percentage ductility on 50 mm gauge length are obtained on production welds in as welded and undressed condition. Using the data generated the acceptance standard for RPT welding is brought out.