Numerical investigation of Magnetic Pulse Welding of D9 Steel Tube to SS316LN End Plug using Lagrangian Finite Element and Smoothed Particle Hydrodynamics (SPH) and its Experimental Validation

M. R. Kulkarni[1], Deepak Kumar[1], Arup Nandy[1], Tanmay Kolge[1], Sachin D. Kore[1], and R. I. Bakhtsingh[1]

[1]Affiliation not available

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Abstract

Conventional mesh-based numerical methodologies cannot accurately simulate high-speed impact welding due to extreme distortion of mesh. Therefore, a smoothed particle hydrodynamics (SPH) based methodology is implemented to study the welding morphology and jetting phenomenon during magnetic pulse welding (MPW) of D9 clad tubes and SS 316LN end plugs after carrying out electromagnetic and structural deformation analysis using Lagrangian Finite element method. Different experimental parameters like taper angle, taper length, stand-off distance and discharge energies are varied to minimise leak-tightness. Discharge voltage of 17 kV and 18 kV and taper angle of 8 degrees is observed to be best suited during the experiment. Simulation results are validated with experimental observations. Furthermore, the joints are tested with the help of various non-destructive and destructive techniques. Uniformity at the joint interface is established by X-ray computer tomography. Moreover, the hydraulic pressure burst test shows failure in the unwelded region at the burst pressure of 105 MPa. Therefore, the current work discusses the applicability of the MPW technique as an alternative method to create a D9 tube to SS 316 LN end plug for a fast breeder reactor and the SPH technique on successfully reproducing experimentally observed interface morphology.

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