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# Design, Simulation and Fabrication of Electro-Magnetic Pulse Welding Coil and Initial Experimentation

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**Abstract :** Electro-Magnetic Pulse Welding (EMPW) is a solid state welding process carried out at almost room temperature, in which joining is enabled by high impact velocity deformation. In this process, high voltage capacitor's stored energy is discharged in an EM coil resulting in a damped, sinusoidal current with an amplitude of several hundred kiloamperes. Due to these transient magnetic fields of few tens of Tesla near the coil is generated. As the conductive (tube) part is positioned in this area, an opposing eddy current is induced in this part. Consequently, high Lorentz forces act on the part, leading to acceleration away from the coil. In case of a tube, it gets compressed under forming velocities of more than 300 meters per second. After passing the joining gap it collides with the second metallic joining rod, leading to the formation of a jet under appropriate collision conditions. Due to the prevailing high pressure, metallurgical bonding takes place. A characteristic feature is the wavy interface resulting from the heavy plastic deformations. In the process, the formation of intermetallic compounds which might deteriorate the weld strength can be avoided, even for metals with dissimilar thermal properties. In order to optimize the process parameters like current, voltage, inductance, coil dimensions, workpiece dimensions, air gap, impact velocity, effective plastic strain, shear stress acting in the welding zone/impact zone etc. are very critical and important to establish. These process parameters could be determined by simulation using Finite Element Methods (FEM) in which electromagnetic –structural couple field analysis is performed. The feasibility of welding could thus be investigated by varying the parameters in the simulation using COMSOL. Simulation results shall be applied in performing the preliminary experiments of welding the different alloy steel tubes and/or alloy steel to other materials. The single turn coil (S.S.304) with field shaper (copper) has been designed and manufactured. The preliminary experiments are performed using existing EMPW facility available Institute for Plasma Research, Gandhinagar, India. The experiments are performed at 22kV charged into 64μF capacitor bank and the energy is discharged into single turn EM coil. Welding of axi-symetric components such as aluminum tube and rod has been proven experimentally using EMPW techniques. In this paper EM coil design, manufacturing, Electromagnetic-structural FEM simulation of Magnetic Pulse Welding and preliminary experiment results is reported.

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