Abstract

In the current context of industrial advancement, there is a rapid surge in electricity demands. Meeting this escalating need involves either enhancing the efficiency of existing power plants or establishing new ones. Pulverized coal stands out as the cost-effective fuel choice predominantly utilized in power industries. However, the expansion of power plants contributes to increased emissions of gases like CH_4 and CO_2. The efficiency of power plants hinges largely on their operational steam parameters, particularly temperature and pressure. Supercritical power plants offer a solution by boosting efficiency through elevated operating conditions, resulting in reduced coal consumption and lower CO_2 emissions. Fabricating and maintaining power plants pose significant challenges due to the demanding working conditions. Utilizing cutting-edge high-temperature materials has become imperative in the power plant sector. Different components and structural elements necessitate dissimilar metal welds to enhance structural integrity and performance. This research endeavors to develop Shielded Metal Arc Welding (SMAW) electrode coatings aimed at enhancing performance and mitigating issues associated with high-temperature failures. SMAW is widely employed for welding, repairs, and maintenance in this context. However, detailed information on the welding consumables currently in use remains classified and limited in the public domain.

This research aims to develop coated electrode for producing Inconel 617/SS304H dissimilar joints, particularly for power plant applications. Utilizing the extreme vertices methodology, the coating compositions were formulated from mineral systems like CaO-TiO_2-SiO_2-Na_3AlF_6 and CaO-CaF_2-SiO_2-SrO. The experimental characterization focused on thermophysical, physicochemical, and wettability properties of the coatings. A regression model was employed to analyze the impact of coating constituents. Subsequent multipass bead-on-plate experiments using these coatings were used to evaluate their performance. Qualitative and quantitative assessments of the resulting beads determined electrode suitability. The most effective coating was then applied to fabricate dissimilar IN617/SS304H welds using extruded IN-617 core wire. Mechanical, microstructural, and hot corrosion properties of the welds were thoroughly examined. Additionally, a comparative analysis between our laboratory-developed electrodes and commercially available ones was conducted. Overall, the study demonstrates successful development of SMAW electrode coatings tailored for welding IN617/SS304H, specifically for A-USC power plant applications. These developed electrodes exhibit superior mechanical properties, high-temperature corrosion resistance, and satisfactory microstructural stability compared to their commercially available alternatives.