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Simulation study on the mechanism of flux strip influence on arc characteristics in FBCA ultra-narrow gap welding of high-strength steel T-joints

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Addressing the issues of arc climbing and incomplete penetration at the root of T-joint welds in high-strength steel I-groove sandwich plates with ultra-narrow gap (<6mm) FBCA welding, this study explores the control mechanism of arc behavior influenced by the solid and burn-off process of flux bands through experimental and numerical simulation research. The paper initially investigates the burn-off state of flux bands under various welding processes using high-speed photography, simplifying the burn-off state into a burn-off height model to analyze the changes in arc temperature, velocity, pressure, and potential distribution at different burn-off heights of flux bands through numerical simulation. Results show that at a flux bands burn-off height of 2mm, the weld root is effectively heated by the arc, rectifying the issue of incomplete penetration. When the flux bands burns down to 1mm, the arc focuses heat on the weld root, leading to insufficient heating at the wire axis's groove bottom and inadequate weld penetration depth; when the burn-off exceeds 2mm, the flux band’s constraining effect on the arc diminishes, and the sidewall becomes one of the arc's conductive paths, preventing effective heating of the weld root. The simulation outcomes align well with the experimental findings.