77th IIW Annual Assembly and International Conference on Welding and Joining
7-12 July 2024
Rhodes, Greece

OP 444

Underwater Flux-Cored Arc Welding (UWFCAW) - how pulling and drag angle affect process stability, microstructure, and mechanical properties

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Underwater-Flux-Cored-Arc-Welding (UWFCAW) is a wet underwater welding process that produces shielding gas bubbles, which protect both electrical arc and weld pool from contact with water. One challenge is detachment of such bubbles due to their growth and buoyancy during welding. This, together with comparably high cooling rates, can impair welding process stability and weld metallurgy, causing e.g. excessive porosity. This has hindered process automation, so far. Typical approaches to overcome these challenges are supportive methods, e.g. stimulation by ultrasonics, pulsed wire feed or the tempered bead technique.
This study focuses on the influence of welding torch inclination on process, metallurgy and mechanical properties. Therefore, deposit welds were produced semi-automatically on carbon steel plates by applying the pulling technique under varying heat input. Transient measurements of welding current and voltage and recording of the gas bubble with a high-speed camera were accomplished. As a result, process stability, i.e. the arc's tendency to interruptions, was found to improve with 20° as optimum torch angle. Furthermore, the effect on microstructure and mechanical properties such as tensile strength, and hardness were investigated. The results suggest that the pulling technique enables better control of the heat input resulting in improved process stability and weld quality.