SUMMARY

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Title: The influence of the technological and material factor on the properties and quality of the welded joints using high-energy methods of the 17-4PH stainless steel and nickel-based superalloy Inconel 718

In this work, the influence of technological and material factors on the quality, microstructure and mechanical properties of the welded joints of nickel-based superalloy IN718 and stainless steel 17-4PH was investigated. The welding process was performed using two methods: electron beam welding (EBW) and tungsten inert gas welding (TIG). The influence of the method of the preparation before welding, the contamination of the welded surfaces and the influence of different welding parameters (EBW and TIG processes) was examined to determine the technological factors that affect the quality of the welded joints. The study also focused on determining the influence of the material factors on the quality of welded joints. The influence of the initial condition of the material (solution-annealed condition, aged, over-aged) and the post-heat treatment, on the properties and quality of welded joint was also studied.

The study of the influence of the preparation process consisted of the contamination with coolant immediately before the welding and 2 weeks before welding process, as well as contamination of the welded parts with magnesia of the materials being welded. An analysis of the effect of welding parameters: welding speed, welding current, frequency of pulsed current (DC) and heat input, on the quality of the welded joints was carried out. The effect of the initial condition of 17-4PH steel was investigated: solution-annealing condition 1040°C, aged (solution 1040°C/1h + aging 550°C/4h) and over-aged (over-aging 760°C/2h + 620°C/4h) and nickel-based superalloy IN718: solution condition 960°C and aged (solution 960°C/1h + aging 720°C/8h + 620°C/8h) on the welded joints quality. The effect of the post-heat treatment consisted of the solution and aging, on the microstructure and mechanical properties of welded joints was also determined.

It was found that coolant and magnesia contamination significantly affect the quality of the welded joints. The welding parameters also affect the quality and the size of the welded joints. The initial state of the material, for both materials affects the microstructure and mechanical properties. For 17-4PH, the solution condition had the highest strength properties R_m=1181MPa, $Re_{0,2}$ =893MPa. However, for nickel-based superalloy IN718, the aged condition had the highest strength properties (R_m=996MPa, $Re_{0,2}$=636MPa). The mechanical properties of welded joints of 17-4PH stainless steel and nickel-based superalloy IN718 after post-heat treatment are similar regardless of the initial condition of the material (solution condition, aged, over-aged).

The knowledge gained during the research on the influence of technological and material factors will provide valuable theoretical and practical knowledge and contribute to improving the quality of welded joints, which is the main purpose of this dissertation. It will also improve the planning of welding processes and improve the production flow, which will reduce the cost of poor quality of the welded joints.

Keywords: 17-4PH Stainless Steel, Nickel-based superalloy IN718, Electron beam welding (EBW), Tungsten inert gas welding (TIG)