

The Effect of Rejuvenation Heat Treatments on the Repair Weldability of Wrought Alloy 718

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Abstract

Alloy 718 is a Ni-base superalloy that is widely used in the manufacture of gas turbine engines. Under normal operating and service conditions, repair welding is often required to restore the structural integrity of various turbine engine components. It has been previously shown that multiple repair and post weld heat treatment cycles degrade the weldability of Alloy 718 due to an increase in the liquation cracking susceptibility. Long term isothermal heat treatments of 954°C/40hr-100hr have been used to simulate this degradation in laboratory experiments

Extensive precipitation of needle- and plate-shaped δ phase in the γ -nickel matrix of wrought Alloy 718 is the major metallurgical change resulting from simulated multiple weld repair/post weld heat treatment (PWHT) cycles. Grain size did not change appreciably during these heat treatments owing to δ phase pinning on grain boundary(GB). The weldability of Alloy 718 degraded as a result of the multiple weld repair/PWHT cycles. The weldability degradation is due to the short time high temperature GB liquation caused by the combined effects of δ phase dissolution, boron carbide constitutional liquation and GB segregation. A short time rejuvenation treatment (1010°C/2hr) effectively restored the degraded weldability by removing the adverse influence of δ phase through simple dissolution above the δ -phase solvus, and promoting a spontaneous grain refinement and increase of volume fraction of special GBs owing to the elimination of δ phase pinning of GBs. The combined effects of δ phase, grain size and special GBs are discussed regarding HAZ liquation cracking that occurs during repair welding of Alloy 718.

Key words: rejuvenation heat treatment, HAZ liquation cracking, PWHT, repair weldability, δ phase, grain refining, special grain boundary