Interstitial diffusion from the weld metal into the high temperature heat affected zone in 11-12% chromium steel welded joints

By

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Titel: Interstisiële diffusie vanaf die sweismetaal na die hoë temperatuur hitte-invloedsone in 11 –12% chroomstaal sweislasse

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Samevatting

Kommer oor ferrietkorrelgroei in die hitte-invloedsone van sweise in ferritiese roesvrye staal is ook van toepassing op sweise in 3CR12. Korrelgroei beïnvloed die slageienskappe van sweislasse in 3CR12 nadelig.

'n Hoër fraksie korrelgrensausteniet in die hitte-invloedsone van sweise in 3CR12 behoort ferrietkorrelgroei te strem. Koolstof en stikstof is sterk austenietstabiliseerders, en behoort 'n dubbel-fasestruktuur in die hitte-invloedsone van sweise in 3CR12 te produseer. Hierdie dubbel-fasestruktuur sou dan ferrietkorrelgroei kon vertraag.

Hierdie werk bewys, deur berekening en eksperimentele werk, dat die fraksie austeniet in die hitte-invloedsone, die ferrietkorrelgrootte en die slageienskappe van 'n sweislas in 3CR12, deur diffusie van koolstof en stikstof vanaf die sweismetaal na die hitte-invloedsone beïnvloed kan word.

Sweismetale met verskillende koolstofvlakke is tydens handboogsweising en gas-metaalsweising gebruik. Vervolgens is die mikrostrukture van die verskillende hitte-invloedsones ondersoek. 'n Kleiner ferrietkorrelgrootte is waargeneem in die hitte-invloedsones van sweislasse met 'n hoër koolstofinhoud in die sweismetaal. Verder is die slageienskappe van die sweislasse ook verbeter. Die stikstofinhoud van die sweismetaal is verhoog deur een derde stikstofgas by 'n suiwer argon skermgas te voeg, en die mengsel tydens gas-metaalsweising as skermgas te gebruik. Hierdie sweise het eweneens kleiner ferrietkorrels in die hitte-invloedsone gehad. Chemiese analise het laat blyk dat die koolstof- en stikstofinhoud van die hitte-invloedsone wel verhoog het. Die resultaat kan egter nie as finale bewys beskou word nie, aangesien die toetsmonster moontlik deur die sweismetaal besoedel kon wees.

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Synopsis

Concerns regarding the grain growth in the heat-affected zones of welds in ferritic stainless steels also apply to 3CR12. Ferrite grain growth has a detrimental effect on the impact properties of welds in 3CR12.

A higher fraction of grain boundary austenite in the heat-affected zone of a weld in 3CR12 should inhibit ferrite grain growth. Carbon and nitrogen are strong austenite stabilisers and should produce a dual phase in the heat-affected zone in 3CR12 welds, thereby slowing ferrite grain growth.

This thesis shows, through calculation and experimentation, that the fraction of austenite in the heat affected zone, the ferrite grain size and the impact properties of welds in 3CR12 can be influenced by diffusion of carbon and nitrogen from the weld metal, across the fusion line into the heat-affected zone.

Weld metals with different carbon contents were used in shielded metal arc welding and gas metal arc welding. The microstructures of the heat-affected zones of the

different welds were examined. The ferrite grain sizes in the heat-affected zones of the higher carbon welds were smaller than in the lower carbon welds. Furthermore, the impact properties of the welds with the higher carbon filler metal were improved. The nitrogen content of the weld metal was increased by adding one third of nitrogen gas to a pure argon shielding gas during gas metal arc welding. The heat-affected zone grain size of these welds was smaller. Chemical analysis seemed to confirm that diffusion of carbon and nitrogen across the fusion line occurred. Results were however not conclusive because of possible contamination of the test samples by the weld metal, as the high temperature heat affected zone is very narrow and samples were obtained by drilling.

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