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The effect of friction hydro-pillar processing on the properties and characteristics of ASTM grade P92 steel

Moropene, Tumelo

2021
https://hdl.handle.net/10539/32951

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ABSTRACT

The effect of the Friction Hydro-Pillar Process (FHPP) on the microstructure and hardness of P92 ferritic/martensitic steel was studied to determine whether FHPP could be used to repair cracks in the main steam pipes of power plants. The microstructural evolution, phase formation and hardness of the P92 steel were analysed.

Thermo-Calc software with the TCFe5 database was used to calculate phase proportion diagrams for the P92 pipe and weld samples. Gleeble uniaxial compression tests were used tosimulate the FHPP weld. Hot compression tests were done at 1100°C and 1200°C at strain rates of 10 s^{-1} and 50 s^{-1} in order to simulate FHPP weld. The compressed samples were subsequently heat treated at 760°C for 3 hours 45 minutes or 5 hours because the provided FHPP welds had been heat treated.

Thermo-Calc phase proportion diagrams indicated BCC as the major phase with minoramounts of $M_{23}C_6$, MnS, M_2B, MX, FCC and Laves phases. The Gleeble uniaxial compression results showed that the flow stress increased with decreased deformation temperature and increased strain rate. The FHPP weld had good integrity without defects. The FHPP weld sample was fully tempered martensite with 254±19 $HV_{0.3}$ hardness, whereas the hot compressed specimens had 449±11 $HV_{0.3}$ hardness. The heat treatment reduced the hardness of the hot compressed samples to 280±29 $HV_{0.3}$. Gleeble compression tests with subsequent heat treatment reproduced the FHPP weld structure. Thus, FHPP can be used to repair steam pipes because of the good integrity of the weld.