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Microstructure and Mechanical Properties of Low Alloy Steel with Double Austenitizing Tempering Heat Treatment

Authors : Jae-Ho Jang, Jung-Soo Kim, Byung-Jun Kim, Dae-Geun Nam, Uoo-Chang Jung, Yoon-Suk Choi

Abstract : Low alloy steels are widely used for pressure vessels, spent fuel storage, and steam generators required to withstand the internal pressure and prevent unexpected failure in nuclear power plants, which these may suffer embrittlement by high levels of radiation and heat for a long period. Therefore, it is important to improve mechanical properties of low alloy steels for the integrity of structure materials at an early stage of fabrication. Recently, it showed that a double austenitizing and tempering (DTA) process resulted in a significant improvement of strength and toughness by refinement of prior austenite grains. In this study, it was investigated that the mechanism of improving mechanical properties according to the change of microstructure by the second fully austenitizing temperature of the DAT process for low alloy steel required the structural integrity. Compared to conventional single austenitizing and tempering (SAT) process, the tensile elongation properties have improved about 5%, DBTTs have obtained result in reduction of about -65℃, and grain size has decreased by about 50% in the DAT process conditions. Grain refinement has crack propagation interference effect due to an increase of the grain boundaries and amount of energy absorption at low temperatures. The higher first austenitizing temperature in the DAT process, the more increase the spheroidized carbides and strengthening the effect of fine precipitates in the ferrite grain. The area ratio of the dimple in the transition area has increased by proportion to the effect of spheroidized carbides. This may the primary mechanisms that can improve low-temperature toughness and elongation while maintaining a similar hardness and strength.

Keywords : double austenitizing, Ductile Brittle transition temperature, grain refinement, heat treatment, low alloy steel, low-temperature toughness
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