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Development of ultrahigh strength cast-grade microalloyed steel by simple innovative heat treatment techniques for industrial applications

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Abstract

Aim of the present study is to devise simple and economical heat treatment methods to develop ultrahigh strength cast-grade microalloyed steel for industrial applications. Typical heat treatment cycles were designed on the basis of critical temperatures, A_{c3} & A_{c1} (obtained through Thermo-Calc software) and TTT/CCT curves (constructed using JMatPro software). In this work, homogenized annealed samples have been subjected to typical heat treatment cycles that consisted of repeated short-duration holding at different critical temperatures followed by forced air cooling/ice-brine quenching. The two cycles heat treatment (i.e., holding for 6 min at $A_{c3}+50^{\circ}\text{C}$ followed by forced air cooling + holding at intercritical zone for 20 min followed by ice-brine quenching) has resulted a significant increase in the strength with a significant amount of ductility (UTS=1545MPa, hardness=446HV, 9% elongation). This could be attributed to the development of a typical complex microstructure consisted of degenerate pearlite, fragmented cementite and finely dispersed NbC/VC in the matrix of spider network like martensite. Development of such typical microstructure has been enlightened through the analysis of divorced eutectoid transformation and diffusion controlled mechanisms. Therefore, these heat treatments techniques could be extremely useful to develop ultrahigh strength cast grade steels economically for structural/industrial applications.

Keywords:

Microalloyed steel; Thermo-Calc analysis; Divorced eutectoid transformation; Fragmented cementite; Spider net like martensite; Mechanical properties.

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