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Investigation of Microstructure of Differently Sub-Zero Treated Vanadis 6 Steel

Authors : J. Ptačinová, J. Ďurica, P. Jurči, M Kusý

Abstract : Ledeburitic tool steel Vanadis 6 has been subjected to sub-zero treatment (SZT) at -140 °C and -196 °C, for different durations up to 48 h. The microstructure and hardness have been examined with reference to the same material after room temperature quenching, by using the light microscopy, scanning electron microscopy, X-ray diffraction, and Vickers hardness testing method. The microstructure of the material consists of the martensitic matrix with certain amount of retained austenite, and of several types of carbides – eutectic carbides, secondary carbides, and small globular carbides. SZT reduces the retained austenite amount – this is more effective at -196 °C than at -140 °C. Alternatively, the amount of small globular carbides increases more rapidly after SZT at -140 °C than after the treatment at -140 °C. The hardness of sub-zero treated material is higher than that of conventionally treated steel when tempered at low temperature. Compressive hydrostatic stresses are developed in the retained austenite due to the application of SZT, as a result of more complete martensitic transformation. This is also why the population density of small globular carbides is substantially increased due to the SZT. In contrast, the hardness of sub-zero treated samples decreases more rapidly compared to that of conventionally treated steel, and in addition, sub-zero treated material induces a loss the secondary hardening peak.

Keywords : microstructure, Vanadis 6 tool steel, sub-zero treatment, carbides
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