Influence of Niobium on High-Temperature Properties of Cr-Mo-V Creep Resistant Steel

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We investigated the impact of niobium additions on the high-temperature properties and microstructure of a Cr-Mo-V creep-resistant steel. The experimental chemical compositions were determined based on ThermoCalc calculations, and laboratory charges were made accordingly. The steel samples were hot forged and heat treated. Our research included chemical analysis, dilatometric analysis, and hardenability testing to determine the optimal austenitizing temperature. Mechanical testing included hardness measurements, tensile tests, impact toughness tests, and accelerated creep tests. The microstructure was analyzed with light optical and scanning electron microscopy, and we also conducted automated analysis of precipitates and inclusions. Our findings indicate that niobium, in concentrations between 0.05 and 0.1 mass%, improves both strength and creep resistance of the steel without significantly compromising toughness. The enhanced creep resistance can be attributed to the formation of more stable MX precipitates during creep, that hinder dislocation movement and contribute to precipitation hardening. However, at higher niobium concentrations (0.3 mass%), large primary Nb(C,N) precipitates form during solidification, negatively affecting the steel's mechanical properties, particularly its toughness.