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The effect of molybdenum during hot rolling on the microstructure and mechanical properties of wear resistant steels

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In addition to wear resistance, an optimum balance of strength, toughness and formability is the ultimate goal for wear resistant steels. The microstructure of wear resistant steels are typically martensitic which can create high strength and hardness, but at the expense of toughness and formability. The key is to achieve the proper microstructures for high strength and high hardness, but also achieve optimum toughness and formability. Thermomechanical rolling is an effective way to improve the final properties of wear resistant steels via austenite deformation prior to quenching. Rolling below non-recrystallization temperature results in elongation of prior austenite grains in rolling direction, i.e. pancaking of austenite.
Therefore, the effect of microstructure on the mechanical properties of three thermomechanically rolled and direct quenched wear resistant steel plates was investigated. The prior austenite morphology and transformed microstructure was studied and compared to tensile properties, impact toughness and bendability. Decreasing the finishing rolling temperature increased the level of austenite pancaking. Centerlines of samples consisted mainly of auto-tempered martensite. With lower finishing rolling temperatures and higher reductions in the non-recrystallization regime the formation of polygonal ferrite and bainite increased at the quarter thickness. High fraction of polygonal ferrite seemed to have a detrimental effect on strength and impact toughness. Impact toughness is also impaired by the presence of coarse inclusions.
According to these results, it is recommendable to choose low finishing rolling temperatures to increase the pancaking of austenite, which improves the impact toughness and strength of wear resistant steel plates. However, finishing rolling temperature should be high enough to prevent the excessive formation of polygonal ferrite resulting in highly inhomogeneous microstructure. Also, the quenching should be rapid enough to ensure the homogeneous, mostly martensitic microstructure. By eliminating coarse inclusions via proper steelmaking operations, excellent impact toughness levels could be obtained.

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