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Investigations on the effect of cooling rate on quenching & partitioning (Q&P) in martensitic stainless steels

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Quenching and partitioning (Q&P) is a heat treatment used to adjust the retained austenite content in the microstructure. The heat treatment consists of a hardening step followed by rapid cooling to a certain quenching temperature between martensite start and martensite finish temperature and subsequent partitioning, i.e. heating and then holding at temperature. During partitioning, the formed martensite is tempered and the austenite is stabilised by diffusion of carbon atoms from the martensite into the austenite. This type of heat treatment is mainly used for low-alloyed steels. However, the partitioning effect has also an influence on higher alloyed steels, such as martensitic stainless steels. The typical heat treatment for these steels is quenching and tempering (Q&T). For large-scale tools, it happens that the centre region of the tool is not cooled down to room temperature before the tempering step takes place, resulting in a Q&P instead of a Q&T treatment. This can lead to higher retained austenite content or even fresh martensite in the microstructure after heat treatment.

Q&P depends on the dissolved alloy content in the matrix before quenching, which is controlled by the material composition and the austenitizing temperature. Important factors are also the quenching and partitioning temperatures and the cooling rate. Especially with larger components the cooling rate in the inner area is lower than in the peripheral area. Therefore, the influence of the Q&P on martensitic stainless steels at fast and slow cooling rates was investigated in this work. Heat treatments with different parameters were carried out on a dilatometer. Subsequently hardness and retained austenite content of the samples were determined in order to compare the properties. It will be shown that the alloy content and the cooling rate have an influence on the retained austenite content of the finale microstructure and also the hardness.

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