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MS-4-P-6062 Effects of the Localized Overheat On the Microstructure of Centrifugally Cast HP-Steels Used In Steam Reformer Furnaces

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High strength at elevated temperatures is an important characteristic of heat-resistant cast stainless steels, an example of these steels is ASTM A297, grade HP, which is used as radiant tubes in pyrolysis and reformer furnaces. In operational conditions the wall temperature in these tubes can reach a maximum of 950°C. During that operational condition, the gradual deterioration of the catalyst in the radiant tubes can result in increased temperature over 1000°C in localized regions[1]. The radiant tubes usually take 100000 h as a reference lifespan but, nowadays requirements for higher productivity have raised the demand for improved performance. In this context Nb and Ti were added in the chemical composition of the normal grade, resulting in the modified HP steels. Despite the improvement in the structural stability by the additions of Nb and Ti, during service at high temperatures the microstructure changes due to aging time [2]. Modified HP steels have a fully austenitic matrix with primary Cr and Nb carbides along the interdendritic region. During aging time, besides the coalescence of the primary interdendritic carbides, a fine secondary precipitation in the matrix and a partial transformation of the primary NbC to a G-Phase ($Ni_{16}Nb_6Si_7$) occurs [3]. Despite this, some uncertainties remain concerning the integrity of tubes that don’t collapse during an overheating events and the possibility of reusing them. In this context, the aim of this work is evaluate the effects of the localized overheating on these modified HP steels aged in different conditions during long term exposure in service by SEM and TEM. The microstructural analysis was performed using samples in aged, over-aged and localized overheated conditions, obtained from radiant tubes reached 70.000 h of service. The SEM samples were prepared by conventional grinding and polishing techniques and TEM samples were prepared by electro-polishing techniques. Despite the fragmentation of primary carbides, including the G-Phase, the SEM analysis of the samples in the same region of different tubes showed mainly a massive secondary precipitation in the aged condition and an apparently complete dissolution of these precipitates in the overheated tube, Fig. 1. But in fact, the TEM analysis, Fig. 3, showed a partial dissolution of the secondary precipitates. This fact broad the discussions about the possibility of reuse these radiant tubes, who suffered the temperature burst and showed a microstructure near than tubes in the aged condition.

[1] F.C. Nunes et al., Mater Charact. 58 (2007) 132. [2] G.D.A. Soares et al., Mater Charact. 29 (1992) 387. [3] R.A.P. Ibañez et al., Mater Charact. 30 (1993) 243.

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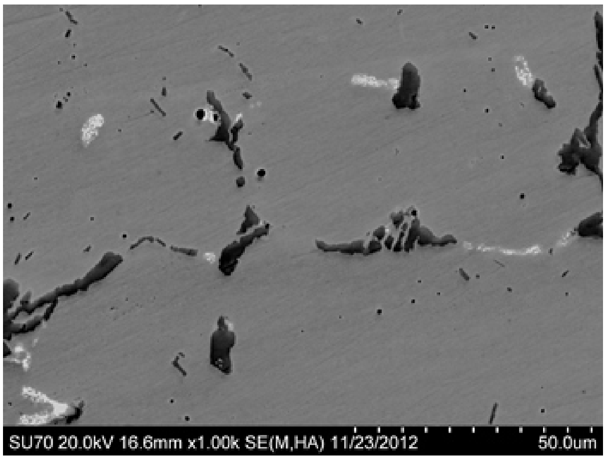

Fig. 1: SEM image of the microstructure an overheated condition.

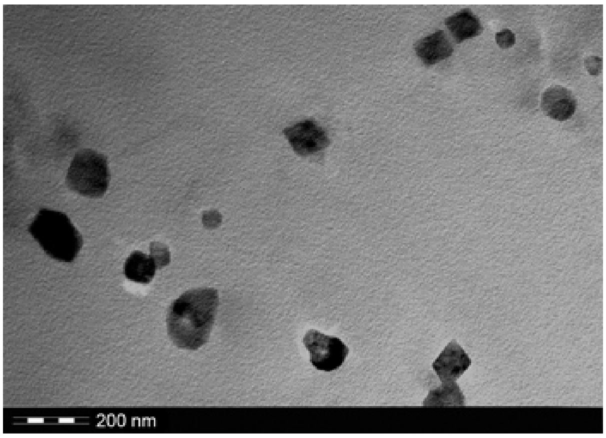

Fig. 2: TEM image of secondary precipitation.

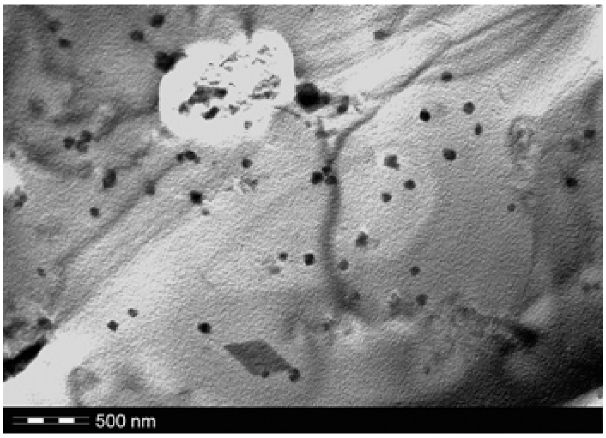

Fig. 3: TEM image of secondary precipitation, aged condition.

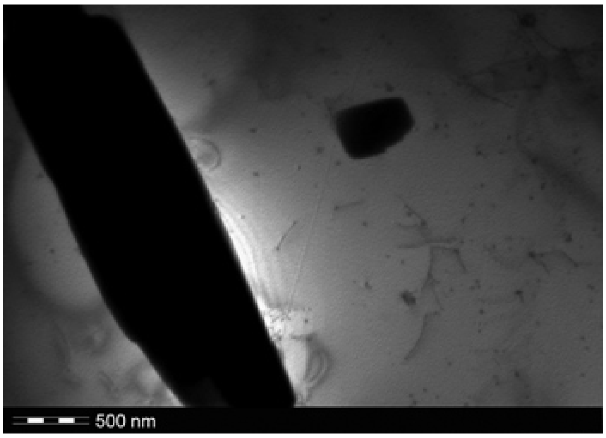

Fig. 4: TEM image of secondary precipitation, overheating condition.