Characterization of oxide layers grown on Fe-Mn-Si-Cr-Ni alloys after cyclic oxidation.

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This work aims to characterize the oxide layer grown on three Fe-Mn-Si-Cr-Ni alloys previously tested under cyclic oxidation. The chemical nominal composition (wt%) used were Fe-17Mn-5Si-10Cr-4Ni-(VC), Fe-17Mn-8Si-10Cr-4Ni-(NbC) and Fe-12Mn-5Si-10Cr-4Ni-(NbC), hereafter named alloys 1, 2 and 3 respectively. Cyclic oxidation tests were performed during approximately 400 hours under 1000°C degrees and at least 750 hours at 800°C. The oxidized samples were characterized by SEM, EDS and also X-ray diffraction (XRD) for the samples tested at 1000°C.
The SEM images showed the irregular layers morphology, mainly after 1000°C test. EDS observations in the three alloys showed Mn and Cr presence for both temperatures and, in some cases, also Fe and Si. The Mn was dispersed in the whole layer causing depleted zones in the base material (Fig.1) [1]. The Cr was always concentrated at the interface oxide/metal and, for the tests at 1000°C, it was also dispersed in the whole oxide layer. The test temperature increasing generated higher silicon oxidation, all the alloys at 1000°C showed some amount of Si dispersed in the layer, and the alloy 1 and 3 also presented small amounts of Si for 800°C. The Fe appeared dispersed in the oxide layer in the alloy 1 (800 and 1000°C) and alloy 3 (1000°C), but in fewer amounts than Cr and Mn. XRD and EDX results suggested the oxides shown in the Table 1. For all alloys the Cr-Mn oxides detected were probably Cr_2MnO_4, $CrMn_2O_4$ or $CrMn_{1,5}O_4$. Although the diffraction peaks of the oxides Cr_2O_3, Mn_2O_3, Mn_3O_4 and SiO_2 also could be fitted by XRD (at the same peaks of more complex oxides), the EDS maps just presented small areas with only one oxidated element. The main occurrence was the Cr oxide at metal/oxide interface. Moreover, some oxides allow Fe or other elements solubility forming for example Mn_7SiO_{12}, Cr_2SiO_4, Cr_2FeO_4 and $FeMn_2O_4$.
Keywords: Fe-Mn-Si-Cr-Ni alloy, oxide characterization, SEM, XRD.

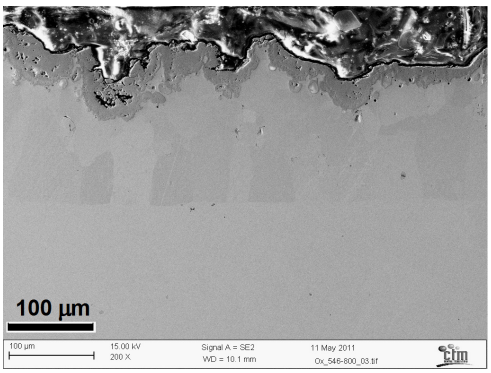

Fig.1 - alloy 1 oxidized at 800°C.

Alloy	oxides estimated by XRD and EDS results at 1000°C
01	Cr_2MnO_4, $CrMn_{1,5}O_4$, $CrMn_2O_4$ and Cr_2O_3
02	Cr_2MnO_4, $CrMn_{1,5}O_4$, $CrMn_2O_4$, Cr_2O_3, Mn_2O_3, Mn_7SiO_{12}, Mn_3O_4 and SiO_2
03	Cr_2MnO_4, $CrMn_{1,5}O_4$, Mn_2O_3 and Mn_7SiO_{12}

Tab. 1 - oxides based on XRD and EDS results.

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