Modeling of Selective and Competitive Oxidation of Fe-Ni-Cr Alloys at 1173 K

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We present the extended model of selective and competitive oxidation of multi-component alloys. The model is based on;

- the generalized Darken method of interdiffusion;
- the Wagner model of the Ni-Pt alloy oxidation;
- the postulate that the values of fluxes in reacting alloy are limited (the kinetic constraint) and
- the thermodynamics of the Fe-Ni-Cr system.

We show the extended tests of the model. We start from the initial stages of the reaction (non-stationary period of the reaction) during which the Cr surface concentration is time dependent, through the quasi-stationary period (constant Cr surface concentration) up to complete chromium depletion from the oxidized alloy.

We demonstrate that the model enables to predict the evolution of component distributions in reacting ternary alloy. The results of the oxidation of the 310SS steel are presented and calculated concentration profiles are compared with the experimental data. The satisfactory agreement allows conclude that the oxidation reaction is limited by interdiffusion in reacting alloy. We show that the oxide spallation markedly increases the chromium deplation from the very beginning of the reaction ($t > \sim 2$ hours). The computations demonstrate that chromium depletion affects the scale composition. Upon combining the presented model with thermodynamics of the Fe-Ni-Cr-O system one can guess on the scale composition as a function of reaction time.