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Solution nitriding of a Fe-0.13%C-1.2%ni-13%Cr grade steel: a theoretical and experimental study

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Solution nitriding is a high temperature nitriding process carried out in a gaseous atmosphere composed of pure nitrogen under various pressure. It is notably used to reinforced stainless martensitic steels while limiting loss of stainless properties due to chromium precipitation. The aim of the study is to propose an approach based on thermodynamics considerations for identifying adequate treating parameters for a given steel grade. Therefore, a theoretical study has been conducted considering a Fe-0.13%C-1.2%Ni-13%Cr steel. The use of thermodynamics calculation software permits on one hand, to determine the nitrogen solubility limit in the austenitic region before precipitating chromium nitrides for the considered steel and on the other the hand, to estimate the maximum nitrogen content that it is possible to introduce in steel with respect to the treatment pressure. Nitrogen profile could then be estimated thanks to use of diffusion modelling software. To confront the theoretical approach with experimental results, samples were treated on laboratory equipment under N2 and N2-NH3 atmospheres at temperatures comprised between 1000 ℃ and 1100 ℃. Nitrided layers were investigated using light optical microscopy, hardness measurements and glow discharge optical emission spectroscopy (GDOES). Degradation of stainless properties was evaluated using voltammetry method. The thermochemical approach of the solution nitriding process developed in this study, based on the coupling between thermodynamics et kinetics, appears to be a reliable support for the identification of conditions allowing minimization of stainless properties loss for nitrided stainless martensitic steel.

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