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Alternative Annealing Process for NGO Electrical Steels Using Hydrogen Combustion: A Comparative Study

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To reduce CO2 emission H2 could be used as a fuel for energy intensive thermal processes such as hot rolled strip annealing. This article presents approach and results of laboratory trials at developing an alternative CO2-free fuel application for the annealing of Non Grain-Oriented (NGO) electrical steels in the annealing and pickling line (APL), where the annealing of the material is carried out using fumes from Hydrogen combustion instead of natural gas. To understand the differences produced by the use of the two different atmospheres, oxidation tests were conducted on high Silicon percentage (3.16%Si-1.04%Al) hot-rolled steel strips at various temperatures and different air/fuel ratio . The evaluations conducted included considerations on productivity as well as the impact of Hot Band Annealing (HBA) on the main properties which are known to affect the quality of the finished products. Descaling and pickling tests were carried out, which allowed predictions on the process productivity. SEM investigations with EDS and XRD analyses were conducted to identify differences in morphology and composition of the scale present at the end of HBA with particular attention to the formation of the Iron silicate (Fe2SiO4) known as fayalite. Possible residues of internal oxidation at the end of the pickling process were also checked. Potential nitriding and carburization phenomena that may occur to different extents within the two atmospheres were investigated using a CNS elemental analyzer. To obtain a comprehensive overview, the analysis also included observations of the microstructure of the annealed and pickled material. The process under examination was evaluated as its adoption could allow an elimination of direct CO2 emissions up to 50 kg per ton of steel.

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