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INVESTIGATION OF THE SELECTIVE OXIDATION PROCESS FOR HIGH STRENGTH STEELS

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ABSTRACT

The combination of strength and formability makes Advanced High Strength Steels (AHSS) superior to other lightweight materials. Such properties are obtained by adding different alloying elements (C-below 0.3 wt.%, Mn-1 to 15 wt.%, Si-upto 5 wt.%, Cr-upto 1 wt.% and Al-upto 2 wt.%). The corrosion resistance property is improved by applying a protective Zn coating on the surface by Hot dip galvanizing line. Before entering into the liquid Zn bath, the steel strip is continuously annealed in radiant tube or direct- fired furnace, at about 820 °C. The furnace atmosphere (95% N_2+ 5% H_2 at a dew point of -40 ^{O}C) is maintained such a way that although Fe is not oxidised but the other alloying element will selectively oxidized to form MnO, SiO_2, Al_2O_3 etc. In the presence of such surface oxide the formation of interfacial layer during the Zn coating is disturbed, which results in poor adhesion of the coating. In order to achieve better adhesion, the surface is oxidised at first to form FeO layer on the top surface. Oxides of other alloying elements are embedded within the FeO layer or lie under the FeO layer. In the next step, the FeO is reduced in a reducing atmosphere to form pure Fe layer on thesurface. In the present work, a 1D implicit model has been developed to simulate simultaneous diffusion of chemical species and precipitation of simple and mixed oxides in the steel matrices for different alloy compositions and dew points. oxidising experiments for each of IF steel, alloy S1 (Fe-1.58 wt.% Mn) and S2 (Fe- 2.52 wt.% Mn) were done in Hot Dip Process Simulator (HDPS) at different temperature and dew point combinations to determine the suitable environment for optimum Wustite formation. Characterisation of the oxidised samples has been done using GA-XRD and Raman Spectroscopy. Thermo Gravimetric Analysis has been done by heating the samples at 15 K/min and holding them at the peak temperatures of 650 ^{O}C,750 ^{O}C and 850 ^{O}C for 2 hours in an atmosphere of Ar+CO+CO_2, having CO_2/CO ratio of 1, 2 and 3 followed by cooling at 15 K/min.

From the precipitation simulation at 800 ^{O}C temperature and -40 ^{O}C dew point for 1.235, 1.58, 2.52, 3.58 wt. % Mn steel, internal oxidation depth of 0.38 μm was obtained. Increase in dew point results increase of internal oxidation zone's depth exponentially. The simulation data of Fe-1.225 wt.% Mn-0.075 wt.% Si steel oxidised at 800 ^{o}C at -40 ^{o}C dew point shows precipitation of MnO solely at the surface node while SiO_2 precipitate over a large region (up to 0.98 μm depth). Parabolic growth followed by linear growth has been observed from the TGA graphs. With increasing temperature, parabolic region decreased and linear growth dominates. Top surface morphology of the oxidised sample changes with increasing temperature and the oxide particle size found to be increase with increasing CO_2/CO ratio.

Keywords: Advanced High Strength Steel, Hot-Dip Galvanizing, Selective Oxidation, Kinetics, Dew Point, Internal oxidation Zone depth (IOZ)