Effect of Automobile coatings on permeation of Hydrogen in High Strength Steels

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Coating processes such as phosphating and electrophoretic deposition are widely used surface treatment techniques in automobile industries on Body In White (BIW) components. Aim is to enhance the corrosion and wear resistance of the structure and improve adhesion of subsequent layers of coating. However, as the coating processes are carried out in conditions which can introduce hydrogen in the material, a thorough understanding of the coating processes, with the perspective of hydrogen entry, is necessary. Also, with increased use of High Strength Steels (HSS), the concern for Hydrogen Embrittlement (HE) in these structural components is increasing. A lot of literature is available explaining the effect of hydrogen in steel, however, the interaction of hydrogen with steel during the coating processes remains relatively less investigated.

Hydrogen permeation is carried out in DP1000 steel, with and without Zn coating, using modified Devanathan Stachurski(DS) cell to investigate the contribution of Zn coating on hydrogen absorption in metal substrate. The effect of the contribution of the phosphate layer was later studied on the two different samples.

Hydrogen permeation studies revealed that presence of galvanized coatings increased the susceptibility of the substrate to HE. The hydrogen permeation curve of the galvanized sample exhibited a higher breakthrough time, the current rose steadily until it reached a maximum and then decreased until it reached a steady state which corresponded to the steady state current of the bare metal. This is believed to be because of the additional anodic reaction occurring due to the dissolution of Zn. The effect of phosphating, on the other hand had different effect on both the samples. In presence of phosphate layer on bare sample, the permeation current remained the same or marginally increased. On the other hand, the phosphate layer on galvanized sample, reduced the permeation current significantly.

Keywords: Hydrogen Permeation, Phosphating, High Strength Steels (HSS).