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Investigation of Anti-corrosion Properties of Epoxy Coating Containing Clay Nanoparticles Using EIS and Scanning Kelvin Probe

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INTRODUCTION

One of the most important methods of controlling the corrosion rate is the use of polymer and composite coatings on the internal surfaces of refinement and pipelines. Epoxy base coatings containing anti-corrosion pigments are suitable coatings for this purpose [1]. The pigments used in these coatings can interfere with the surface of the steel and corrosive environments with different mechanisms such as damping or barrierity. The barrier pigments protect steel from corrosion by reducing the permeability of liquids and gases. The clay nanoparticles are introduced into the polymeric structure by solvent, in situ polymerization and direct mixing. Oxygen, water, and corrosive ions can control corrosion [2, 3]. Various studies have shown that the addition of the clay alone or with other nanoparticles to the epoxy matrix improves the anti-corrosion properties of the coating. In a study conducted in 2007, the effect of adding zinc, silicon dioxide, clay oxide and iron oxide on the resistance of epoxy coatings and reducing the rate of corrosion in a 3% solution of brine has been compared. According to the results of the impedance test, all of these particles reduced the corrosion rate and increased the coating strength, but the clay particles and iron oxide had the highest impact [4, 5].

These nanoparticles can form a barrier layer and slow down the electrolyte penetration pathway.

METHODOLOGY

The materials used are: D.E.N 431 Epoxy Resin with EEW = 175, Polyamino Hardener with 24 HW =, Nanoclay (Monte Myrnolite) Closite30b Sigma Aldrich. Clay nanoparticles were added to the resin in two volumes of 3 and 5 wt.%. Mechanical coatings such as stirrer and glass balls were used to coat nanoparticles.

Finally, the resin is mixed with the desired nanoparticle so that the particles are completely dispersed in the resin evenly. This process was performed for 6 hours at 2000 rpm. After ensuring that no particles were agglomerated and uniformly distributed, using a thin film on the glass, the polypropylene hardener was added to the resulting mixture and mixed for 15 minutes. The weight/weight ratio of the resin to Hardener was 13 to 1. The resulting paint was applied to the scalded and depleted steel plates.

Applying the paint was performed using the air spray process and single-layer. The thickness of all coatings was in the range of 35-50 µm. In addition, to ensure complete cooking, they were kept in oven at 35 ° C for 15 days. How to disperse nanoparticles in epoxy resin using a CM 30 Philips Co. (TEM) transmitted electron microscope (TEM) was investigated.

RESULTS AND DISCUSSION

In the project, the effect of the clay nanoparticles on the increase of protective properties of the epoxy coating on carbon steel was studied. The results of the electrochemical impedance showed that the addition of this nanoparticle increased the resistance of the epoxy coating applied to the steel substrate. The coating resistance of 3% clay after a 1000-hour immersion in salt water was at about 107 Ω.cm, indicating good resistance to the coating in the corrosive environment. The purpose of this study was to investigate the effect of the Clay nanoparticles on the protective properties of the epoxy coating on carbon steel. The results of the electrochemical impedance spectroscopy showed that the addition of this nanoparticle increased the corrosion resistance of the epoxy coating. The resistance of the coating containing 3% nanoclay after 1000 hours immersion in NaCl 3.5 wt.% was about 3.1 × 106 Ω.cm, indicating good resistance to the coating in the corrosive environment. Also, the results of electrochemical impedance showed that coating containing 3% nanoclay showed better resistance than coating containing 5% nanoclay. The results of the Scanning Kelvin Probe (SKP) showed that in nanoclay-containing samples after 2500 hours, the average potential of the surface gradually dropped from -345 mV to -700 mV, and the drop in surface potential in the presence of nanoclay was much less than in presence of nanoclay which indicates the positive effect of these nanoparticles on corrosion control. Volta potential of varnish without a nanoparticle reached a much lower level over the same period than a nanoclay sample of about 1500 mV. Exfoliated nanoclays by reducing and prolonging the penetration path of electrolyte containing oxygen, water and corrosive ions controlled the corrosion rate and postponed the time of penetration of the electrolyte.

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