EXECUTIVE SUMMARY

UGC MINOR RESEARCH PROJECT

On

ELECTROCHEMICAL INVESTIGATION ON THE CORROSION OF MARAGING STEEL IN ACID MEDIUM- FUNCTIONALISED NANOPARTICLES AS CORROSION INHIBITORS

2103-MRP/15-16/KAMA002/UGC – SWRO Dated 25 APRIL, 2016

For centuries during the middle age, alchemists worked wistfully to achieve the ultimate goal of creating gold or silver from other elements, but to no avail. Recently, however, scientists and engineers are becoming “new-age alchemists” by diving into a new scientific realm known as nanotechnology to create materials that will change the way we will live. Existing materials will be stronger, lighter, and more durable when coupled with nanotechnology. Isolated nanoparticles exhibit amazing properties, and when mixed with other materials the new compound becomes improved in a variety of ways. There are already many nanomaterial-enhanced products in the market, and efforts are being made that would turn polymers into efficient solar energy converters simply by mixing them with nanocrystals. The infinite possibilities that nanotechnology has on the production of nano materials is going to significantly alter the material world

The field of nanoscience and nanotechnology is nowadays one of the important interdisciplinary sciences. At the frontier of technology, scientific research and engineering, this branch of academia has garnered much attention from the academic community over the past two to three decades. Research in this field is vast and is of interdisciplinary nature.

Corrosion is defined as the continuous destruction or deterioration of a material by chemical or electrochemical attack. Corrosion, once thought, a problem concerned with only metallurgists and chemists, is now a field of interdisciplinary subject as metals are universal in their use. Several engineering disasters, such as crashing of civil and military aircraft, naval and passenger ships, explosion of oil pipelines and oil storage tanks, collapse of bridges and decks and failure of drilling flat forms and tanker trucks have been witnessed in recent years. Corrosion has been a very important factor in many of these disasters. Applying the knowledge of corrosion protection can minimize such disasters.

An inhibitor is a chemical substance which, when added in small concentrations to an environment, effectively checks, decreases, or prevents the reaction of the metal with the environment. Inhibitors find major use in closed environment systems that have good circulation, so that an adequate and controlled concentration of inhibitor is ensured. For instance use of inhibitors in cooling water recirculation systems, oil production, oil refining and acid pickling of steel components.

The application of nanotechnology in the corrosion protection of metal has recently gained momentum as nanoscale materials have unique physical, chemical and physicochemical properties, which may improve the corrosion protection in comparison to bulk- size materials. Microorganisms such as bacteria, fungi or viruses develop microbial corrosion.

Functionalization has shown to protect nanoparticles against agglomeration and render them compatible in other phases. Functionalization also improves the physical, chemical and mechanical properties of nanoparticles, which are synergetic.

The present project aimed to achieve following objectives like, Preparation and Characterization of the functionalized nanoparticles, Investigation of particle size and observing complex crystalline nature of the functionalized nanoparticles by using TEM, Study of surface morphology of the functionalized nanoparticles by Scanning Electron Microscopy. Study of corrosion inhibition property of these nanoparticles on maraging steel

Amino functionalized silica nanoparticles (ASiN), Carboxylic acid- functionalized silica nanoparticles and biogenic silica nanoparticles are prepared by the literature reported procedure

Characterization of functionalized nanoparticles are carried out by using XRD, SEM, TEM, FTIR and UV- visible spectroscopy techniques. Corrosion measurement was carried out by Weight loss method , Potentiodynamic polarization(PDP) measurements (Tafel extrapolation method) and Electrochemical impedance spectroscopy (EIS) measurements

The results of both PDP and EIS measurements clearly show that the corrosion rate increases with temperature for Maraging Steel in the entire concentration ranges of acid mixture studied. The energy of activation, enthalpy of activation and entropy of activation for the corrosion of the Maraging Steel in the acid mixture medium studied were calculated from the Arrhenius plot and [ln(υ_{corr}) vs 1/T] plot at all the concentrations of acid mixture studied. The energy of activation of corrosion for the Maraging Steel in acid mixture medium was calculated from the Arrhenius plot at all the concentrations of acid mixture studied.

The value of E_a for the Maraging Steel increases with decreasing acid concentration. This indicates that the formation of activated complex or transition state complex is slower in lower acid concentrations, and becomes faster as the concentration increases. The variation of E_a value is in accordance with the observed trend that corrosion rate of Maraging Steel increases with the increase in the concentration of sulphuric acid. The variation of $\Delta H^{\#}$ with concentration of sulphuric acid is similar to the variation of E_a. The negative values of $\Delta S^{\#}$ imply that the activated complex in the rate determining step represents association rather than dissociation

From the results obtained it can be concluded that the Synthesized functionalized nanoparticles act as a good corrosion inhibitor for Maraging Steel in an acid medium containing sulphuric acid and hydrochloric acid. They act as mixed type inhibitors in (1 M + 0.5 M) and (0.5 M + 0.25 M) acid mixture, affecting both anodic and cathodic reactions but act as cathodic type inhibitor in (0.25 M +0.125 M) acid mixture. Inhibition efficiency on Maraging Steel increases with increase in concentration of acid mixture and decreases with increase in temperature from 30 ºC-50 ºC for lower concentration of the inhibitor and increases for higher concentration of the inhibitor. Inhibitor obeys Langmuir's model of adsorption and the adsorption is predominantly through chemisorption. The adsorption process is spontaneous and exothermic process accompanied by an increase of entropy.

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