

**Corrosion Mitigation Effect of Synthesized Water Soluble Acryl  
Terpolymers on Mild Steel in HCl and Preliminary  
Investigation as Oil Filled Inhibitors  
on N80 Steel**

By

**Geethanjali, R  
(Roll No. 11PH27)**

*Supervisor*

**Dr. S. Subhashini**

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***Certificate***

This is to certify that the thesis entitled "**Corrosion Mitigation Effect of Synthesized Water Soluble Acryl Terpolymers on Mild Steel in HCl and Preliminary Investigation as Oil Filled Inhibitors on N80 Steel**" submitted to the Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore - 641043, in partial fulfilment of the requirements for the award of the **Degree of Doctor of Philosophy in Chemistry** is a record of original research work done by **Geethanjali, R.** during the period of her study in Department of Chemistry, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore - 641043, under my supervision and guidance, has not formed the basis for the award of any Degree / Diploma / Associateship / Fellowship or similar title to any candidature of any other university.

**Signature of the  
Head of the Department**

**Signature of the Supervisor**

**Signature of the Dean**

*Declaration*

I hereby declare that the matter embodied in the thesis entitled **“Corrosion Mitigation Effect of Synthesized Water Soluble Acryl Terpolymers on Mild Steel in HCl and Preliminary Investigation as Oil Filled Inhibitors on N80 Steel”** submitted to Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore - 641043, in partial fulfilment of the requirements for the award of the **Degree of Doctor of Philosophy in Chemistry** is a record of original research work done by me under the supervision and guidance of **Dr. (Tmt.) S.Subhashini.**, M.Sc, M.H.Ed (Annamalai), M.Phil (Bharathiar), Ph.D (Avinashilingam), Professor, Department of Chemistry, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore - 641043 and that it is not formed the basis for the award of any Degree / Diploma/ Associateship / Fellowship or similar title to any candidature of any other University.

**Signature of the Supervisor**

**Signature of the Candidate**

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## List of Abbreviations

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%	-	Percentage
$\theta$	-	Surface Coverage
AFM	-	Atomic Force Microscopy
$b_a$	-	Anodic Tafel Slope
$b_c$	-	Cathodic Tafel Slope
$C_{dl}$	-	Double Layer Capacitance
CPE	-	Constant Phase Element
CR	-	Corrosion Rate
DSC	-	Differential Scanning Calorimetry
DTA	-	Differential Thermal Analysis
$E_{corr}$	-	Corrosion Potential
EDX	-	Electron Dispersive X ray Analysis
EIS	-	Electrochemical Impedance Spectroscopy
FTIR	-	Fourier Transform Infrared Spectroscopy
$H_2SO_4$	-	Sulphuric acid
HCl	-	Hydrochloric Acid
HOMO	-	Highest Occupied Molecular Orbital
$i_{corr}$	-	Corrosion Current Density
IE	-	Inhibitor Efficiency
LUMO	-	Lowest Occupied Molecular Orbital
Mpy	-	Mills Per Year
MS	-	Mild Steel

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NMR	-	Nuclear magnetic resonance
PDP	-	Potentiodynamic Polarization
PVA-AAm-PVBS	-	Polyvinyl alcohol-g-poly(acrylamide-p-vinyl benzenesulfonate)
PVA-AAm-VSA	-	Polyvinyl alcohol-g-poly(acrylamide-vinyl sulfonate)
PVA-AA-PVBS	-	Polyvinyl alcohol-g-poly(acrylic acid-p-vinyl benzenesulfonate)
PVA-AA-VSA	-	Polyvinyl alcohol-g-poly(acrylic acid-vinyl sulfonate)
PVA-VSA-PVBS	-	Polyvinyl alcohol-g-poly(vinyl sulfonate-p-vinyl benzene sulfonate)
PZC	-	Potential Zero Charge
QSAR	-	Quantitative Structure Activity Relationship
$R_{ct}$	-	Charge Transfer Resistance
RMS	-	Root Mean Square
$R_p$	-	Polarization Resistance
SEM	-	Scanning Electron Microscope
TEMED	-	Tetraethyl Methyl Ethylene Diammine
TGA	-	Thermogravimetric analysis
UV	-	Ultra Violet – Visible spectroscopy

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## Abstract

Five different water soluble terpolymers based on Polyvinyl alcohol: PVA-AAm-VSA, PVA-AA-VSA, PVA-AAm-PVBS, PVA-AA-PVBS and PVA-VSA-PVBS have been developed and tested for their efficacy to control mild steel corrosion in 1 M HCl. The grafted terpolymers were characterized by UV spectroscopy, FTIR spectroscopy and  $^1\text{H}$  NMR spectroscopy. The thermal stability of the terpolymers was tested using thermo gravimetric analysis and differential scanning calorimetric analysis. The corrosion inhibition measurements were carried out by weight loss techniques and electrochemical techniques by varying time, temperature and concentration. Weight loss studies were conducted at 303 K for 1, 3, 6, 9 and 12 hours immersion time, and at 303-313 K for half-an-hour immersion time. All the terpolymers under investigation were found to provide a maximum inhibition efficiency around 90 % at 6-12 hours of immersion time at 0.45 wt.% concentration. At optimum inhibitor concentration, the terpolymers provided inhibition efficiency around 90 % at 333 K. The data obtained from temperature studies were fitted to various adsorption isotherms and the best fit was selected. The nature of the isotherm provided detailed insight into the nature of the adsorption. In this study, Temkin isotherm was found to provide a best fit and the thermodynamic parameters of adsorption indicates the chemical nature of adsorption of the terpolymers. The effect of inhibitors on the corrosion process was analyzed by constructing Arrhenius plot and Transition plot. The kinetic parameters were also determined. A suitable mechanism for the inhibitive action was proposed. To test the terpolymers as corrosion inhibitors for the oil field, corrosion studies were performed using N80 steel in 10 % HCl, 3.5 % NaCl and simulated well water. The inhibitors were assessed by potentiodynamic and impedance techniques. The best inhibitor concentration from the electrochemical studies was selected and tested in static and dynamic conditions at 55-60°C for 6 hours immersion time. The results provided a preliminary validation of the inhibitor such that they can be optimized and used for corrosion in oil and gas industries.