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

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A Thesis Submitted to

Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore – 641043

In Partial Fulfilment of the requirements for the Degree of

Doctor of Philosophy in Chemistry

July 2015

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 Filed 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 Filed 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**

Acknowledgement

I humbly bow my head before the Almighty who blessed me with willpower and courage to complete this endeavor successfully.

I extend my wholehearted thanks to **Mr. T. S. K. Meenakshisundaram,** M.A., M.Phil., Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women**,** Coimbatore, for providing the opportunity to conduct my investigation in this esteemed university.

With profound respect, I express my deep sense of reverential gratitude towards Dr**. (Mrs.) Sheela Ramachandran**, M.Sc., P.G. Dip., Ph.D., Vice Chancellor, Avinashilingam Institute for Home Science and Higher Education for Women**,** Coimbatore, for providing necessary facilities for the completion of the study.

I place a deep sense of gratitude to **Dr.(Mrs.) A.Venmathi**, M.Sc., Dip.Ed., M.Phil., Ph.D, Registrar incharge, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore for providing adequate help required for the research work.

I express my sincere thanks to **Dr. (Mrs.) A. Parvathi**, M.Sc., Dip.H.Ed., M.Phil., Ph.D., Dean, Faculty of Science, Avinashilingam Institute for Home Science and Higher Education for Women**,** Coimbatore, for her support and encouragement.

I express my special gratitude to **Dr. (Mrs.) R. Parvatham**, M.Sc, Dip.Ed, M.Phil, Ph.D, Former Dean, Faculty of Science, Avinashilingam Institute for Home Science and Higher Education for Women**,** Coimbatore, for her encouragement.

I owe my special thanks to **Dr. (Mrs.) R. Rajalakshmi,** M.Sc., B.Ed, M.Phil., Ph.D., Professor and Head, Department of Chemistry, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore for her timely help and kindness rendered to me.

With great pleasure I would like to express my cordial thanks to **Dr. (Mrs.) R. Shyamala**, M.Sc., Dip. Ed, M.Phil., Ph.D., Former Head, Department of Chemistry, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore for providing laboratory facilities and for her unflinching encouragement during the course of this study.

I feel extremely privileged and fortunate to work under the supervision of my esteemed guide **Dr. (Mrs.) S. Subhashini**, M.Sc., M.H.Ed., M.Phil., Ph.D., Professor, Department of Chemistry, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, for her scrupulous guidance and support. Her

inspiration, untiring patience, constant motivation and enthusiasm have helped me to compile and complete the thesis.

I specially acknowledge **"Tamil Nadu State Council for Science and Technology, Government of Tamil Nadu"** for catalyzing and financially supporting the research work under RFRS scheme.

Special thanks go to **Dr. BS. Chauhan**, DGM (Chemistry), R&D lab, IOGPT, and **Dr. Jharna (Chief Chemist) of Regional Research Laboratory** of ONGC Mumbai, for carrying out dynamic studies.

I wholeheartedly thank all the teaching members of Department of Chemistry Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore for their benevolent support, encouragement and timely help throughout the research.

On a personal note I extend my sincere thanks to all my friends of Chemistry Department, Avinashilingam Institute for Home Science and Higher Education, especially to **Dr. (Mrs.) A. Ali Fathima Sabirneeza**, **Ms. R. Menaka** and **Mrs. V. N. Sheeja,** and all the research scholars for their valuable suggestions and co-operation during this pleasurable investigating trip.

I express my sincere thanks to **SAIF NMR Center of IIT Chennai**, **SRM University**, **Mr.Srinivasan** AFM analyst and **Mr. Mansoor** TGA Analyst for their help rendered to me in analytical techniques.

Above all, I thank my life partner **Mr. N**, **Ganesh**, for without whom there is no glossary for this glory. His constant support and encouragement helped me complete this thesis successfully.

I would like to express my exceptional debt of gratitude to **my parents Vasuki R** and **Rajendran N** and other family members and **my in-laws Rajeswari N** and **Nagarajan, D.P** for their unconditional love, support and encouragement to pursue my interests. This doctoral study was achievable only because of the foundation laid by their sacrifices and support.

Geethanjali, R.

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List of Abbreviations

%	-	Percentage
θ	-	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

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}	-	Change 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

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}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^{o}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.