ASSESSMENT OF ASPARTAME AS A GREEN AND EFFECTIVE CORROSION INHIBITOR FOR T95 CARBON STEEL IN STRONG HCl SOLUTIONS

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (M.Sc) DEGREE IN INDUSTRIAL CHEMISTRY IN THE DEPARTMENT OF CHEMISTRY, COLLEGE OF SCIENCE AND TECHNOLOGY, COVENANT UNIVERSITY.

JULY, 2022

ACCEPTANCE

This is to attest that this dissertation has been accepted in partial fulfilment of the requirements for the award of the degree of Master of Science in Industrial Chemistry in the Department of Chemistry, College of Science and Technology, Covenant University, Ota, Nigeria.

Mr. Taiwo B. Erewunmi
(Secretary, School of Postgraduate Studies) **Signature and Date**

Prof. Akan B. Williams
(Dean, School of Postgraduate Studies) **Signature and Date**

DECLARATION

I, **UZOMA IFEANYI EMMANUEL (20PCC02312)**, declare that dissertation is a representation of my work, and is written and implemented bt me under the supervision of Dr. Moses. M. Solomon of the Department of Chemistry, College of Science and Technology, Covenant University. I attest that this dissertation has in no way been submitted either wholly or partially to any other university or institution of higher learning for the award of a masters' degree. All information cited from published and unpublished literature has been duly referenced.

UZOMA, IFEANYI EMMANUEL

Signature and Date

CERTIFICATION

We certify that this Dissertation title "**ASSESSMENT OF ASPARTAME AS A GREEN AND EFFECTIVE CORROSION INHIBITOR FOR T95 CARBON STEEL IN STRONG HCl SOLUTIONS"** is an original research carried out by **UZOMA, IFEANYI EMMANUEL (20PCC02312**) in the Department of Chemistry, College of Science and Technology, Covenant University, Ota, Ogun State, Nigeria, under the supervision of Dr. Moses. M. Solomon. We have examined and found the work acceptable as part of the requirement for the award of Masters of Science (M.Sc) in Industrial Chemistry.

Dr. Moses. M. Solomon
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Prof. Joseph A. O. Olugbuyiro
(Head of Department) **Signature and Date**

Prof. Asekun O. Taiwo
(External Examiner) **Signature and Date**

Prof. Akan B. Williams
(Dean, School of Postgraduate Studies) **Signature and Date**

DEDICATION

I dedicate this work to my dearest father, Mr Uzoma Agbotian, who inspires, drives, and encourages me to be a better individual in every ramification.

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ACRONMYS AND ABBREVIATIONS

ACPC	(E)-5-amino-N′-(4-chlorobenzylidene)-3-(4-chlorophenyl)-1Hpyrazole-4-carbohydrazide
AMPC	-(E)-5-amino-3-(4-methoxyphenyl)-N′-(1-(4-methoxyphenyl)ethylidene)(1Hpyrazole-4-carbohydrazid
ASP	Aspatame
$CaCO_3$	Calcium Carbonate
$CaMgCO_3$	Dolomite
CO	Carbon monoxide
CS	Carbon steel
CTCH	1-cinnamylidine-3-thiocarbohydrazide
DCTCH	1,1-dicinnamylidine-3-thiocarbohydrazide
EDAX	Energy dispersive X-ray analysis
EIS	Electrochemical impedence spectroscopy
Fe_2O_3	Iron oxide
$FeCO_3$	Siderite
HCl	Hydrochloric acid
KI	Potassium Iodide
NTHC	N^1,N^1-diallyl-N^6,N^6,N^6-tripropylhexane-1,6-diaminium chloride
OCP	Open circuit potential
OP	Optical profilometer
PDP	PolPotentiodynamic polarization
poly- NTHC	poly(N^1,N^1-diallyl-N^6,N^6,N^6-tripropylhexane-1,6-diaminium chloride)
SDS	Sodium docylesulphate
SEM	Scanning electron microscope
WL	Weight loss

ABSTRACT

Oil well acidizing, although a stimulation process, induce the corrosion of metallic equipment and well tubings. It is a necessity to use an effective corrosion inhibitor during oil well acidizing. However, current acidizing inhibitors, although effective are toxic to the natural environment and in some cases, very expensive. There is therefore, at present a high demand of effective, low-cost, and less toxic corrosion inhibitor for acidizing process. This work was thus designed to formulate a green and low-cost inhibitor formulation based on Aspartame (ASP) that can compete favourably with the commercially available acidizing corrosion inhibitors. The inhibitive effect of ASP for T95 CS in 15 and 28 wt.% HCl solution at 60, 70, 80, and 90ºC was investigated using the weight loss, electrochemical impedance spectroscopy (EIS), potentiodynamic polarization (PDP), scanning electron microscope (SEM), energy dispersive spectroscopy (EDX), and optical profilometry (OP) techniques. Results from the weight loss and the electrochemical techiniques show that the retardation efficacy of ASP enhances with increase in concentration and temperature. At 90ºC and 2000 ppm of ASP, inhibition efficiency of 85% and 88% is obtained in 15 wt.% and 28 wt.% HCl solution, respectively. Following the variation of inhibition efficiency of ASP with temperature, chemisorption mechanism is proposed for the adsorption of ASP onto the T95 CS surface in both 15 wt% and 28 wt.% HCl solution. In order to enhance the inhibitive performance of ASP, studies were undertaken to ascertain whether or not there is synergistic effect between ASP, potassium iodide (KI), and sodium dodecylsulfate (SDS). Results from weight loss studies reveal that synergistic effect existed between ASP, KI, and SDS especially at 90ºC. Based on the synergistic studies, ASP-based cocktail was formulated in a ratio of 2 (ASP): 0.1 (KI): 0.1 (SDS). The formulation performed outstandingly at the studied corrosive media. At 90ºC, 2000 ppm of the formulation exhibits inhibition efficiency of 92% and 96% in 15 wt% and 28 wt.% HCl solution, respectively from EIS technique. A comparison of the performance of the formulation with that of a commercially available acidizing inhibitor reveals that, the formulation perform better than the commercial inhibitor in 28 wt.% HCl solution but compete considerably in 15 wt% solution. The PDP results reveal that ASP alone and in combination with additives acted as a mixed-type corrosion inhibitor in the studied environment and inhibited both the anodic oxidation and cathodic reduction reactions. The SEM, OP, and EDX results confirmed the adsorption and high inhibitive performance of ASP-based inhibitor. The ASP-based formulation is a potential inhibitor for oil well acidizing process.

Keywords: Acidizing; Corrosion; Greenness; Aspartame; Adsorption.