

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

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JULY, 2022

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BY

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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.

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Signature and Date

DECLARATION

I, **UZOMA IFEANYI EMMANUEL (20PCC02312)**, declare that dissertation is a representation of my work, and is written and implemented by 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 All information cited from published and unpublished literature has been duly referenced.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.

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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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TABLE OF CONTENTS

COVER PAGE	
TITLE PAGE	
ACCEPTANCE	iii
DECLARATION	iv
CERTIFICATION	v
DEDICATION	vi
ACKNOWLEDGEMENTS	vii
TABLE OF CONTENTS	viii
LIST OF FIGURES	xiii
LIST OF TABLE	xi
LIST OF SCHEMES	xv
ACRONMYS AND ABBREVIATIONS	xvii
ABSTRACT	xvii
CHAPTER ONE : INTRODUCTION	1
1.1. Background of the study	1
1.2. Statement of the research problem	3
1.3. Research questions	4
1.4. Aim and Objectives	5
1.4.1. Aim of the study	5
1.4.2. Objective of the study	5
1.5. Justification for the study	5
1.6. Scope of the study	6
CHAPTER TWO : LITERATURE REVIEW	7
2.1. The chemistry of acidizing process	8
2.2. Inhibitors: Why needed?	10
2.3. Corrosion inhibitor for acidizing process	12
2.4. Organic-based acidizing inhibitors	13
2.5. Polymeric-based inhibitors	27
2.6. Intensifiers in acidizing process	37
2.6.1 Formic Acid	38
2.6.1 Potassium Iodide	40
2.6.2 Potassium Iodide Copper Iodide	41
2.6.3 Antimony Chloride	42
2.6.4 Acetic Acid	42

2.7. Research gaps	43
CHAPTER THREE : MATERIALS AND METHODS	45
3.1 Materials	45
3.2 Methods	45
3.2.1 Materials preparation	45
3.2.2 Weight loss measurements	46
3.2.3 Electrochemical experiments	46
3.2.4 Surface characterization	47
CHAPTER FOUR :RESULTS	48
4.1 Performance of aspartame as corrosion inhibitor	48
4.2 Individual performance of potassium iodide and sodium dodecylsulfate as corrosion inhibitors	64
4.3 Inhibitive performance of aspartame with additives	66
4.4 Surface examination	80
CHAPTER FIVE : DISCUSSION	92
5.1 Corrosion inhibitive effect of aspartame	92
5.2 Mechanism of inhibition by aspartame	98
5.3 Corrosion inhibition performance by potassium iodide and sodium dodecylsulfate	100
5.4 Effect of additives on aspartame inhibitive property	101
5.5 Surface observation studies	104
CHAPTER SIX : CONCLUSION AND RECOMMENDATIONS	107
6.1 Summary	107
6.2 Conclusion	107
6.3 Contribution to Knowledge	107
6.4 Recommendation	108
REFERENCES	109

LIST OF FIGURES

FIGURES		PAGES
Figure 1.1	Chemical structure of Aspartame	3
Figure 2.1	The basic structure of amino acids	26
Figure 2.2	Comparative (a) TGA and (b) FTIR spectra of pure poly-NTHC and poly- NTHC recovered from 15 wt. % HCl solution after being heated at 90°C for 12 h	35
Figure 2.3	SEM images showing the surface morphology of the API X60 steel sample surface (a) before immersion and after immersing in 15 wt. % HCl solution containing (b) no inhibitor, (c) 1000 mg/L NTHC, and (d) 100 mg/L poly- NTHC for 6 h at 90°C	36
Figure 4.1	Variation of open circuit potential (OCP) with time for T95 corrosion in 15 wt.% HCl solution without and with selected concentrations of Aspartame at different temperatures	50
Figure 4.2	Variation of open circuit potential (OCP) with time for T95 corrosion in 28 wt.% HCl solution without and with selected concentrations of Aspartame at different temperature	51
Figure 4.3	Nyquist electrochemical plots for T95 corrosion in 15 wt.% HCl solution without and with selected concentrations of ASP at different temperatures	52
Figure 4.4	Nyquist electrochemical plots for T95 corrosion in 28 wt.% HCl solution without and with selected concentrations of ASP at different temperature	53
Figure 4.5	Bode electrochemical plots for T95 corrosion in 15 wt.% HCl solution without and with selected concentrations of ASP at different temperature	54
Figure 4.6	Bode electrochemical plots for T95 corrosion in 28 wt.% HCl solution without and with selected concentrations of ASP at different temperature	55
Figure 4.7	Equivalent circuit used in the analysis of (a) all the electrochemical impedance data except the data for blank at 90°C in which (b) was used for 15 wt.% and (c) for 28 wt.%	56
Figure 4.8	Potentiodynamic polarization graphs for T95 corrosion in 15 wt.% HCl solution without and with selected concentrations of Aspartame at different temperature	60
Figure 4.9	Potentiodynamic polarization graphs for T95 corrosion in 28 wt.% HCl solution without and with selected concentrations of Aspartame at different temperature	61
Figure 4.10	Nyquist electrochemical plots for T95 corrosion in 15 wt.% HCl solution without and with different additives at 60 – 90°C	69
Figure 4.11	Nyquist electrochemical plots for T95 corrosion in 28 wt.% HCl solution without and with different additives at 60 – 90°C	70
Figure 4.12	Potentiodynamic polarization plots for T95 corrosion in 15 wt.% HCl solution without and with different additives at 60 – 90°C	75

Figure 4.13	Potentiodynamic polarization plots for T95 corrosion in 28 wt.% HCl solution without and with different additives at 60 – 90°C	76
Figure 4.14	SEM micrographs of (a) the polished T95, (b) the steel specimen immersed in 15% HCl solution without the additives, the steel specimen immersed in 15% HCl solution containing (c) 2000 ppm inhibitor, (d) 2000 ppm inhibitor + 1 mM KI, (e) formulations and (f) commercial inhibition at 60 oC after 4 h immersion	81
Figure 4.15	SEM micrographs of (a) the polished T95, (b) the steel specimen immersed in 15% HCl solution without the additives, the steel specimen immersed in 15% HCl solution containing (c) 2000 ppm inhibitor, (d) 2000 ppm inhibitor + 1 mM KI, (e) formulations and (f) commercial inhibition at 90oC after 4 h immersion	82
Figure 4.16	SEM micrographs of (a) T95 specimen immersed in 28 wt.% HCl solution without the additives, the steel specimen immersed in 28 wt.% HCl solution containing (b) 2000 ppm inhibitor, (c) 2000 ppm inhibitor + 1 mM KI, (d) formulations and (e) commercial inhibition at 90oC after 4 h immersion	83
Figure 4.17	EDAX spectra of (a) the polished T95, (b) the steel specimen immersed in 15% HCl solution without the additives, the steel specimen immersed in 15% HCl solution containing (c) 2000 ppm inhibitor, (d) 2000 ppm inhibitor + 1 mM KI, (e) formulations and (f) commercial inhibition at 90oC after 4 h immersion	84
Figure 4.18	EDAX spectrum of (a) T95 specimen immersed in 28 wt.% HCl solution without the additives, the steel specimen immersed in 28 wt.% HCl solution containing (b) 2000 ppm inhibitor, (c) 2000 ppm inhibitor + 1 mM KI, (d) formulations and (e) commercial inhibition at 90oC after 4 h immersion	85
Figure 4.19	Surface profilometer images of (a) the polished T95, (b) the steel specimen immersed in 15% HCl solution without the additives, (c) 2000 ppm inhibitor, (d) 2000 ppm inhibitor + 1 mM KI, (e) formulations and (f) commercial inhibition at 60°C after 4 h immersion	87
Figure 4.20	Surface profilometer images of (a) the polished T95, (b) the steel specimen immersed in 15 wt.% HCl solution without the additives, the steel specimen immersed in 15 wt.% HCl solution containing (c) 2000 ppm inhibitor, (d) 2000 ppm inhibitor + 1 mM KI, (e) formulations and (f) commercial inhibition at 90°C after 4 h immersion	88
Figure 4.21	Surface profilometer images of (a) the polished T95, (b) the steel specimen immersed in 15% HCl solution without the additives, the steel specimen + 1 mM KI, (e) formulations and (f) commercial inhibition at 60°C after 4 h immersion	89

Figure 4.22	Surface profilometer images of (a) the steel specimen immersed in 28 wt.% HCl solution without the additives, the steel specimen immersed in 28 wt.% HCl solution containing (b) 2000 ppm ASP, (c) 2000 ppm ASP + 1 mM KI, (d) formulations and (e) commercial inhibitor at 60°C after 4 h immersion	90
Figure 4.23	Surface profilometer images of (a) the steel specimen immersed in 28% HCl solution without the additives, the steel specimen immersed in 28% HCl solution containing (b) 2000 ppm inhibitor, (c) 2000 ppm inhibitor + 1 mM KI, (d) formulations and (e) commercial inhibition at 90°C after 4 h immersion	91
Figure 5.1	Mechanism action of Aspartame	100

LIST OF TABLES

TABLES		PAGES
Table 2.1	Dissolving power of acids	9
Table 2.2	Some examples of organic-based acidizing corrosion inhibitors	13
Table 2.3	Some effective polymeric inhibitors for acidizing condition	28
Table 4.1	Weight loss (WL), corrosion rate (v), surface coverage (θ), and inhibition efficiency (IE) for T95 corrosion in 15 wt.% and 28 wt.% HCl solution in the absence and presence of different concentrations of Aspartame (ASP) at different temperatures from weight loss measurements	48
Table 4.2	EIS parameters derived for T95 corrosion in 15 wt.% HCl at different temperatures without and with 500 ppm and 2000 ppm Aspartame	57
Table 4.3	EIS parameters derived for T95 corrosion in 28 wt.% HCl at different temperatures without and with 500 ppm and 2000 ppm Aspartame	59
Table 4.4	Potentiodynamic polarization parameters derived for T95 corrosion in 15 wt.% HCl solution without and with selected concentrations of Aspartame at different temperatures	62
Table 4.5	Potentiodynamic polarization parameters derived for T95 corrosion in 28 wt.% HCl solution without and with selected concentrations of Aspartame at different temperatures	63
Table 4.6	Weight loss, corrosion rate (v), surface coverage (θ), and inhibition efficiency (IE) for T95 corrosion in 15 wt.% and 28 wt.% HCl solution in the absence and presence of different additives at different temperatures from weight loss	64
Table 4.7	Weight loss (WL), corrosion rate (v), surface coverage (θ), and inhibition efficiency (IE) for T95 corrosion in 15 wt.% and 28 wt.% HCl solution in the absence and presence of different additives at different temperatures from weight loss measurement.	66
Table 4.8	Calculated synergism parameter	68
Table 4.9	EIS parameters derived for T95 corrosion in 15 wt.% HCl at different temperatures without and with 2000 ppm Aspartame alone and in combination with additives	71
Table 4.10	EIS parameters derived for T95 corrosion in 28 wt.% HCl at different temperatures without and with 2000 ppm Aspartame alone and in combination with additives	73
Table 4.11	Potentiodynamic polarization parameters derived for T95 corrosion in 15 wt.% HCl at different temperatures without and with 2000 ppm Aspartame alone and in combination with additives	77
Table 4.12	Potentiodynamic polarization parameters derived for T95 corrosion in 28 wt.% HCl at different temperatures without and	79

	with 2000 ppm Aspartame alone and in combination with additives	
Table 4.13	Surface parameters derived from profilometer surface analysis of the corroded T95 immersed in 15 wt.% HCl without and with additives at 60°C after 4 h immersion	86

LIST OF SCHEMES

SCHEMES		PAGES
Scheme 2.1	Synthesis of the indolizine derivative Di-BQC and MDi-BQC from quaternary quinolinium salts BQC and AcQC	24
Scheme 2.2	Reaction scheme for AMPC and ACPC	25
Scheme 2.3	Mechanism by which intensifiers function	38

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-cinnamylidene-3-thiocarbohydrazide
DCTCH	1,1-dicinnamylidene-3-thiocarbohydrazide
EDAX	Energy dispersive X-ray analysis
EIS	Electrochemical impedance spectroscopy
Fe ₂ O 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 90°C 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 techniques show that the retardation efficacy of ASP enhances with increase in concentration and temperature. At 90°C 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 90°C. 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 90°C, 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.