In collaboration with

PRESENTS

2012 International Conference on Clean Technology & Engineering Management (ICCEM 2012)

2012 INTERNATIONAL CONFERENCE

ON

CLEAN TECHNOLOGY AND CONTEMPORARY ENGINEERING MANAGEMENT

NOVEMBER 12 – 15, 2012

@

COVENANT UNIVERSITY, OTA

CONFERENCE AGENDA

Conference Chair:
Engr. Prof. F.A Oyawale

Conference Secretary:
Engr. S.O Oyedepo

CONFERENCE PROGRAMME

November 12 - 15, 2012

Day One: Monday, November 12, 2012
Venue: Mechanical Engineering Building
2:00pm – 6:00pm: Registration of Participants /Arrival of Invited Guests

Day Two: Tuesday November 13, 2012
Session 1: Plenary Opening Ceremony
THEME: INNOVATIONS, CLEAN TECHNOLOGY AND CONTEMPORARY ENGINEERING MANAGEMENT
Venue: African Leadership Development Center, Covenant University, Ota

10:00am – 10:05am:	National Anthem
10:05am – 10:10am:	University Anthem
10:10am – 10:15am:	Opening Prayer (**University Chaplain**)
10:15am – 10:30am:	Introduction of Guests/Dignitaries (**Dr. Ogunsina B.S**)
10:30am – 10:40am:	Welcome Address (**Dean CST**)
10:40am – 11:00am:	Goodwill Message (**Prof. C.K Ayo**, Vice Chancellor, Covenant University)
11:00am – 11:05am:	Goodwill Message (Engr. M.B Shehu, President, Nigerian Society of Engineers)
11:05am – 11: 10am:	Goodwill Message (Engr. A. Fanimokun, Chairman, Nigerian Institution of Mechanical Engineers)
11:10am- 11:40am:	Special Keynote Address (Ogbeni (Engr.) Rauf Aregbesola, Executive Governor of Osun State
11:40am – 12:20pm:	Keynote Address (Prof. Onwalu, P, Director General, Raw Materials Research and Development Council)
12:20pm – 12:30pm	Remark from Deputy Dean, Sch. of Engrg – Dr. Agboje
12:30pm – 12:40pm:	Vote of Thanks (Prof. F.A Oyawale, Chairman (LOC))
12:40pm – 12:45pm:	Closing Prayer (Dr. Ajayi, O.O)
12:45pm – 1:00pm:	Group Photograph/Departure
1:00pm – 3:00pm:	Lunch Break/Exhibition of Students Projects
3:00pm – 5:00pm:	Plenary session 2

3:00pm – 5:00pm: First Concurrent Session
Technical Session A

THEME FOCUS: CONTEMPORARY ENGINEERING MANAGEMENT

Tract 1 ***Building Services***
Venue: ***500 Lecture Hall, Mechanical Engineering Department Building***

Chairman: **Prof. T.O. Mosaku**
Secretary: **Dr. S.T. Adedokun**
Rapporteurs: **Mr. Banjo Solomon & Mr. Abidakun, O.A.**

Speakers/Papers:

Paper A1: **Mr. Adekeye, Engr. S.O. Oyedepo & Oyebanji**
Design & Development of Vapour Absorption Refrigeration System for Rural Dwellers.

Paper A2: **P.O. Babalola**
Electromechanical Systems in Building Services Engineering

Paper A3:

Paper A4:

Track 2 ***Applied Mechanics/Management***
Venue: ***Computer Lab, Mechanical Engineering Department Building***

Chairman: **Dr. Osheku, C.A**

Secretary: **Dr. R.J.O Ekeocha**
Rapporteurs: **Engr. Oyebanji, J.A & Mr. Ocheja, J.P**

Paper A5: **Razak I. Adeniji and Olawale O.E. Ajibola**
Resolving Energy Crisis through Communication: The Case of PHCN.

Paper A6: **Olateju O.I, Oyeobu A.J and Nwatulegwu B.I**

Effects of project management techniques on primary health care delivery

Paper A7: **Diji, C.J.**
Sustainability Assessment of Electricity Production and Consumption in Nigeria

Paper A8: **Loto M.A. & Ojakinwa TB**
Human Capital Formation Technological Diffusion and Economic Growth In Sub-Saharan African Countries: Evidence From Panel Data Analysis

Paper A9: **OLATEJU O.I, HOTEPO O.M and OYEOBU A.J**
An evaluation of total quality management practices on business performance of the Nigerian telecommunication sector

Paper A10: **Alamutu S.A, Hotepo O.M, Oyeobu A.J and Nwatulegwu B.I**

An evaluation of total quality management practices on business performance of the Nigerian telecommunications sector: a case study of MTN Nigeria Limited

Paper A11: **Olateju, O.I, Olateju, R.O and Mohammed, T.O**
Effects of project management techniques on the performance of the oil sector

<u>Track 3</u> ***<u>Mechatronics</u>***
Venue: ***Conference Room, Mechanical Engineering Department Building***

Chairman: **Prof. Katende, J**
Secretary: **Engr. R. O Leramo**
Rapporteurs: **Engr. Omotosho, O.A & Mr. Babarinde Taiwo**
Speakers/Papers:

Paper A11: **Aru, O.E and Opara, F.K.**
Applying intelligent Systems in medical Diagnosis

Paper A12: **C. A. Bolu**
Integrating Mechatronics into Mechanical Engineering Curriculum in Nigeria

Paper A13: **V.O.S. Olunloyo, O.O.E. Ajibola and O. Ibidapo-Obe**
Active fuzzy control of tall civil engineering structures

DAY THREE: Wednesday, November 14, 2012

9:00am – 12:00pm: <u>Second Concurrent Session</u>

<u>Technical Session B</u>

THEME FOCUS: **CLEAN TECHNOLOGY AND ENVIRONMENTAL SCIENCE & TECHNOLOGY**

<u>Tract 1</u> ***<u>Clean Technology/Environmental Science & Technology</u>***
Venue: ***CNC Lab, Mechanical Engineering Department Building***

Chairman: **Engr. Awoyele**
Secretary: **Engr. O.S. Ohunakin**
Rapporteurs: **Mr. Gbenebor,P.O & Mr. Abioye, P.O**

Speakers/Papers:

Paper B1: **Engr. Abolarin, T.S**
Identification of Major Noise Donors, A Sure Way To Abating Noise.

Paper B2:	**Antai E.E** Environmental Liquid Effluent, a Novel Approach for Treatment Of Industrial Waste Water
Paper B3:	**Olukani D.O and Akinyinka O.N** Environment Health and Wealth: Towards Analysis of Municipal Waste Management in Ota
Paper B4:	**Ovri J.E.O** Design and Construction of an Anearobic Digester for the Production of Biogas
Paper B5:	**Ekpeni L.E.N. and Olabi A.G.** Homogenisation In High Pressure Homogenizer (HPH) - A Deviced Technique for Biomass Conversion in Biogas
Paper B6:	**Inegbenebor, A.I., Aruwajoye I.O. and Inegbenebor, A.O.** Evaluation of homogeneity from ore-bodied in Nigeria for secondary mineral prospective
Paper B7:	**Babalola P.O.** Design and construction of parabolic solar heater using polymer matrix composite
Paper B8:	**Tunde F. Adepoju, Adeyinka O. Adetunji, Emmanuel M. A. Olatunji and Bello J. Olatunde** HCME: An environment-friendly I.C. engine fuel
Paper B9:	**Ogunsina, B.S, Ojolo S.J, Ohunakin, O.S, Oyedeji, O.A, Matanmi, K.A** Potentials for generating alternative fuels from empty palm fruit bunches by pyrolysis

Track 2 ***Nanoscience and Materials***

Venue: ***300 Lecture Hall, Mechanical Engineering Department Building***

Chairman:	**Engr. Prof. C.A Loto**
Secretary:	**Engr. J.O. Okeniyi**
Rapporteurs:	**Mr. Ajayi, C.O & Mrs. Joseph, O.O**

Speakers/Papers:

Paper B10:	**Gbenebor, P.O. Aasa, S.A, Inegbenebor, A.O.** Effect of Pouring Temperature on Solidification Profiles of Aluminium Alloy

Paper B11: **O. Sanni, A.P.I. Popoola and C.A. Loto**
Inhibition Effect of Ferrous Gluconate on the Electrochemical Corrosion Behaviour of Aluminium Alloy in H_2SO_4

Paper B12: **C.A Loto and R.T. Loto**
Corrosion Polarisation Susceptibility Behaviour of Duplex (α β) Brass in Nitric Acid Concentrations

Paper B13: **Ovri J.E.O**
Corrosion Inhibition of Stainless Steel Using Molasses

Paper B14: **O.S.I Fayomi, A.P.I Popoola, C.A Loto and O.M Popoola**
Morphology and Properties of Zn-Al-TiO_2 Composite on Mild Steel

Paper B15: **C .A. Loto and R. T. Loto**
Corrosion resistance evaluation of Ferritic stainless steel and αβ (duplex) Brass in strong acids and acid chloride environments

<u>Track 3</u> ***<u>Renewable Energy Systems</u>***
Venue: ***Conference Room, Mechanical Engineering Department Building***

Chairman: **Prof. A.S. Sambo**
Secretary: **Dr. R.J.O Ekeocha**
Rapporteurs: **Engr. Makun, T.O.K & Mr. Ocheja, J.P**

Speakers/Papers:

Paper B16: **Aasa S.A, Gbenebor O.P and Ajayi O.O**
Thermodynamics Charcterisation of Density Models For Solar Water Heater Sizing.

Paper B17: **Sobamowo, M. G, Ogunmola, B.Y, Ogbemhe, J. A and Adeoye S.A.**
Analysis of a wind-tidal power generating system for marine environment

Paper B18:

Paper B19:

<u>Track 4</u> ***<u>Thermal Engineering / Power</u>***
Venue: ***Computer Lab, Mechanical Engineering Department Building***

Chairman: **Prof. S.S Adefila**
Secretary: **Dr. S.T. Adedokun**
Rapporteurs: **Mr. Banjo Solomon & Mr. Abioye, P.O.**

Speakers/Papers:

Paper B20: **Omorogiwa Eseosa and Odiase O.F**
Sensitivity studies in the Nigeria restructured 330KV Power network using FAT devices

Paper B21: **Sobamowo, M.G and Ogunmola, B.Y**
Transient Heat transfer analysis in longitudinal straight fin of rectangular profiles

Paper B22: **Diji, C.J.**
Exergoeconomic Analysis of a Steam – Fired Power Plant in Nigeria

Paper B23: **Oyedepo S. O and Kilanko**
Thermodynamic analysis of a gas turbine power plant modeled with an evaporative cooler

Tract 5 ***Industrial Engineering / Manufacturing***
Venue: ***500L Lecture Hall, Mechanical Engineering Department Building***

Chairman: **Prof. Charles Owaba**
Secretary: **Engr. O.A. Abidakun**
Rapporteurs: **Engr. Olugboye, D.O & Mr. Babarinde Taiwo**

Speakers/Papers:

Paper B24: **Oyebanji J.A, Oyedepo, S.O and Adekeye, T**
Performance evaluation of two palm kernel nut cracker machine

Paper B25: **Adeyemo, J. A**
Investigation of drillware and tool life in Cutting sintered powdered steel materials

Paper B26: **Oyawale F. A and Fashola, A. A**
Quality Characteristics of Concrete Poles manufactured in the Ibadan Metropolis, South West, Nigeria

Paper B27: **Adekunle, A.S. Odusote, J.K. and Rabiu, A.B.**
Effect of Using Vegetable Oils As Quenching Media For Pure Commercial Aluminium

Paper B28: **Babalola P.O., Inegbenebor, A.O.**
Design and construction of tilting furnace for producing aluminium matrix composites

Paper B29: **Christian A. Bolu, Ademisoye O. Tolulade and Alimi Adeshina**
University Optical Fibre Network Access Optimisation: A Case Study

2:00pm – 5:00pm: Third Concurrent Session
Technical Session C

Track 1 ***Nanoscience and Materials***
Venue: ***Computer Lab, Mechanical Engineering Department Building***

Chairman: **Engr. Prof. A.O. Inegbenebor**
Secretary: **Engr. R. O Leramo**
Rapporteurs: **Engr. Makun, T.O.K & Mr. Olugboye, D.O**

Speakers/Papers:

Paper C1: **C.A. Loto**
Influence of *Ananascomosus* Juice Extract as Additive on the Electrodeposition of Zinc on Mild Steel in Acid Chloride Solution

Paper C2: **Okeniyi, J.O., Oladele I.O., Ambrose, I.O., Omoniyi, O.M., Okpala, S.O., Loto C.A. and Popoola, A.P.I.**
Effects Of Na2Cr2O7 Inhibitor On The Corrosion Potentils Response Of Steel Reinforced Concrete In Saline Medium

Paper C3: **R.T. Loto, C.A. Loto and A.P.I. Popoola**
Inhibitive effect of Di-Metyl-Aminiethanol on the Corrosion of Austenitic Stainless Steel Type 304 in Acidic Media

Paper C4: **Ajayi, O.O., Joseph, O.O., Omotosho, O.A. and Olabowale, T.O**
Rauvolfia vormitoria Effect on the Degradation of Aluminium Alloy in 2.5 M Hydrochloric Acid Solution

Paper C5: **Fayomi, O. S. I, Abdulwahab, M., Gbenebor, O. P and Popoola, A. P. I.**
Physio-Chemical and Mechanical Behaviour of (*Pinussylvestris)* as Binders on Foundry Core Strength

Paper C6: **C.A. Loto and R.T. Loto**
Electrochemical Corrosion Resistance Evaluation of Ferritic Stainless Steel in HCl

Track 2 ***Engineering Innovations***
Venue: ***500L Lecture Hall, Mechanical Engineering Department Building***

Chairman: **Engr. Prof. F.A. Oyawale**
Secretary: **Mr. S.A. Aasa**
Rapporteurs: **Engr. Oyebanji, J.A. & Mr. Adelekan, D.S**

Speakers/Papers:

Paper C7: **Abidakun, O.A.**
Effect of expression conditions on the yield of dika nut (*irvingia gabonesis*) oil under uniaxial compression

Paper C8: **James Katende and Abubakr Sadiq Bappah**
An autotuner for industrial PID control loops

Paper C9: **Olateju O.I, Oyeobu A.J and Nwatulegwu, B.I**
Effects of project management techniques on primary health care delivery

Paper C10: **Ilori, T.A., Dauda.,T.O., Raji.A.O, and Kilanko,. O. O**
Occupational Mobility in Engineering Profession (Craftman and Artisan) in Oyo State, Nigeria

Track 3 ***Modelling & Simulations***
Venue: ***Conference Room, Mechanical Engineering Department Building***

Chairman: **Dr. Anake, T.**
Secretary: **Mrs. O.O. Joseph**
Rapporteurs: **Engr. Adekeye, T. & Engr. Kilanko, O.**

Speakers/Papers:

Paper C11: **David O. Olukanni, Kenneth O. Adekalu and Joel J. Ducoste**
Hyderaulic modelling and optimisation of a waste water treatment system for developing nations using CFD

Paper C12: **Ramalingam Periasamy**
Mathematical model of alternate methods of dispersion of fluid gases from Power generation units

Paper C13: **Katende, J, Awelewa, A.A, Samuel, I.A and Iyiola, S.O.**
Root Locus-Based Magnetic Levitation System Stabilization: An Undergraduate Control System Design Approach

Paper C14: **M. G. Sobamowo, S.O. Ismail and A.M. Ayerin**
Experimental and numerical investigations of free convection heat transfer in solar ovens

Paper C15: **Tunde F. Adepoju, Eriola Betiku, Bamidele O. Solomon, Bello J. Olatunde and Emmanuel M. A. Olatunji**
Statistical approach to optimization of the transesterification reaction from sorrel (*hibiscus sabdariffa*) oil

Inhibitive effect of ferrous gluconate on the electrochemical corrosion of aluminium alloy in H_2SO_4 solution

O Sanni(1), A.P.I. Popoola(1), C.A. Loto(2)
[1]Department of Chemical and Metallurgical Engineering, Tshwane University of Technology, Pretoria, South Africa
[2]Department of Mechanical Engineering, Covenant University, Ota, Nigeria
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Abstract
The use of ferrous gluconate as corrosion inhibitor on aluminium alloy in 0.5M H_2SO_4 solution was studied using gravimetric and potentiodynamic polarization measurements. The surface morphology of the aluminium alloy was studied after exposure to 0.5 M H_2SO_4 solution in the presence and absence of inhibitor using high resolution scanning electron microscopy equipped with energy dispersive spectroscopy (HRSEM – EDS). The adsorption behaviour of the inhibitor was investigated. The results of the investigation show that increase in concentration of ferrous gluconate corresponds to an improvement on inhibition efficiency. Equally, the results showed the ferrous gluconate to be an effective corrosion inhibitor for the aluminium in the acidic medium. The results obtained from the two methods used were found to correlate with each other.

***Key words**: Corrosion test, Ferrous gluconate, Inhibition efficiency, Adsorption*

1. Introduction

Corrosion of metals/alloys can be defined as the deterioration or disintegration of materials due to their interaction with the environment. The subject has continued to receive attention over the years. Corrosion scientists are relentless in seeking better and more efficient ways of combating the corrosion of metals /alloys [Fontana, 1987].

Aluminium and its alloys are generally light, cheap, good conductors of heat and electricity and resist corrosion at moderate temperatures. They are therefore used widely as materials for cooking utensils, electricity cables, bottle tops, food and beverage containers, roofing sheets [Uppal and Bhatia, 2001]. Bottle tops of most alcoholic and non-alcoholic drinks, industrial machine parts are found to corrode rapidly in moist air thus constituting a health hazard to the end users. Although the oil and gas, beverage and metallurgical industries sink a large sum of money in an attempt to control corrosion of their engine parts and products, however, the problem still persist. In some chemical industries, equipment becomes corrosive after few years. In view of this, the need to research into the field of corrosion inhibition becomes necessary [Onen et al, 2010].

Inhibitors are chemical compounds that, when added to a fluid or gas decreases the corrosion rate of the metal or an alloy [Asuke, 2008]. The effectiveness of a corrosion inhibitor is a function of many factors like: fluid composition, quantity of water and flow regime [Asuke, 2008; Scamans et al, 1989; Schmitt, 1984]. In the oil extraction and processing industries, inhibitors have always been considered to be one of the defences against corrosion [Thomas, 1980; Fontana and Greene, 1987].

Various methods namely weight loss and gasometric [Ekpe et al, 1995; Ita et al, 1997; Ebenso et al 2004; El-Naggar, 2007; Ait Chikh et al, 2005; Ebenso et al, 1999; Ekpe et al, 2001; Obot et al, 2010; Ebenso et al, 2008], electrochemical and analytical [Ait Chikh et al, 2005] and polarization [Abdulwahab et al, 2012] have been employed in the determination of corrosion rates and inhibition studies. There have been several studies on corrosion inhibition of aluminium, mild steel, copper, and zinc in acidic and other medium. Some corrosion inhibitors such as synthetic compounds [Ait Chikh et al, 2005; Ebenso et al, 1999; Ekpe et al, 20011], natural products [Obot et al 2010] and dyes [Ebenso et al, 2004; Ebenso et al, 2008] have been investigated and reported as good corrosion inhibitors. In this work, the use of ferrous gluconate (FG) as corrosion inhibitor was investigated for aluminium alloy in sulphuric acid solution using gravimetric and potentiodynamic polarization methods

2. Experimental methods

2.1 Materials and Methods

As – received aluminium alloy of dimension 12 x 12 x 2 mm with chemical composition shown in Table 1 was used. A 3.0mm diameter hole was drilled about 5 mm from the top of the 12 mm edge. The gravimetric test specimens were degreased in ethanol, dried, weighed and stored in desiccators for further tests. Selected specimens were connected to an insulated flexible wire and cold mounted in methyl methacrylate resin. They were subsequently used for potential measurement. A concentration of 0.5M H_2SO_4 was prepared as required for the experiment. FG as inhibitor was used in H_2SO_4 medium. The molecular structure of the inhibitor is presented in Figure 1. The experiment was conducted at 28^0C.

Table 1: Chemical composition of the aluminium used.

Si(%)	Fe(%)	Cu(%)	Mn(%)	Mg(%)	Zn(%)	Ni(%)	Cr(%)	Ti(%)	Ag(%)
0.157	0.282	0.0025	0.024	0.51	<0.0010	<0.0010	0.023	0.0046	<0.0001

B(%)	Be(%)	Bi(%)	Ca(%)	Cd(%)	Co(%)	Li(%)	Na(%)	p(%)	Pb(%)
0.0007	<0.0001	<0.0010	0.0011	0.0005	<0.0010	<0.0002	0.0005	<0.0010	<0.0005

Sn(%)	Sr(%)	V(%)	Zr(%)	Al(%)
<0.0010	<0.0001	0.0035	0.002	99

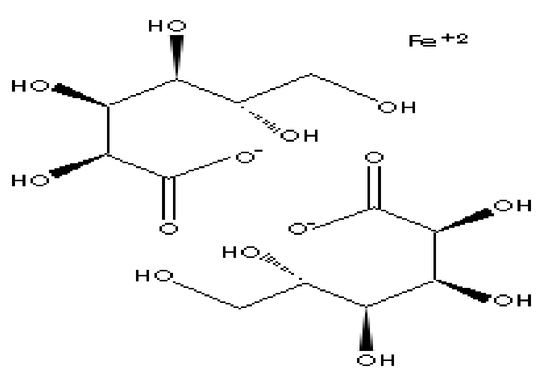

Figure 1: Molecular structure of ferrous gluconate

2.2 Gravimetric measurements

Corrosion test was carried out on the previous weighed samples in the presence and absence of inhibitor and one of the samples was used as control (i.e. without inhibitor) while other samples were with inhibitor. The ferrous gluconate was dissolved in 0.5 M H_2SO_4, the experiment was repeated with varying concentration of inhibitor (0.5 – 2.0) % g/v.

For each experiment, the samples were washed, dried and weighed over a period of twenty – eight days. The weight loss measurements were taken at an interval of 48h. The corrosion rate, degree of surface coverage and inhibitor efficiency were determined. The weight loss was determined by finding the difference between the initial weight of the samples and the final weight after 48 h using the equation below

$$W = W_O - W_F \quad (1)$$

Where:

W = weight loss in mg, W_O= initial weight, W_F= final weight.

The corrosion rate was determined in millimeter per year (mm/yr)

$$CR \text{ (mm/yr)} = \frac{87.6W}{DAT} \quad (2)$$

Where W = weight loss in mg, D = density of the materials in g/cm^3, T = time of exposure in hours and A = area of specimen in cm^2

The degree of coverage and efficiency of the inhibitor was determined using the relationship reported elsewhere [Halambek et al, 2010]

2.3 Electrochemical measurement

The potentiodynamic polarization techniques were used to evaluate the corrosion rate of the aluminium alloy in FG-H_2SO_4 solution. All electrochemical measurements were obtained using Autolab frequency response analyzer (FRA) coupled to potentiostat and connected to a computer system as source of data acquisition. A standard corrosion cell was used as described elsewhere [Abdulwahab et al, 2012]; saturated Ag/Ag reference electrode and aluminium sample as working electrode were used for the electrochemical study. The working electrode samples were positioned at the glass corrosion cell kit, leaving 1 cm^2 surfaces in contact with the solution. Polarization test was carried out at 28^0C in 0.5 M H_2SO_4 solution using a 668 VA AUTOLAB potentiostat with 1.8 NOVA software package; a scan rate of 0.0016V/sec was used. From the Tafel corrosion analysis, the corrosion rate, potential and linear polarization resistance data were obtained in a static solution.

2.4 Surface morphology

The as – received and as – corroded aluminium alloy surfaces were examined with high resolution scanning electron microscopy equipped with energy dispersive spectroscopy (HR SEM/EDS) Model : (Joel JSM – 7600F) was used to assess the surface of the corroded samples.

3. Results and discussion

3.1 Weight loss measurement

The results obtained for the variation of corrosion rate, inhibition efficiency and degree of surface coverage with exposure time for the aluminium alloy specimens immersed in 0.5 M sulphuric acid with varied concentrations of FG are represented in Figures 2 and 3.

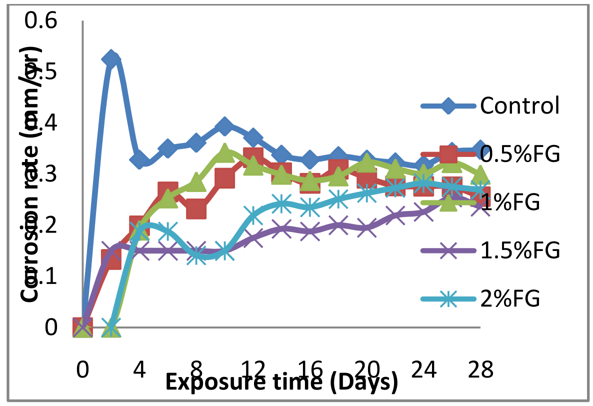

Figure 2: Variation of corrosion rate with exposure time for the aluminium specimen immersed in sulphuric acid for different concentration of inhibitor.

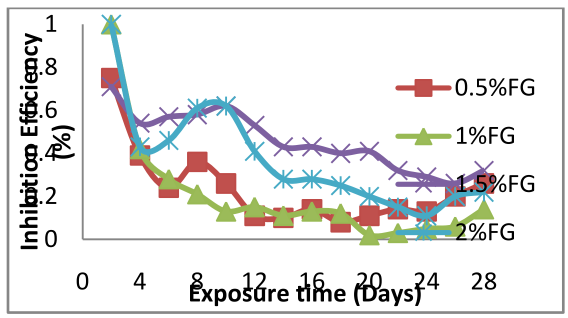

Figure 3: Variation of inhibition efficiency with exposure time for the aluminium specimen immersed in sulphuric acid for different concentration of inhibitor.

The corrosion rates of the aluminium coupons in 0.5M H_2SO_4 in the presence and absence of different concentrations of inhibitor (FG) were determined using equation 2. The results obtained are presented in Figure 2. The corrosion rates decreased with addition of ferrous gluconate. This indicates that (FG) in the solution inhibits the corrosion of aluminium in acidic medium and that the extent of corrosion inhibition depends on the amount of the ferrous gluconate present.

The percentage inhibitor efficiency shown in Figure 3 shows the variation of inhibitor efficiency with time at different concentrations of the inhibitor. The inhibition efficiency decreases with increase in exposure time with final values of 26%, 14%, 32%, and 22% when inhibitor concentration was increased from 0.5% to 2% with 0.5% incremental range. It shows that percentage inhibition efficiency of ferrous gluconate progressively decreases with increase in time of exposure.

3.2 Potentiodynamic polarization

The potentiodynamic polarization measurement for aluminium alloy in 0.5 M H_2SO_4/ferrous gluconate is presented in Table 2. Potentiodynamic polarization –corrosion rate (PP-CR), potentiodynamic polarization corrosion density (PP-Icorr) and linear polarization resistance (LPR) data were used as criteria for evaluation of corrosion resistance of aluminium alloy in the medium.

Table 1: Electrochemical corrosion data obtained for aluminium alloy in 0.5 M H_2SO_4- varying concentration of ferrous gluconate at 28^0C.

S/N	C (% g/v)	Icorr (A/cm2)	ba(v/dec)	bc (v/dec)	LPR Rp(Ω cm2)	Ecorr (V)	CR (mm/yr)
1	0	1.73E-05	0.025551	0.12493	5.33E+02	-0.33054	0.559600
2	0.5	4.27E-06	0.111520	0.22570	7.60E+03	-0.35751	0.138000
3	1.0	6.30E-09	0.892180	1.72760	4.06E+07	-0.34318	0.000206
4	1.5	5.43E-06	0.042048	0.035871	1.55E+03	-0.33054	0.175710
5	2.0	6.05E-09	1.958100	0.74874	3.90E+07	-0.34318	0.000197

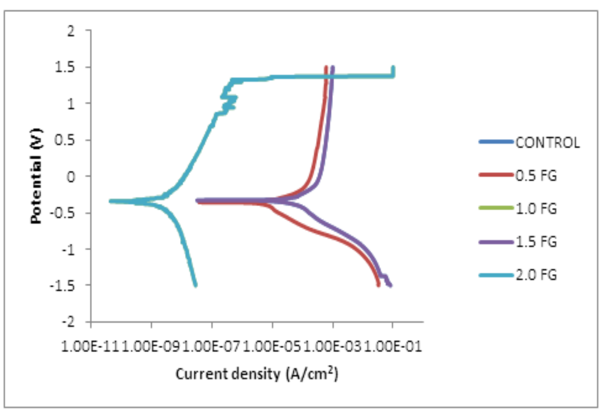

Figure 4: Linear polarization of aluminium in 0.5M H_2SO_4 solution / ferrous gluconate environment at 28^0C.

Figure 4 shows the polarization curves for 0.5 M H_2SO_4-Ferrous gluconate. The environment demonstrated a decrease in the corrosion rate and current density with addition of the inhibitor.

While the corrosion potential (Ecorr) and polarization resistance increases with inhibitor concentrations. The trend in the corrosion under this study is similar with the previous report [Abdulwahab et al, 2012]. The inhibited aluminium in 0.5M H_2SO_4 –Ferrous gluconate revealed that corrosion rate decreases from 0.17571 mm/yr to 0.138, 0.000206 and 0.000197 at 1.5% g/v, 0.5% g/v,1.0% g/v and 2.0% g/v ferrous gluconate. Corrosion rate of aluminium alloy –H_2SO_4 is lower in 2.0% g/v and 1.0%g/v ferrous gluconate when compared to 0.5% g/v and 1.5% g/v respectively. Also, the changes in anodic and cathodic region suggest the mixed –type corrosion inhibition for aluminium alloy-0.5M H_2SO_4/ferrous gluconate.

3.3. Corroded surface analysis

The SEM microstructure of aluminium surface is shown in Figure 5 to 6. The as - received aluminium alloy sample Figure 6, shows that ferrous gluconate was able to exhibit some degrees of inhibition which retard the corrosion rate of aluminium in H_2SO_4 solution.

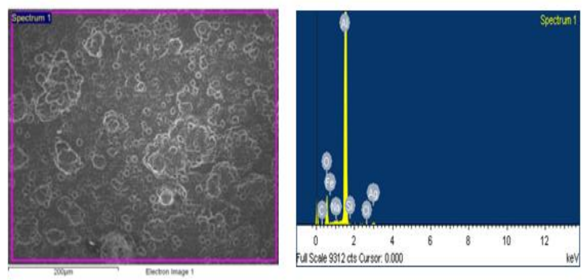

Figure 5: SEM micrograph of the as-received aluminium sample with the EDS spectrum

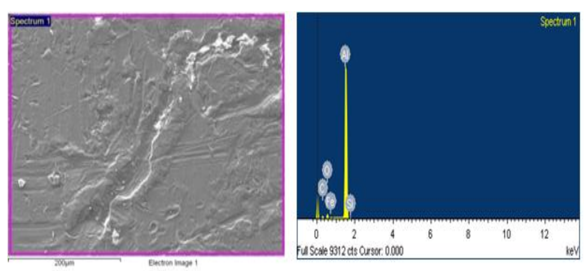

Figure 6: SEM micrograph of aluminium in 1.0%g/v ferrous gluconate in 0.5M H_2SO_4 with the EDS spectrum

3.4. Efficiency of Inhibitor and adsorption isotherms

The percentage inhibitor efficiency (%IE) of the aluminium alloy –ferrous gluconate in H_2SO_4 solution was computed using the equation reported elsewhere [Halambek et al, 2010] .The computed data for the IE using potentiodynamic polarization corrosion rate (PP-CR), potentiodynamic polarization-corrosion density (PP-Icorr), linear polarization resistance (LPR) and gravitational method (GM) are presented in Figure 7 for 0.5M H_2SO_4/ferrous gluconate. The result revealed that the highest %IE of ferrous gluconate was achieved at 1.0 and 2.0%g/v and there was a correlation in all the methods used. The adsorption mechanism was shown from the variation between log θ with log C indicating linearity for the environment and the adsorption behavior is believed to have obeyed Freundlich adsorption isotherm.

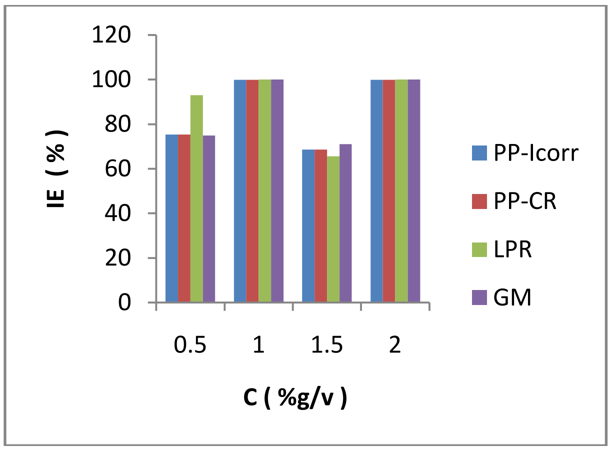

Figure 8: Comparism of inhibitor efficiency (IE) for 0.5M H_2SO_4 solution / ferrous gluconate concentration obtained from gravimetric method and potentiodynamic polarization.

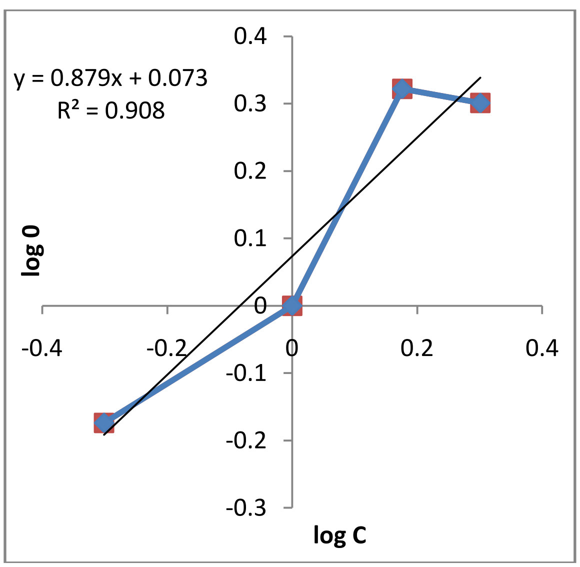

Figure 9: Freundlich isotherm for the adsorption of ferrous gluconate on the aluminium alloy in 0.5 M H_2SO_4 solution obtained from gravimetric method at 28^0C.

4. Conclusion

The deductions from the experimental investigations show that ferrous gluconate (FG) acts as a good inhibitor for the corrosion of aluminium in 0.5M H_2SO_4 because the inhibitor was able to reduce the corrosion rate. Potentiodynamic polarization curves reveals that ferrous gluconate is a mixed – type inhibitor. The adsorption of ferrous gluconate follows Freundlich adsorption isotherm.

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