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ARPN Journal of Engineering and Applied Sciences August 2016 | Vol. 11 No. 15

Title: Performance analysis of a vertical well with a finite-conductivity fracture in gas composite reservoirs

Author (s): Yu Long Zhao, Freddy Humberto Escobar, Claudia Marcela Hernandez and Chao Ping Zhang

Abstract: It is well known that hydraulic fracturing can efficiently be applied to develop both low permeability and unconventional gas reservoir. Sometimes, the formations cannot be fully fractured and, then, the resulting fracture does not end up with infinite conductivity. Besides, for either tight or unconventional gas reservoir, a fracture network will be developed around the well during the fracturing process. This paper presents a semi-analytical model governing fluid flow in porous material for a finite-conductivity-fractured well in a composite gas reservoir, considering the fractures as either partially or fully penetrated. By nature, a fracture-network system around the well is always induced in tight gas formations, then, a composite model with inner dual-porosity to describe stimulated reservoir volume is established. Solutions for both constant-production rate and constant-bottom hole pressure are obtained by using the point-source function and the Laplace transformation techniques which are used along with the Stehfest algorithm to obtain the numerical inversion of the pressure and rate variables. The pressure-time and rate-time behaviors are then analyzed by careful observation to both transient-pressure and the rate-decline type curves. The models and type curves introduced in this work possess both theoretical and practical valuable application in the field of well test interpretation for the system under consideration.

Title: Green inhibitor for API 5L x65 steel in HCL 0.5 m

Author (s): Femiana Gapsari, R. Soenoko, A. Suprapto and W. Suprapto

Abstract: The research is the preliminary study of the ability of Cera alba (CA) extract inhibitors. The adsorption and corrosion inhibition characteristic of CA extract on API 5L X65 steel was investigated by weight loss and potentiodynamic polarization methods. The results showed that the inhibition efficiency increases with increasing inhibitor concentration. The weight loss and potentiodynamic polarization methods revealed that CA extract act as mixed type inhibitor.

GREEN INHIBITOR FOR API 5L X65 STEEL IN HCL 0.5 M

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ABSTRACT

The research is the preliminary study of the ability ofCeraalba (CA) extract inhibitors. The adsorption and corrosion inhibition characteristic of CA extract on API 5L X65 steel was investigated by weight loss and potentiodynamic polarization methods. The results showed that the inhibition efficiency increases with increasing inhibitor concentration. The weight loss and potentiodynamic polarization methods revealed that CA extract act as mixed type inhibitor.

Keywords: adsorption, carbon steel, corrosion, green inhibitor, inhibition efficiency.

INTRODUCTION

Carbon steels are widely used in petroleum industry, chemical processing, marine applications, chemical processing, mining and metal processing equipment (Lazano *et al*, 2014). Nevertheles, carbon steel is not the most corrosion resistant for many environmentsAPI 5L Grade X65 steel is a type of steel pipe used in pipelines for gas, water, and oil in the subsea pipeline. Corrosion in oilfields occurs at all stages from downhole to surface equipment and processing facilities. It appears as leaks in tanks, casings, tubing, pipelines, and other equipment. Corrosion in oil fields occurs at all stages from operating problems and equipment maintenance, resulting in severe economic losses (Okafor *et al*, 2009; Garcia-Arriaga *et al*, 2010).

The protection of metal surface from the aggressive environment in industries are used various methods such as cathodic and anodic protection, coating, and inhibitors. Due to economic reason, inhibitor widely used as an appropriate method in reducing the corrosion rate (Muthukumar *et al*, 2009). Inhibitor is substances which when added in small concentrations to corrosive media prevent the reaction of metal with media (Benabdellah *et al*, 1998; Ahmad, Z., 2009).Inhibitors are widely used today is an organic inhibitor. Because it is cheap and eco friendly.Organic compounds containing polar groups including nitrogen, sulfur, and oxygen and heterocyclic compounds (Gomma *et al*, 1994; Khaled *et al*, 2004; Zucchi *et al*, 1996; Elmorsi *et al*, 1999; Al-Hajjar *et al*, 1998). Organic inhibitor can be derived from plant extracts [Oguzie, E.E., 2007; Sathapaty *et al*, 2009; Okafor *et al*, 2008; Behpour *et al*, 2012; Quraishi *et al*, 2010).

For this study uses CA extract as corrosion inhibitor. Solution used in this study was 0.5 M HCl because this acid is a corrosive media commonly used in industry (Zaferani *et al*, 2013).

METHOD

The experimet were perfomed with 304SS with the following composition (wt %): 0.04%C, 0.52 % Si, 0.92 % Mn, 0.030% P, 0.002 % S, 9.58% Ni, 18.15 % Cr, Bal.Fe.The specimens were polished consecutivelywith emery paper of from 500 to 2000 grades. The specimen were washed with distilled water, rinsed in ethanol, degrased with acetone and finally dried.

CA was extracted by solid-liquid method in order to obtain the optimum conditions. Half of CA powder was extracted by maceration method using 99% ethanol (Merck). 100 g of CA was extracted with 100 ml of ethanol. The ethhanol evaporated using a water bath. CA extract was analyzed by FTIR to determine the functional groups contained. Infrared spectra were recorded in Shimadzu IR Prestige-21.The test media of 0.5 M HCl was prepared by dilution of AR grade 37% HCl (Merck) using distilled water.

The weight loss tests were conducted by specimen coupons dimension 20x20x10 mm. The specimens were immersed in 200 ml 0.5 HCl. Before weight loss test, the specimens were polished consecutively with emery paper from 500 to 2000 grades. Immersion times as independent variables used in this study were 7,14, and 21 days. The inhibition efficiency (IE) was calculated by equation 1. (Victoria *et al*, 2015).

$$\frac{W0 - W1}{W0} \qquad (1)$$

The electrochemical meausurement using AutolabPGSTAT 128N.All measurements were done using a 100 mL corrosion cell in which a reference electrode (Ag/AgCl electrode), a counter electrode (Pt electrode), a working electrode (API 5L X65). The metal was added to epoxy resin with a geometric exposed surface area measuring 1 cm^2 and connected to the electrolyte.The tafel plots were obtained by polarization potentiodynamic test. The potential range from -100mV to +100mV at Open Circuit Potential (OCP) with scan rate 1 mV/s.Independent variables used in this study were 0, 100, 200, 300, 400, and 500 ppm CA extract concentration. Ambient temperature at 25^0C. Inhibition efficiency calculated by equation (2) (Stupniˇsek-Lisac *et al*, 2002; Awad, M.I., 2006):

$$IE\ (\%) = \frac{Icor - Icor(i)}{Icor} \times 100\ \% \qquad (2)$$

where I_{cor} dan $I_{cor(i)}$ is corrosion current density in case of absence and presence inhbitor.

VOL. 11, NO. 15, AUGUST 2016ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

RESULT AND DISCUSSIONS

Weight loss experiments

The inhibition efficiency for the specimen coupons immersed in 0.5 M hydrochloric acid solution with different inhibitor concentrations and immersion times are shown in Figure-1. The inhibition efficiency increase with inhibitor concentration. The increased inhibition efficiency with inhibitor concentration was caused to adsorption of inhibitor molecules on the metal surface/solution (Loto *et al*, 212). All variation of immersion time showed same trend in the addition of CA extract inhibitor. The maximum efficiency inhibition 84.28% obtained in 14 days immersin time. A longer immersion time showed smaller efficiency inhibition due to desorption of inhibitors molecules from the metal surface (Victoria *et al*, 2015).

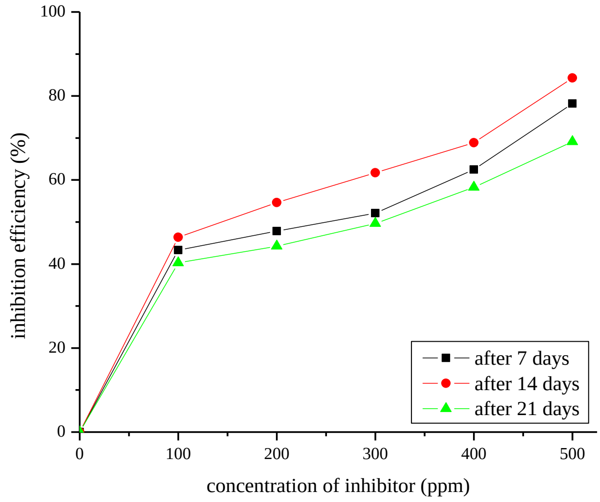

Figure-1. Concentration of inhibitor effect to the inhibition efficiency in 0.5 M HCl.

Based on the Figure-1 showed that the rate of corrosion inhibitors could inhibit metal effectively with the increase of concentration inhibitor. This was caused by the interaction between inhibitor molecules larger than inhibitor interaction on the metal surface (Fekry *et al*, 2011). Due to the efficiency inhibition in 21 days lower than 14 days of immersion time, the adsorption of inhibitor is physisorption. The chemisorption involves high energy and immersion time (Quartarone *et al*, 2003).

Potentiodynamic polarization studies

The efficiency inhibition can be determined by potentiodynamic polarization. Potentiodynamic polarization measured with the variation of the concentration of the extract CA at ambient temperature.

Table-1. Inhibition Efficiency Calculation of Polarization Measurements.

Conc. of inhibitor (ppm)	**βa** (V/dec)	**βc** (V/dec)	E_{corr} (V)	I_{corr} (A/cm^2)	**IE** (%)
0	0.087	-0.703	-0.34	$9.23x10^{-6}$	-
100	0.191	5.968	-0.30	$4.33x10^{-6}$	52.43
200	0.046	0.079	-0.35	$3.67x10^{-6}$	60.25
300	0.039	0.069	-0.33	$1.02x10^{-4}$	88.95
400	0.043	0.078	-0.33	$9.83x10^{-7}$	89.35
500	0.39	0.053	-0.29	$4.68x10^{-7}$	94.50

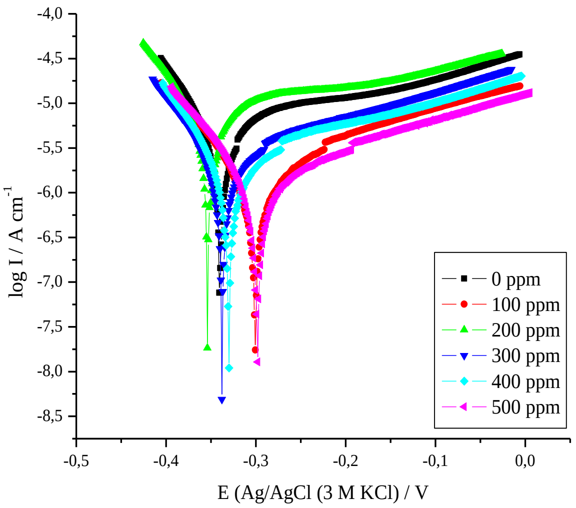

Figure-2. Polarization curve of API 5L X65 in the hydrochloric acid 0.5 M in various concentrations of inhibitors.

Experiment data of potentiodynamic polarization measuments which has been in the Tafel extrapolation shown in Table-1. Inhibition efficiency (IE%) obtained the maximum of 94.50% on the addition of inhibitors of 500 ppm (Table-1). These results indicated that the rate of corrosion inhibitors can inhibit API 5LX65 steel effectively with the increasing concentration up to 500 ppm inhibitor.

Anodic Tafel constants (βa) associated with the inhibitor molecules adsorbed on the anodic side.While, cathodic Tafel constants (βc) associated with the cathodic hydrogen evolution reaction (Fekry *et al*, 2011). Irregularity of βa and βc showed that CA extracts was a bled inhibitors modify the anodic and cathodic reaction mechanism (Quraishi *et al*, 2010) Some studies suggest if the maximum displacement of E_{cor} more than 85mV, it can be concluded the inhibitor is anodic or cathodic. If the maximum displacement less than 85mV it is classified as mixed type inhibitor (Zafareni *et al*, 2013). The maximum displacement was calculated 10 mV, it revealed that the inhibitor act as mixed type inhibitor.

Mechanism Inhibition

The adsorption of organic compounds can be described by two main models of interaction: physisorption and chemisorption (Loto *et al*, 2012). Adsorption ofCA extract at the metal surface are believed initially in the hydrocloric acid. The dissolution of carbon steel (API 5L X65) during the first step causes the formation of Fe^{2+}. The inhibition effect depends on inhibitor concentration and molecular structure. It is observed that, the inhibition efficiency of CA extract increases with increase in CA extract concentration.

CONCLUSIONS

The CA extract evedently can inhibit the corrosion rate of API 5L X65 in HCl 0.5 M by adsorption mechanism. The CA extract act as mixed type inhibitor. A maximum efficiency 94.5% was obtained with the addition of inhibitor 500 ppm in the potentiodynamic polarization studies. From weight loss method obtained 84,28% efficiency inhibition of 500 ppm inhibitor in 14 days immersion time.The adsorption followed physisorption type.

REFERENCES

LozanoMazario E., Olivares-Xometl C.O.,Likhanova N.V., Herrasti P. 2014. Corrosion behaviour of API 5L X52 steel in HCl and H_2SO_4 media in the presence of 1,3-dibencilimidazolio acetate and 1,3-dibencilimidazolio dodecanoate ionic liquids as inhibitors. Materials Chemistry and Physics.147: 191-197.

Okafor P.C., Liu X., ZhengY.G. 2009.Corrosion inhibition of mild steel byethylaminoimidazoline derivative in CO_2-saturated solution.Corrosion Science. 51: 761-768.

Garcia-Arriaga V., Alvarez-Ramirez J., Amaya M., Sosa E. 2010. H_2S and O_2 influenceon the corrosion of carbon steel immersed in a solution containing 3 Mdiethanolamine. Corrosion Science. 52: 2268-2279.

Muthukumar N., Ilangovan A., Maruthamuthu S., Palaniswamy N., Kimura A. 2009. 1-Aminoanthraquinone derivatives as a novel corrosion inhibitor for carbon steel API 5L-X60 in white petrol-water mixtures. Materials Chemistry and Physics.115: 444-452.

BenabdellahM., Benkaddour M., Hammouti B., Bendahhou M., Aouniti A. 2006. Inhibition of steel corrosion in 2 M H_3PO_4 by artemisia oil, Applied Surface Science. 252: 6212-6217.

EL-EtreA.Y. 1998.Natural honey as corrosion inhibitor for metals and alloys. I. Copper in neutral aqueous solution. Corrosion Science. 40: 1845-1850.

Ahmad Z. 2006. Principles of Corrosion Engineering and Corrosion Control.Elsevier. Oxford.

GommaG.K., WahdanM.H. 1994 Effect of temperature on the acidic dissolution of copper in the presence of amino acids.Material Chemistry and Physics. 39: 142-148.

KhaledK.F., Hackerman N. 2004. Ortho-substituted anilines to inhibit copper corrosion in aerated 0.5 M hydrochloric acid. ElectrochimaActa. 49: 485-495.

Zucchi F., Trabanelli G., Fonsati M. 1999.Tetrazole derivatives as corrosion inhibitors for copper in chloride solutions.Corrosion Science. 38: 2019-2029.

Elmorsi M.A., Hassanein A.M. 1999. Corrosion inhibition of copper by heterocyclic compounds.Corrosion Science. 41: 2337-2352.

Al-HajjarF.H., Al-KharafiF.M. 1998. 2-amino-thiazole and 2-amino-4,6 dimethylpyrimidine as corrosion inhibitors for copperCorrosion Science. 28: 163-171.

OguzieE.E. 2007. Corrosion inhibition of aluminium in acidic and alkaline media bySansevieriatrifasciata extract.Corrosion Science. 49: 1527-1539.

SatapathyA.K., Gunasekaran G., Sahoo S.C., Amit K., Rodrigues P.V. 2009. Corrosion inhibition by Justiciagendarussa plant extract in hydrochloric acid solution. Corrosion Science. 51: 2848-2856.

Okafor P.C., Ikpi M.E., UwahI.R., EbensoE.E., EkpeU.J., Umoren S.A. 2008. Inhibitory action of Phyllanthusamarus extracts on the corrosion of mild steel in acidic media. Corrosion Science. 50: 2310-2317.

Behpour M., GhoreishiS.M., Khayatkashani M., Soltani N., 2012. Green approach to corrosion inhibition of mild steel in two acidic solutions by the extract of *Punicagranatum* peel and main constituents.Material Chemistry and Physics. 131: 621-633.

Quraishi M.A., Singh A., Singh V.K., YadavD.K., Singh A.K. 2010. Green approach to corrosion inhibition of mild steel in hydrochloric acid and sulphuric acid solutions by the extract of *Murrayakoenigii* leaves. Material Chemistry and Physics. 122: 114-122.

ZaferaniS.H., Sharifi M., Zaarei D., ShishesazM.R. 2013. Application of eco-friendly products as corrosion inhibitors for metals in acid pickling processes - A review, Journal of Environmental Chemical Engineering. 1: 652-657.

Victoria S.N., Prasad R., Mannivannan R. 2015. Psidiumguajava leaf extract as green corrosion inhibitor for mild steel in phosporic acid.International Journal Electrochemical Science. 10: 2220-2238.

Stupniˇsek-Lisac E., Gazivoda A., Madˇzarac M. 2002. Evaluation of non-toxic corrosion inhibitors for copper in sulphuric acid.. Electrochimica Acta. 47: 4189-4194.

Awad M. I. 2006. Eco friendly corrosion inhibitors: inhibitive action of quinine for corrosion of low carbon steel in 1MHCl. Journal of Applied Electrochemistry. 36: 1163-1168.

LotoR.T., Loto C.A. 2012. Effect of *p*-phenylediamine on the corrosion of austenitic stainless steel type 304 in hydrochloric acid.International Journal Electrochemical Science. 7: 9423-9440.

Fekry A.M., Ameer M.A. 2011. Electrochemical investigation on the corrosion and hydrogen evolution rate of mild steel in sulphuric acid solution.International Journal of Hydrogen Energy. 36: 11207-11215.

Quartarone D., Bellomi T., Zingales A. 2003. Inhibition of Copper Corrrosion by Isatin Aerated 0.5 M H_2SO_4. Corrosion Science. 45: 715-733.