



## Corrosion Underground Tubes of Steel in Soil of Clay with Different Thicknesses from Soil Layer of Clay and Aerations Gases as Geomorphology Study at Kut City-Iraq

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### Abstract

Two methods of weight loss and polarization were studied, where the corrosion of buried underground pipes in clay soil and its effect on the thickness of the clay layer as well as introducing gases such as nitrogen, air and carbon dioxide to the soil were studied. The rate of corrosion of pipeline steel in soil with 6% CO<sub>2</sub>/N<sub>2</sub> The thickness layer of soil affects the speed of corrosion, with a 4 mm layer soil thick representing the greatest rate. The soil layer's contradictory blocking and moisture-retaining capabilities impede steel corrosion. Because more water is trapped in shallow soil layers such as 4 and 6 mm, corrosion rises. The inhibitory effect of layer of soil on corrosive species diffusion becomes more prominent when layer of soil thickness is raised to 12 mm and 14 mm. As a result, the steel's corrosion rate is lowered. Steel degrades quickly in soil layers holding 6% CO<sub>2</sub>/N<sub>2</sub>. Weight-loss experiments and potentiodynamic polarization measurements show a relationship between corrosion rate and soil layer thickness. According to weight-loss studies, steel corrosion rates in soil with varying thicknesses and gassing conditions are generally less than 0.046 mm/y.

**Keywords:** soil, thickness, layer, clay, weight loss, polarization, pipeline.

### 1. Introduction

The corrosion process leads to great losses to the economy and is a major reason that leads to the disruption and collapse of many industrial and vital facilities such as concrete structures, bridges, pipelines, etc. External corrosion has been recognized as one of the major processes producing oil/gas transmission pipeline failures in soil, with potentially negative consequences for the environment and people. A minimal depth of earth cover is commonly used to protect underground pipelines from external damage as well as the hazard to persons and neighboring property [1-16]. When a coating fails, the current used for cathodic protection is unable to reach the steel as a result corrosion occurs. The difficulty of pipeline corrosion is due to the specific features of the soil, in addition to the contact of various environmental elements for example microbial activity, humidity, temperature, ventilation, porosity, and pH [17-26]. The exterior corrosion of

pipes is significantly influenced by the kind and characteristics of the soil in which they are buried. As the pipes are buried, the chemical composition of the soil changes throughout time. Lower altitudes erode rapidly in disturbed soils like tidal wetlands and clays as a result of soil shrinkage. As a result of large changes in aeration and salt buildup, this leads to higher electrical conductivity. [27-35]. Soils with alkaline pH levels may be more prone to corrosion. if the pH of the soil is in the 6–8 range. Corrosion products would linger at the steel surface in soils, protecting the steel from additional corrosion. Corrosion products, most often iron oxides, would alter the pipeline steel's potential. As a result, while applying cathodic protection for corrosion prevention, keep this in mind to avoid overprotection. Clay soils have a low rate of oxygen transport toward the steel surface, which has a substantial impact on corrosion because oxygen acts in aerobic soils as a cathodic depolarizer [36-43].

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## 2. Experimental work

### 2.1 Specimens and soil

Steel sheets with dimensions of 12 mm x 10 mm x 3 mm were used as testing specimens and compositions of chemicals are 0.25 % C, 1.36 % Mn, 0.39 % Si, 0.014 % P, 0.029 % S, 0.12 % V, 0.05 % Nb, 0.08 % Ti, and Fe residual (as weight percent).

The soil utilized in this study was taken from the burying depth of a pipeline in Kut city. As a result, the soil was given the term clay soil. The soil-extracted solution included (in weight %): 0.0077 % NaCl, 0.066 % NaHCO<sub>3</sub>, 0.0755 % Na<sub>2</sub>SO<sub>4</sub>, 0.0012 % NaNO<sub>3</sub>, 0.8653 % CaSO<sub>4</sub>.2H<sub>2</sub>O, 0.0611 % K<sub>2</sub>SO<sub>4</sub>, 0.3346 % MgSO<sub>4</sub>.7H<sub>2</sub>O, and H<sub>2</sub>O balance.[5-10]

### 2.2 Weight loss method

Weight-loss tests and electrochemical measurements were carried out in accordance with ASTM G102 to assess the uniform corrosion rate. The weight loss of the steel coupons was measured 10 days after burying in moist soil. The dirt on the specimen surface was washed with distilled water after testing. The corrosion products were removed using a pickling solution. After being washed with distilled water, The coupons were cleaned and dried in acetone and 100 % ethanol. An electronic balance was used to determine the weight of the coupon. The corrosion rate was calculated using the following equation [10-25].

$$\text{Corrosion rate (C.R)} = 8.76 * \Delta W / D * A * T$$

Where; W is denote to mass loss , K is denote to constant, D is denote to density ,T is denote to time exposure , A is denote to area.

## 3. Results and discussion

### 3.1 Weight loss method

Figure 1 depicts the estimated steel rates of corrosion after 10 days of burial in 6 % wet nitrogen having soils of various thicknesses and a 4 mm thickness soil cover based on the weight loss studies. It is important to note that rate of corrosion obtained the long-term electrochemical characteristics of pipeline steel in the field may not even be accurately reflected after 10 days of soil testing. The steel corrosion rate increases as thickness layer of soil rises from 4 mm to 6 mm. The greatest corrosion rate in the 6 mm thick soil was 0.046 mm/y, as shown in

Figure 2. The rate of corrosion reduces as the thickness layer of soil rises. In this study, the lowest rate of corrosion of 0.01 mm/y was discovered in a 14 mm thick soil layer, as shown in table 1. [22-36]

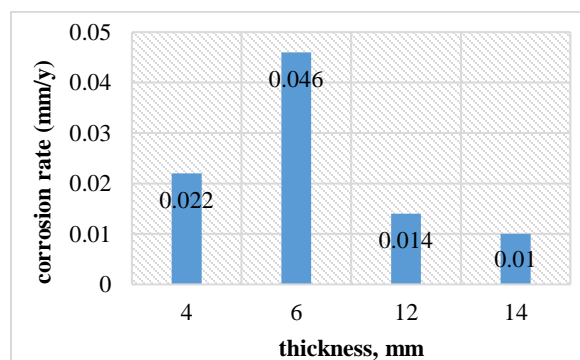


Fig. 1: Relation between corrosion rate and thickness by weight loss tests of 6 % CO<sub>2</sub> /N<sub>2</sub>

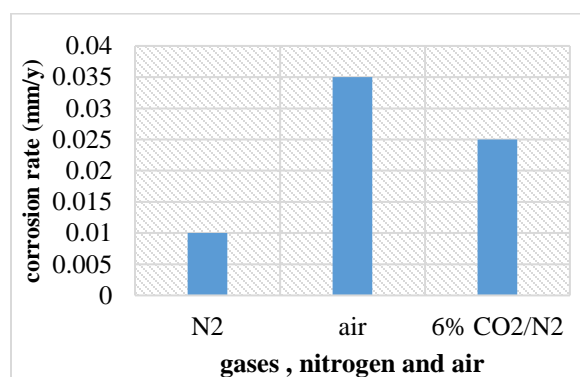


Fig. 2: Relation between corrosion rate and gases by weight loss tests of 4 mm thick soil

Table 1: represents values of thickness with corrosion rate

thickness	Corrosion rate (mm/y)
4 mm soil	0.022
6 mm soil	0.046
12 mm soil	0.014
14 mm soil	0.010
4 mm soil + N2	0.010
4 mm soil + air	0.035
4 mm soil + 6% CO2/N2	0.025

Steel corrosion under the soil is influenced by the gassing process, which involves diffusing the gas via layer of soil and gaining access to surface of a steel. The rate of corrosion in a layer of soil with a constant thickness of 4 mm is also affected by the introduction of a gas. The blocking impact on gas diffusion increases as thickness layer of soil rises. In order to identify the role of gassing condition on steel

corrosion, a thin soil layer (i.e., 4 mm) was utilized in this investigation. Steel corrosion was found to be extremely slow in existence of  $N_2$ , at a value of 0.01 mm/y (Figure 2). The rate of corrosion rises to 0.035 mm/y when air is accessible. Steel corrosion occurs at a rate of 0.025 mm/y in the presence of 6%  $CO_2/N_2$ , demonstrating that oxygen corrosion in the layer of soil is more severe than corrosion caused by 6%  $CO_2$ . The results of the weight loss studies demonstrate that thickness layer of soil influences the rate of corrosion for steel, with the highest possible rate occurring at a layer of soil thickness of 6 mm. Furthermore, at a constant thickness of soil of 4 mm, Steel corrosion occurs more quickly in aerobic soil than in soil having 6%  $CO_2$ . Figure 2 shows that a maximum corrosion rate is seen at a thickness of soil of 6 mm, which is consistent with the earlier study on the function of thickness layer of soil in corrosion of steel. The weight-loss experiment also revealed that, as shown in Figure 1, steel corrosion rates in moist soil with lengthy conditions of gassing and various thicknesses normally do not surpass 0.046 mm/y [5-19].

### 3.2 Potentiodynamic polarization measurements

Figure 4 depicts the steel electrode's curves of potentiodynamic polarization after ten days of test of samples in 6 %  $CO_2/N_2$  having multiple layers of moist clay, under various gassing conditions, as well as in a 4 mm thick soil layer. The cathodic and anodic processes are observed to be regulates activation in the 6 %  $CO_2$  containing soil with various thicknesses. At individual potentials, layers of soil thick (12 and 14) mm are linked with lower cathodic and anodic current density. Although the anodic branch covers the 4 mm thick layer of soil, In the 6 mm thick soil layer, the cathodic current density is maximum. Under various gassing conditions, both the anodic and cathodic processes are triggered and controlled in the polarization curves observed in the 4 mm thick layer of soil. In the presence of  $N_2$  and air, the anodic and cathodic current densities are the smallest and greatest, respectively. The measured data is used to match the electrochemical corrosion parameters, and the results are displayed in Table 2, where E represents corrosion potential and  $i_{corr}$  represents corrosion current density. In existence of 6 %  $CO_2/N_2$ , the greatest and value of 2.21  $\mu A/cm^2$  was obtained in a 6 mm thick soil layer. The corrosion current density drops as thickness of soil layer increases. In existence of air, the greatest  $i_{corr}$  value of 3.23  $\mu A/cm^2$  is found when different gases are enclosed in a 4 mm thick soil layer [10-19]. The  $i_{corr}$  decreases to 2.21  $\mu A/cm^2$  when 6 %  $CO_2/N_2$  is

present, which is greater than the  $i_{corr}$  of 2.01  $\mu A/cm^2$  observed in existence of  $N_2$ . Figure 3 depicts the steel's active dissolving state at various potentials, This lends credence to the argument that the scale of iron carbonate formed at littel temperatures is insufficiently defensive to qualify the steel as passivated. Furthermore, for certain cathodic potentials, the soil layer thickness of 14 mm results in the lowest cathodic current density, Because of the soil blocking effect, the number of species engaged in the cathodic reaction decreases. The layer of soil with a thick 6 mm has the largest cathodic current density, This is due to increased  $CO_2$  being dissolved in water in the soil, whereas the soil layer's blocking action is negligible. As a result, for the integrity of the pipeline where constant corrosion is not a danger on it. In the presence of air, the typical diffusion current that serves as a limiter is not visible in the observed cathodic polarization curve in Figure 3. It's most likely because of 4 mm thin layer of soil, where diffusion-controlled cathodic response behavior isn't as relevant. However, for specified cathodic potentials, the soil layer exposed to air has the largest cathodic current density. As a result, when a soil has a low concentration of  $CO_2$ , such as the 6%  $CO_2$  used in this study,  $CO_2$ -accelerated corrosion is less severe than oxygen-accelerated corrosion [26-36]. It is noticed from table 2 and Figures 3 and 4 that the cathodic and anodic polarization have a role of the anodic and cathodic curves, where the oxidation occurs for the buried pipes, and the corrosion currents and potential were obtained for the different layers of thickness, and there is a great match for the methods of polarization and weight loss , and the accept with previous studies[19-28].

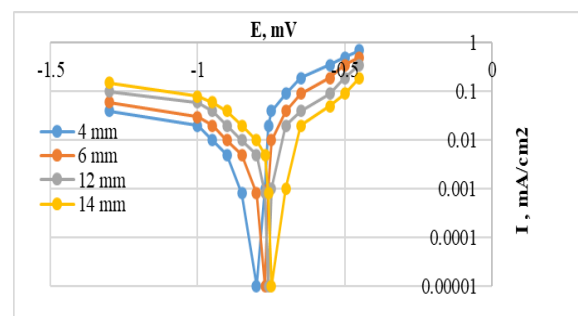


Fig. 3: Relation between the potential and the current density with several thickness

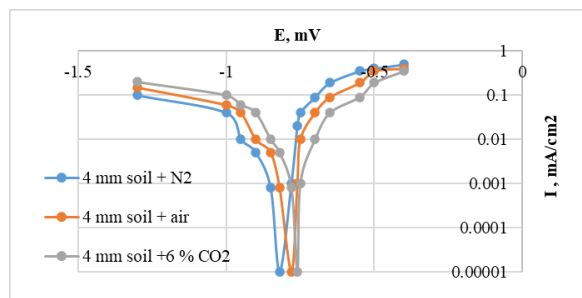


Fig. 4: Relation between the potential and the current density with several gases

Table 2: represents values of thickness with corrosion potential and corrosion current density

thickness	E corr , V	i corr, $\mu\text{A}/\text{cm}^2$
4 mm soil	-0.766	2.25
6 mm soil	-0.794	2.96
12 mm soil	-0.771	2.16
14 mm soil	-0.760	2.05
4 mm soil + N2	-0.783	2.01
4 mm soil + air	-0.780	3.23
4 mm soil + 6% CO <sub>2</sub> /N <sub>2</sub>	-0.770	2.21

#### 4. Conclusions

The thickness layer of soil determines the rate of corrosion steel for pipelines in soil having 6% (CO<sub>2</sub>/N<sub>2</sub>), with the greatest corrosion rate recorded at 4 mm thickness layer of soil. This is owing to the conflicting blocking and moisture-retaining powers of the layer soil on corrosion of steel. As more water is held in the soil, corrosion accelerates in thin layers of soil for example 4 and 6 mm. The inhibitory impact of the layer of soil on species that are corrosive diffusion gets more prominent when the thickness layer of soil is raised to 12 mm and 14 mm. As a result, the steel's corrosion rate is lowered. Steel dissolves quickly in soil layers holding 6% CO<sub>2</sub>/N<sub>2</sub>. Weight-loss experiments and potentiodynamic polarization measurements show a relationship between corrosion rate and soil layer thickness. According to weight-loss studies, steel corrosion rates in soil through varying gassing conditions and thicknesses are generally less than 0.046 mm/y.

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#### 6. References

1. Y.F. Cheng Environmental hazard: Monitor safety of aged fuel pipelines Nature, 529 , pp. 156, (2016).
2. Raheem A.H. Al-Uqaily, Corrosion Inhibition of Steel in HCL Media Using 2-Methoxymethyl-Benzlamine, Journal of Applied Chemistry IOSR, vol.8, issue 4, pp.50-55, (2015).
3. D.N. Dang, L. Lanarde, M. Jeannin, R. Sabot, P. Refait Influence of soil moisture on the residual corrosion rates of buried carbon steel structures under cathodic protection Electrochim. Acta, 176 , pp. 1410-1419, (2015).
4. Subhi A. Al-Bayaty, Raheem A.H. Al-Uqaily, Sadik Hameed, Study of thermal degradation kinetics of high density polyethylene (HDPE) by using TGA technique , AIP Conference Proceedings 2290(1), (2020).
5. L. Wang, L.Z. Dai, H.B. Bian, Y.F. Ma, J.R. Zhang Concrete cracking prediction under combined prestress and strand corrosion Struct. Infrastruct. Eng., 15 , pp. 285-295, (2019).
6. Raheem A.H. Al-Uqaily, Subhi A. Al-Bayaty, Study A Corrosion Inhibitor Of 1-Isoquinolinylnyl Phenyl Ketone For Mild Steel In Acidic Medium As Hcl Acid, Journal of Physics: Conference Series, (2019).
7. D. Kuang, Y.F. Cheng, Understand the AC induced pitting corrosion on pipelines in both high pH and neutral pH carbonate/bicarbonate solutions, Corros. Sci., 85 , pp. 304-310, (2014).
8. H.W. Liu, Y.F. Cheng Mechanism of microbiologically influenced corrosion of X52 pipeline steel in a wet soil containing sulfate-reduced bacteria Electrochim. Acta, 253 , pp. 368-378, (2017).
9. Raheem A.H. Al-Uqaily , Subhi A. Al-Bayaty , Ehsan A. Abdulameer, Inhibition by 4-Phenylpyridine N-oxide as Organic Substance for Corrosion for Carbon Steel in 1 M HCl Media, Journal of Advanced Research in Dynamical and Control Systems, vol.11, special assue 11, 1013-1018, (2019).
10. Ehsan A. Abdulameer, Raheem A.H. Al-Uqaily and Subhi A.H. Al-Bayaty, The Effect of Both Moisture and Clay Content on The Soil Corrosion Process for Different Periods of Time as A Geomorphological Study in Al-Kut City, IOP Conf. Ser.: Earth Environ. Sci. 961 012083, (2022).

11. S. Wang, D. Liu, N. Du, Q. Zhao, S. Liu, J. Xiao, Relationship between dissolved oxygen and corrosion characterization of X80 steel in acidic soil simulated solution, *Int. J. Electrochem. Sci.*, 10, pp. 4393-4404, (2015).
12. Hassan, Y. I., & Saeed, N. H. M. (2012). Kinetics and Mechanism of Oxidation of Diethyl Ether by Chloramine-T in Acidic Medium. *E-Journal of Chemistry*, 9(2), 642-649.
13. A. Benmoussa, M. Hadjel, M. Traisnel Corrosion behavior of API 5L X-60 pipeline steel exposed to near-neutral pH soil simulating solution *Mater. Corros.*, 57, pp. 771-777, (2006).
14. Raheem A.H. Al-Uqaily, Subhi A. Al-Bayaty, Sattar O. Maiws Al-Mayyahi, Study of Kinetics and Inhibition efficiency by " Isoquinoline-5-carboxaldehyde" for Corrosion for carbon Steel in HCl acid, *Journal of Southwest Jiaotong University*, vol.55, (2020).
15. H.W. Liu, T. Gu, Y. Lv, M. Asif, F. Xiong, G. Zhang, H. Liu, Corrosion inhibition and anti-bacterial efficacy of benzalkonium chloride in artificial CO<sub>2</sub>-saturated oilfield produced water, *Corros. Sci.*, 117, pp. 24-34, (2017).
16. B. He, P. Han, C. Lu, X. Bai Effect of soil particle size on the corrosion behavior of natural gas pipeline *Eng. Fail. Analy.*, 58, pp. 19-30, (2015).
17. sdeek, G., Mauf, R., Saleh, M. (2021). Synthesis and Identification of some new Derivatives Oxazole, Thiazole and Imidazol from Acetyl Cysteine. *Egyptian Journal of Chemistry*, 64(12), 7565-7571. doi: 10.21608/ejchem.2021.88755.4267
18. A. El-Shamy, M. Shehata, A. Ismail Effect of moisture contents of bentonitic clay on the corrosion behavior of steel pipelines *Appl. Clay Sci.*, 114, pp. 461-466, (2015).
19. Raheem A. H. Al-Uqaily, Inhibition by 1-methyl isoquinoline for mild steel corrosion in 1 M HCl media, *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)*, vol.14, issue 1, pp.55-63, (2015).
20. L.C. López, E. Arce, J. Torres, J. Vazquez-Arenas, J. Hallen, R. Cabrera-Sierra Corrosion process of API X52 carbon steel immersed in an aqueous solution simulating a clay soil *Corros.*, 67, (2011)
21. Raheem A.H. Al-Uqaily, Subhi A. Al-Bayaty, Anees A. Khadom and Mustafa M. Kadhim, "Inhibitive performance of 4-Methoxyphenethylamine on low-carbon steel in 1 M hydrochloric acid: Kinetics, theoretical, and mathematical views", *Journal of Molecular Liquids*, 350, 118523, (2022).
22. S. Wang, D. Liu, N. Du, Q. Zhao, S. Liu, J. Xiao Relationship between dissolved oxygen and corrosion characterization of X80 steel in acidic soil simulated solution *Int. J. Electrochem. Sci.*, 10, pp. 4393-4404, (2015).
23. Abdullah, L., Saied, S., Saleh, M. (2021). Deep eutectic solvents (Reline) and Gold Nanoparticles Supported on Titanium Oxide (Au-TiO<sub>2</sub>) as New Catalysts for synthesis some substituted phenyl(substituted-3-phenyloxiran)methanone Enantioselective Peroxidation. *Egyptian Journal of Chemistry*, 64(8), 4381-4389. doi: 10.21608/ejchem.2021.68511.349
24. K. Usher, A. Kaksonen, I. Cole, D. Marney Critical review: microbially influenced corrosion of buried carbon steel pipes *Int. Biodeterior. Biodegrad.*, 93, pp. 84-106, (2014).
25. Raheem A.H. Al-Uqaily, Subhi A. Al-Bayaty, Sadik Hameed, 2-Amino-6-Chlorobenzothiazole as Effective Corrosion Inhibitor for Copper in acidic media, *Journal of International Pharmaceutical Research*, vol.46,4,342-345, (2019).
26. I. Cole, D. Marney, The science of pipe corrosion: A review of the literature on the corrosion of ferrous metals in soils, *Corros. Sci.*, 56, pp. 5-16, (2012).
27. Sadik Hameed, Hussein Ali Awad, Raheem A. H. AL-Uqaily, Removal of Iron and Manganese from Ground Water by Different Techniques, *The Journal of Research on the Lepidoptera*, vol.50,4,458-468, (2019).
28. M. Yan, C. Sun, J. Xu, J. Dong, W. Ke Role of Fe oxides in corrosion of pipeline steel in a red clay soil *Corros. Sci.*, 80, pp. 309-317, (2014).
29. Hussein Ali Awad, Raheem A.H. Al-Uqaily, Subhi A. Al-Bayaty, Effect of inhibition by " 2-(2-methoxyphenoxy) benzylamine hydrochloride "for corrosion of mild Steel in HCl media, *Journal of Xidian University*, vol.14,4,3499-3507, (2020).

30. I.M. Gadala, M.A. Wahab, A. Alfantazi Numerical simulations of soil physicochemistry and aeration influences on the external corrosion and cathodic protection design of buried pipeline steels Mater. Des., 97 , pp. 287-299, (2016).
31. Raheem A. H. Al-Uqaily, Using Ethylthiazole-4-Carboxylate as Inhibitor for Copper Corrosion in 0.5 M HCL Acid, International Journal of Recent Research in Physics and Chemical Sciences, vol.2, issue1,pp.1-7, (2015).
32. Al-Thakafy, N., Al-Enizzi, M., Saleh, M. (2022). Synthesis of new Organic reagent by Vilsmeier – Haack reaction and estimation of pharmaceutical compounds (Mesalazine) containing aromatic amine groups. *Egyptian Journal of Chemistry*, 65(6), 685-697. doi: 10.21608/ejchem.2021.101851.4729
33. Ruqaya M. Hamid Al-Sultan, Ammar Abdulsalaam Al-Sultan, Mohammed A. Hayawi, Bilal J M Aldahham, Mohanad Y. Saleh, Hazim A. Mohammed. The effect of subclinical thyroid dysfunction on B- type natriuretic peptide level. *Revis Bionatura* 2022;7(2) 21. <http://dx.doi.org/10.21931/RB/2022.07.02.21>
34. H.W. Liu, T. Gu, G. Zhang, W. Wang, S. Dong, Y.F. Cheng, H. Liu Corrosion inhibition of carbon steel in CO -containing oilfield produced water in the presence of iron-oxidizing bacteria and inhibitors *Corros. Sci.*, 105 , pp. 149-160, (2016).
35. Raheem A.H. Al-Uqaily, Subhi A. Al-Bayaty, Sarah B.Jasim ,Kinetics study of the corrosive behavior of copper in 1 M HCl acid and its inhibition with 2-benzothiazolethiol, solid state technology,vol.63,6, (2020).
36. G.A. Zhang, Y.F. Cheng Corrosion of X65 steel in CO -saturated oilfield formation water in the absence and presence of acetic acid *Corros. Sci.*, 51 , pp. 1589-1595, (2009).
37. Raheem Aziz Hussein Al-Uqaily, Corrosion behavior of Carbon steel in HCL media and Inhibition by 3-Hydroxy-2-Methylpyridine, *International Journal of Advance Scientific and Technical Research*, vol.3, issue 5, pp.181-190, (2015).
38. F. Caleyó, J. Velázquez, A. Valor, J. Hallen, Probability distribution of pitting corrosion depth and rate in underground pipelines: A Monte Carlo study, *Corros. Sci.*, 51 , pp. 1925-1934, (2009).
39. Saeed, N. H. M., & Abbas, A. M. (2020). Kinetics and mechanism of tetrahydrofuran oxidation by chloraminet in acidic media. *Periodico Tche Quimica*, 2020, 17(35), pp. 449-461
40. Subhi A. Al-Bayaty, Najwa J. Jubier, Raheem A.H. Al-Uqaily, Study of Thermal Decomposition Behavior and Kinetics of Epoxy/Polystyrene Composites by using TGA and DSC, *Journal of Xi'an University of Architecture & Technology*, vol.12,3,1331-1341, (2020).
41. Raheem A.H. Al-Uqaily, Subhi A. Al-Bayaty, Athra G. Sager, Inhibition and adsorption by using“ thiazole-2-carboxylic acid ” as anti-corrosion for copper metal in HCl media, *Journal of Southwest Jiaotong University*, vol.55,2, (2020).
42. A. Valor, F. Caleyó, L. Alfonso, J. Vidal, J. M. Hallen, Statistical analysis of pitting corrosion field data and their use for realistic reliability estimations in non-piggable pipeline systems, *Corros.*, 70 , pp. 1090-1100, (2014).
43. Hamdoon, A., salih, W., Ahmed, S., Saleh, M. (2022). Modifying The Rheological Properties Of Asphalt Using Waste Additives and Air Blowing and Studying The Effect Of Time Aging On The Modified Samples. *Egyptian Journal of Chemistry*, 65(5), 447-453. doi: 10.21608/ejchem.2021.94414.4439