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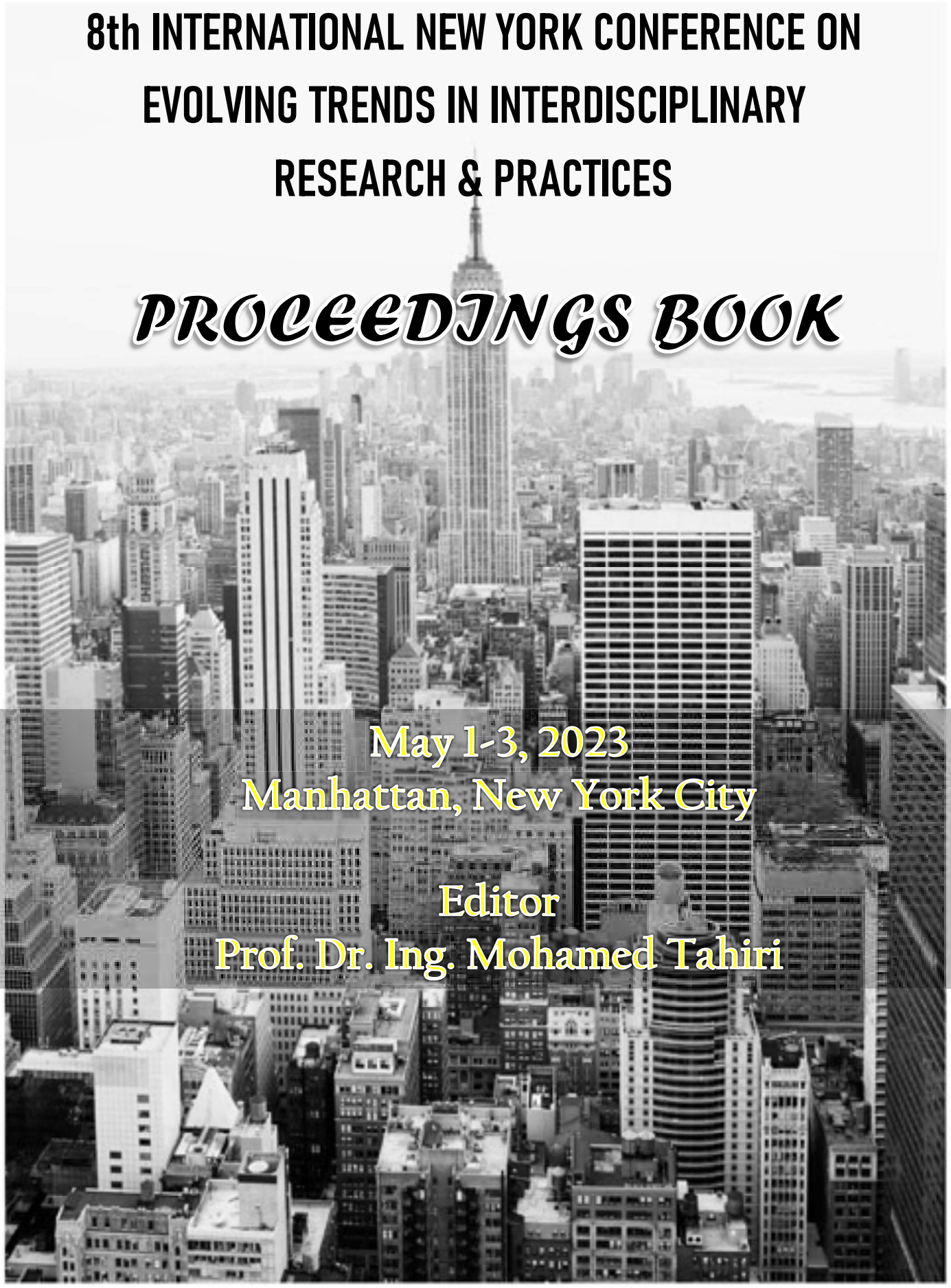
SYNTHESIS OF TWO MONO-CATIONIC SURFACTANTS CONTAINING AMIDE AND ESTER FUNCTIONAL GROUPS LINKED TO PYRIDINIUM NITROGEN AND COMPARISON OF THEIR ANTI-CORROSION PROPERTIES

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8th INTERNATIONAL NEW YORK CONFERENCE ON EVOLVING TRENDS IN INTERDISCIPLINARY RESEARCH & PRACTICES

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May 1-3, 2023
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20.05.2023
ISBN: ISBN: 978-1-955094-48-1

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Published by Liberty Publications - 2023©

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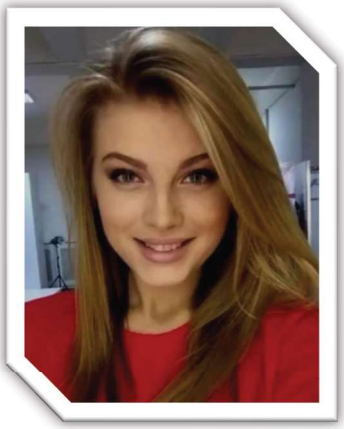


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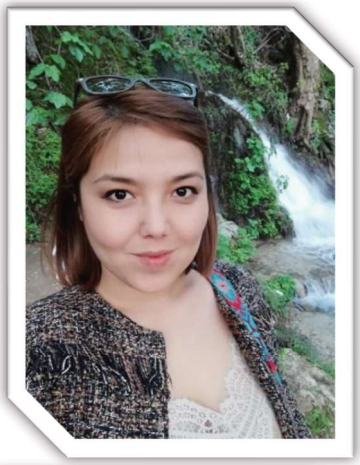


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Natella Aliyeva **Samira Rustamova**	*Azerbaijan National Academy of Sciences*	EVALUATION OF NORMALIZED DIFFERENCE VEGETATION INDEX AND CAROTENOID REFLECTANCE IN CONTRASTING WHEAT GENOTYPES UNDER DROUGHT
Dr. Sümeyra Kayan	*SDU Health Science Institute Isparta, Turkey*	COMPARATIVE EFFECTS OF CAPSAISIN EXTRAXT AND RED PEPPER OF OXSIDATIF STRESS AND OBESITY INDUCED HFD
Hikmet ÖZESMER **Mehmet Tolga KAFADAR** **Eda YILDIZHAN** **Murat AKKUŞ**	*Dicle University, Türkiye*	MONITORING THE PROTECTIVE EFFECTIVENESS OF SESAMIN ON THE ILEUM IN SUPERIOR MESENTERIC ARTERIAL ISCHEMIA CREATED IN RATS
Faruk TATLI **Ercan GEDİK** **Eda YILDIZHAN** **Murat AKKUŞ**	*Dicle University, Türkiye*	COMPARISON OF THE PROTECTIVE EFFICACY OF MANGIFERINE AND AMLODIPINE İN THE PREVENTION OF HEPATOTOXICITY CAUSED BY TETRACYCLINE USE İN RATS
Tuba UZUN	*Siirt University, Türkiye*	ROOTING WITH HOT PIT METHOD OF HARD-WOOD CUTTINGS OF SOME LOCAL GRAPE CULTIVARS GROWED IN SIIRT PROVINCE OF TURKIYE
Ahmad NAFRA **Aseel ALNAHEEL** **Elif KARDAŞ** **Melek YILGIN**	*Firat University, Türkiye*	PRODUCTION OF BIOCOAL FROM PEANUT SHELLS
Ebru MAVİOGLU AYAN **Asli TOPTAŞ** **Mohammad Zakir PARDİS**	*University of Ege, Türkiye*	THE REMOVAL STUDIES OF PB (II) ON THE TURKISH CLINOPTILOLITE-LEONARDITE MIXTURE
Gülşen AKGÜL **Serkan ÖZTÜRK**	*Bursa Uludag University, Türkiye*	SYNTHESIS OF TWO MONO-CATIONIC SURFACTANTS CONTAINING AMIDE AND ESTER FUNCTIONAL GROUPS LINKED TO PYRIDINIUM NITROGEN AND COMPARISON OF THEIR ANTI-CORROSION PROPERTIES
Sajjad Saeed Ali Ali **Nejdet SEN** **Fatih OZCAN**	*Selcuk University, Türkiye*	USE of PYRIDINIUM DIAMIDE-derived Calix[4]arene compounds in Inhibition of Hemoglobin Pseudo-Peroxidase Activity in Patients with Thalassemia

(All speakers required to be connected to the session 10 min before the session starts)
Moderator is responsible for ensuring the smooth running of the presentation, managing the group discussion and dynamics.



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SYNTHESIS OF TWO MONO-CATIONIC SURFACTANTS CONTAINING AMIDE AND ESTER FUNCTIONAL GROUPS LINKED TO PYRIDINIUM NITROGEN AND COMPARISON OF THEIR ANTI-CORROSION PROPERTIES

Gülşen AKGÜL
Serkan ÖZTÜRK
Bursa Uludag University, Faculty of Arts and Sciences, Department of Chemistry, Bursa, Turkey
ORCID: 0000-0003-1231-8385
ORGID: 0000-0002-9396-1403

Abstract

Corrosion is one of the most important problems that adversely affects the metal industry in economic terms. One of the most commonly used methods in the fight against metal corrosion, which occurs more rapidly and intensively in acidic environment, is to use corrosion inhibitors.[1] Surfactants have been discovered to be one of the most effective inhibitors against corrosion of iron and steel in acidic media in recent years in order to control and reduce the corrosion rate. In accordance with the aim of this discovery, in this study, two cationic surfactants with different functional groups (one amide and the other ester group) attached to pyridinium nitrogen were synthesized and their structures were confirmed by spectroscopic methods (FT-IR and H-NMR). The inhibitory activities of these synthesized products against corrosion of mild steel in 1.0 M HCl medium were determined and compared among themselves. The weight loss method on metal plates was used to determine the inhibitory activity. For this, metal plates were immersed for 24 hours in 1M HCl solutions without inhibitors and with different concentrations of inhibitors. At room temperature of 25 ^{o}C, the corrosion inhibition of both synthesized compounds was found to be close to each other. However, at the lower inhibitor concentrations studied, the inhibitor containing the ester functional group showed slightly better inhibition activity. Adsorption isotherm studies were performed to obtain accurate information about the corrosion inhibition mechanism. Isotherm studies based on gravimetric measurements revealed that the adsorption of the synthesized compounds was consistent with the Langmuir isotherm. In addition, in order to support the corrosion inhibition efficiency results, at the end of the corrosion tests, the morphological changes of the surface were observed by taking images of the metal surface with an optical microscope camera.

Key words: Synthesis, Corrosion inhibitor, Weight loss, Adsorption isotherm, Acidic medium

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Gülşen AKGÜL, Serkan ÖZTÜRK

Bursa Uludag University, Faculty of Arts and Sciences, Department of Chemistry, Görükle / BURSA



GİRİŞ (KOROZYON)
[INTRODUCTION (CORROSION)]

YAPILAN DENEYSEL ÇALIŞMALAR
(EXPERIMENTAL STUDIES)

SONUÇ
(CONCLUSION)

GİRİŞ (INTRODUCTION)

KOROZYON

Korozyon, malzemelerin içinde bulundukları ortamın etkisiyle, kimyasal ve elektrokimyasal reaksiyonlar sonucunda fiziksel, kimyasal ve mekanik özellikleri kapsamında değişime uğramalarıdır.

[1] ASTM International. ASTM G15-02. Standard Terminology Relating to Corrosion and Corrosion Testing. West Conshohocken: ASTM International; 2002



CORROSION

Corrosion is the change in the physical, chemical and mechanical properties of materials as a result of chemical and electrochemical reactions with the effect of the environment they are in.



KOROZYON (CORROSION)

Kimyasal Korozyon (Chemical Corrosion)

- **Gaz ortamında (in gas environment)**

Elektrokimyasal Korozyon (Electrochemical Corrosion)

- **Sulu ortamda elektron alışverişi ile (By electron exchange in aqueous medium)**

[2] Doruk, M. 1982. Korozyon ve Önlenmesi. ODTÜ Mühendislik Fakültesi, Yayın No: 70, Ankara.
[3] Üneri, S. 1998. Korozyon ve Önlenmesi. Korozyon Derneği, Ankara, 413 s.



KOROZİF ORTAM (Corrosive Environment)

- ✓ **Oksijen (Oxygen)**
  [yağmur suyu (rain water) , kullanım suyu (drinking water), yapı nemi (building moisture)]

- ✓ **Asitler (Acids)**
  [karbondioksit (carbon dioxide), hidroklorik asit (hydrochloric acid), sülfürik asit (sulfuric acid), v.s. (etc)]

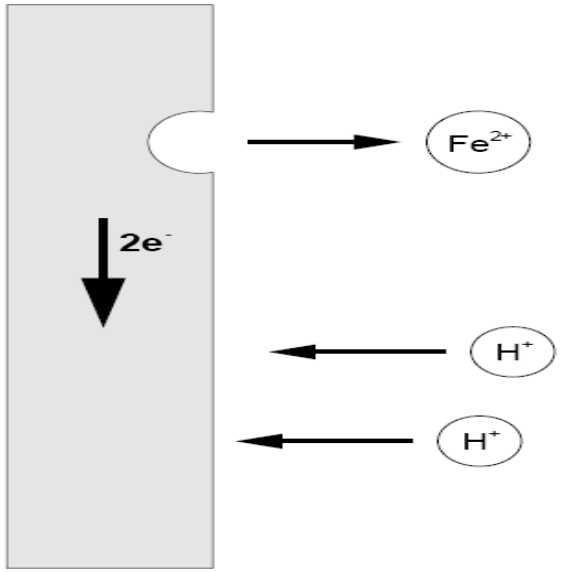
- ✓ **Tuz çözeltileri (Salt solutions)**
  [Kireçli su (Limy water), Sodalı su (Soda water), Alkalik sıvı (Alkaline liquid), v.s. - etc)]

- ✓ **Tuzlar (Salts)**
  [yemek tuzu (table salt), kalsiyum ve magnezyum klorürlü beton ve şap katkıları (concrete and screed additives with calcium and magnesium chloride)]

- ✓ **Su buharı ve kükürt oksit ihtiva eden gazlar (Gases containing water vapor and sulfur oxide)**

[4] Bidi, A., Höffer, U. 2001. Tesisatta Korozyon. V.Ulusal Tesisat Mühendisliği Kongresi ve Sergisi, 3-6 Ekim 2001, Efes Convention Center, İzmir.

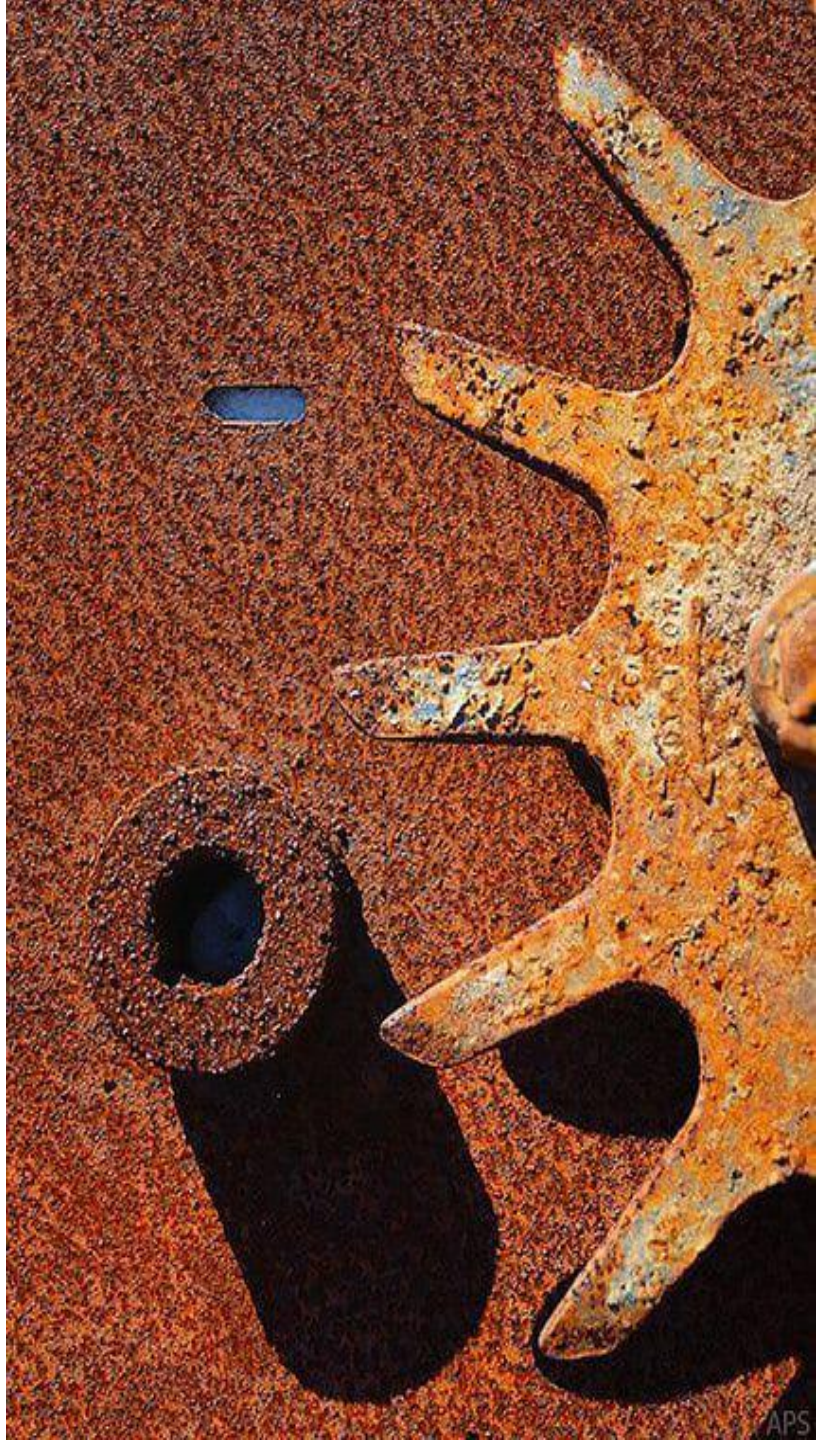
ASİDİK ORTAMDA GERÇEKLEŞEN KOROZYON (CORROSION IN ACIDIC ENVIRONMENT)



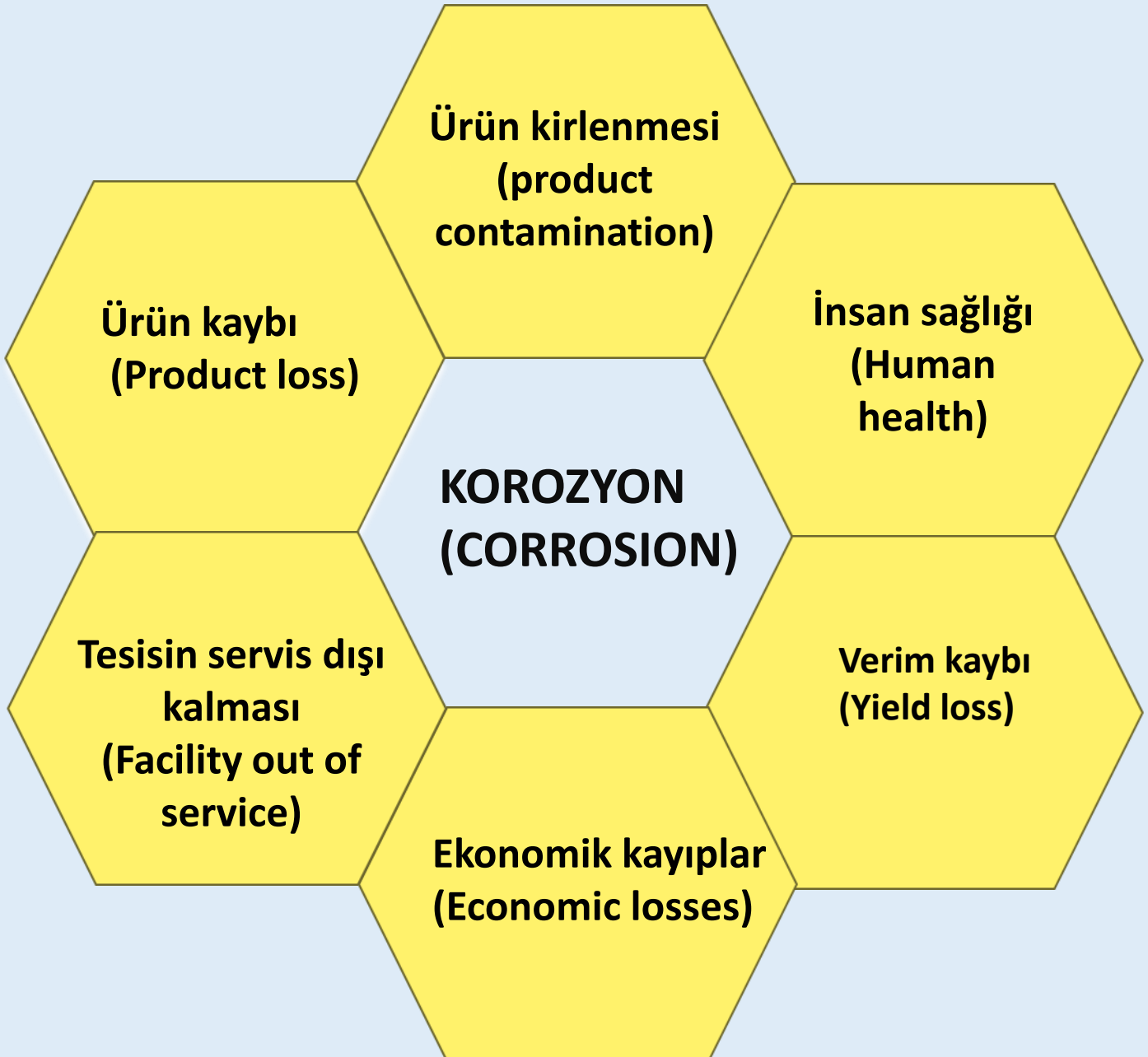
$$Fe \longrightarrow Fe^{+2} + 2e^-$$

$$2H^+ + 2e^- \longrightarrow H_2$$

$$4H^+ + O_2 + 4e^- \longrightarrow 2H_2O$$



KOROZYONUN ÖNEMİ (THE IMPORTANCE OF CORROSION)



KOROZYONA KARŞI MÜCADELEDEKİ AMAÇ :
(OBJECTIVE AGAINST CORROSION)

- Yüzeyin neme, çözünmüş oksijene, tuzlara vs. karşı mekanik olarak korumak (The surface is exposed to moisture, dissolved oxygen, salts, etc. mechanically protect against)

- Korozyonun elektrokimyasal reaksiyonlarının inhibe etmek. (Inhibiting the electrochemical reactions of corrosion.)

KOROZYON İNHİBİTÖRÜ (CORROSION INHIBITOR)

- **Ortama az miktarda eklendiği zaman metalin bulunduğu ortam ile tepkimesini etkin olarak denetleyen, azaltan ya da önleyen kimyasal maddelere *"Korozyon İnhibitörü"* adı verilir.**

(Chemical substances that effectively control, reduce or prevent the reaction of the metal with the environment when added in a small amount are called "Corrosion Inhibitor.)



[5] Papavinasam, S. 2000. Corrosion Inhibitors. In: Uhlig's Corrosion Handbook, W.R. Revie (Editor), Wiley Interscience, p.1089-1105.

YAPILAN DENEYSEL ÇALIŞMALAR (EXPERIMENTAL STUDIES)

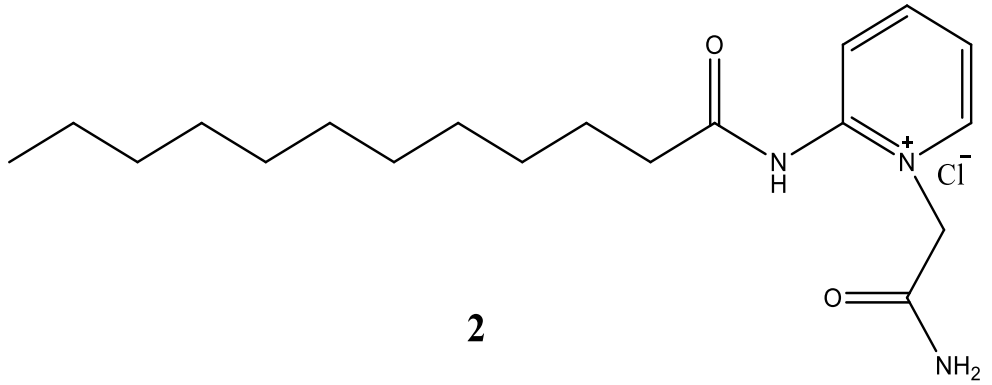
1) Bileşiklerin sentezi
(Synthesis of compounds)

2) Sentezlenen bileşiklerin 1M HCl çözeltisinde meydana gelen metal korozyonuna karşı korozyon inhibisyon etkinliklerinin test edilmesi
(Testing the corrosion inhibition activity of the synthesised compounds against metal corrosion in 1M HCl solution)

3) Adsorpsiyon izoterm çalışmalarının yapılması (Langmuir İzotermi)
[Adsorption isotherm studies (Langmuir Isotherm)]

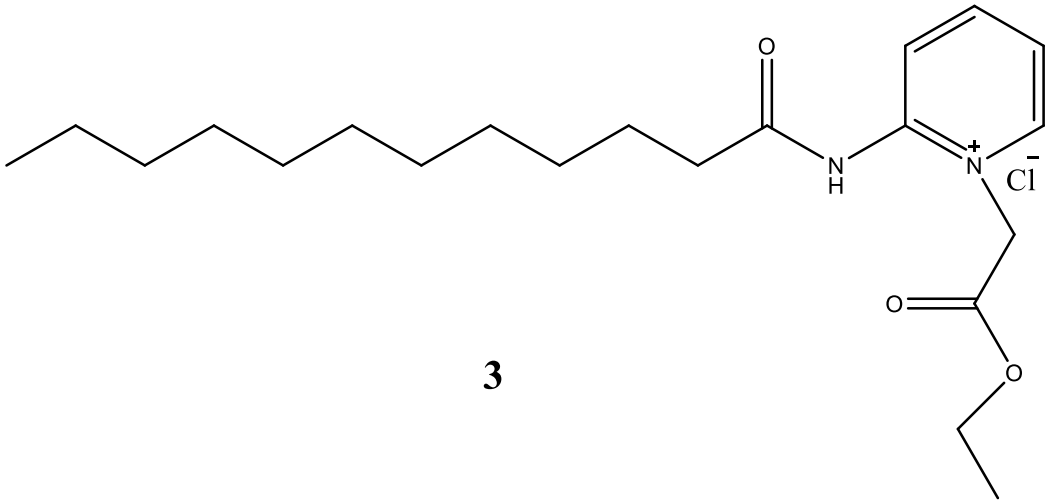
4) Korozyon inhibisyon etkinliği sonuçlarını desteklemek için optik mikroskop ile metal yüzeyi görüntülerinin alınması
(Taking images of the metal surface with an optical microscope to support the corrosion inhibition activity results)

1) Bileşiklerin sentezi (Synthesis of compounds)



2

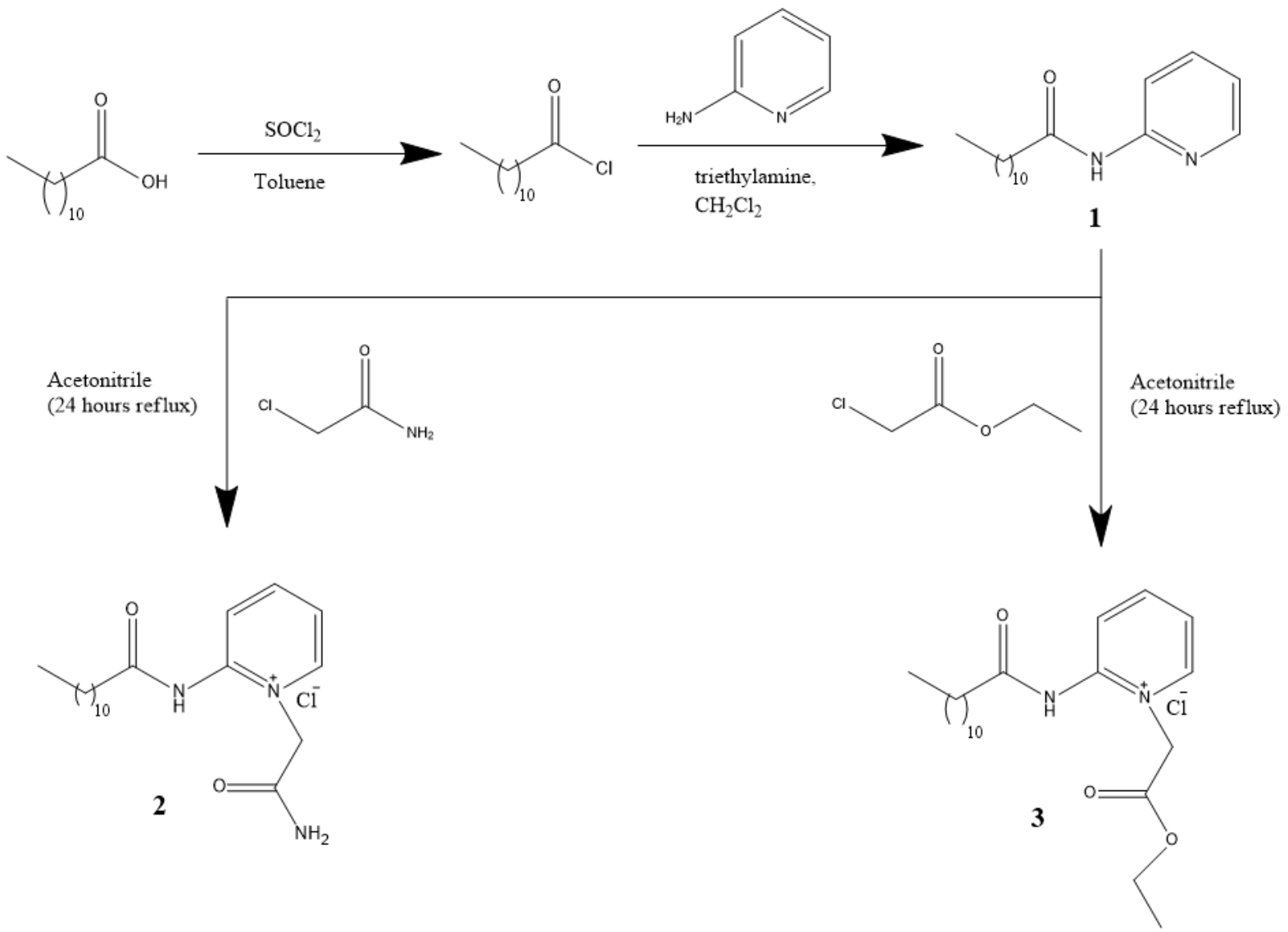
1-(2-amino-2-oxoethyl)-2-dodecanamidopyridin-1-ium chloride



3

2-dodecanamido-1-(2-ethoxy-2-oxoethyl)pyridin-1-ium chloride

REAKSİYON ŞEMASI



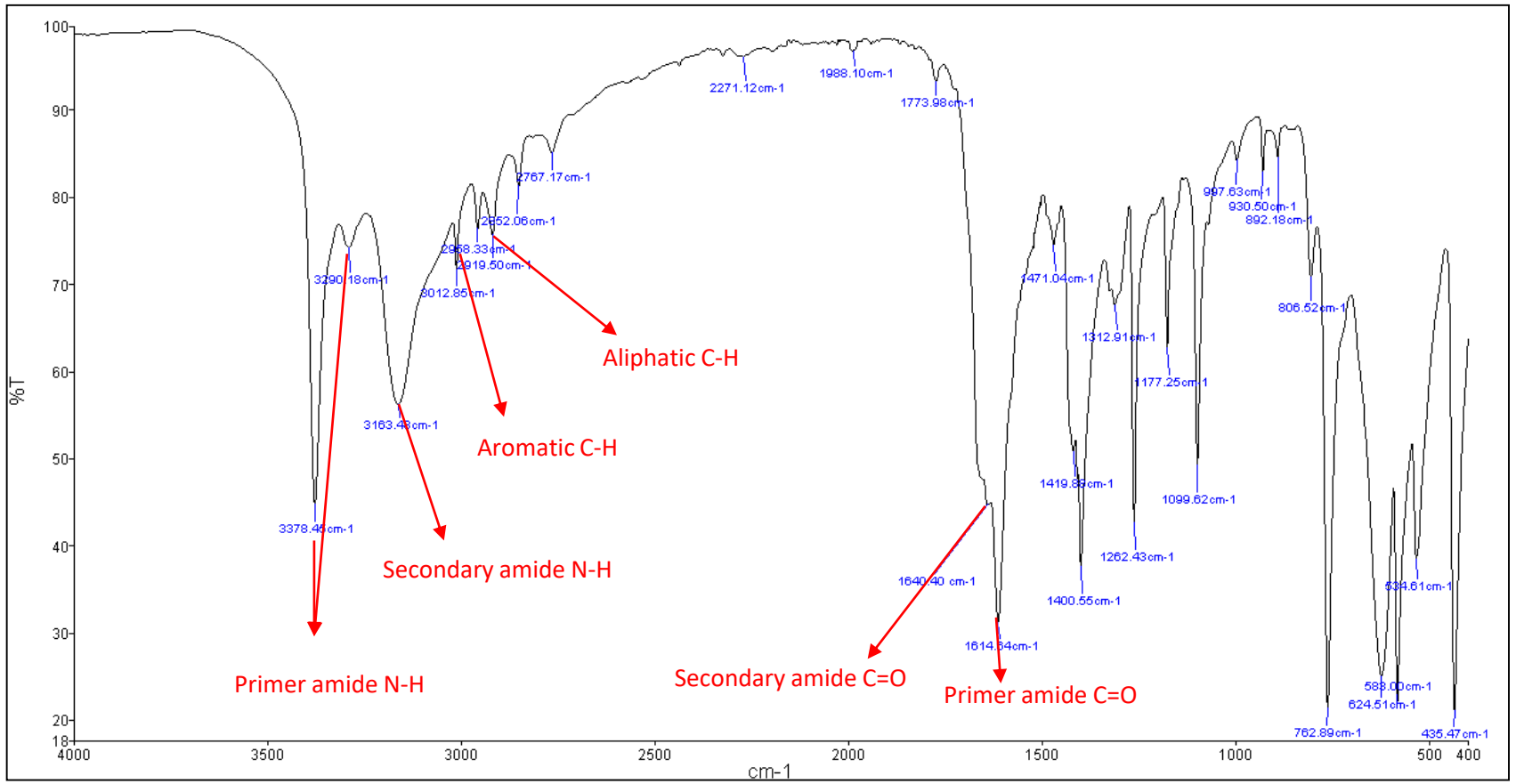
Sentezlenen bileşiklere ait karakterizasyon verileri:

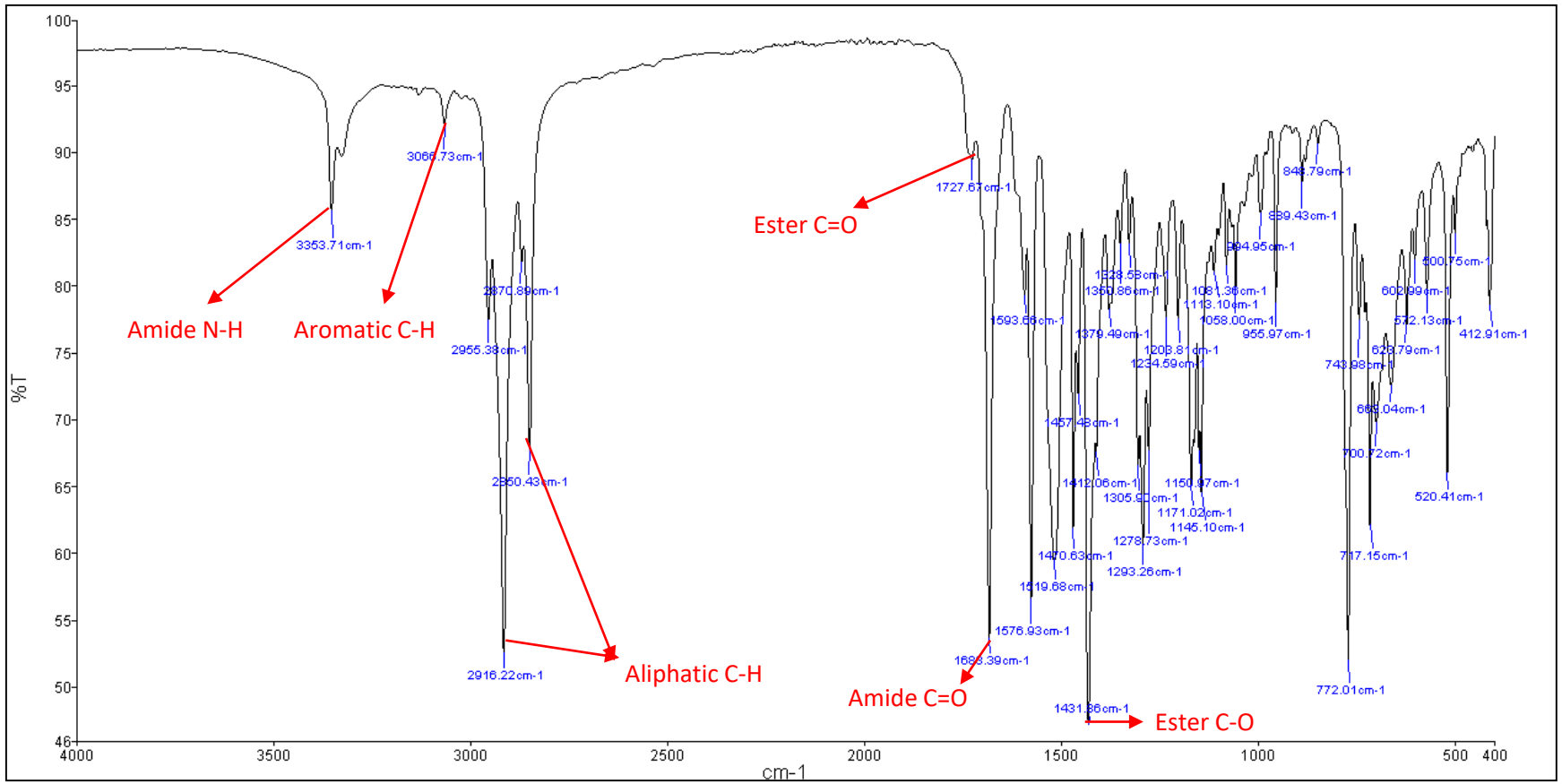
Table 1
Characterization data of the cationic surfactants.

Compounds	Chemical Formula	MW (g/mole)	*wi*(calc.)/% – *wi*(found)/%			Yield (%)	Melting Point (°C)
			C	H	N		
2	$C_{19}H_{32}ClN_3O_2$	369.93	61.69 – 61.82	8.72 – 8.78	11.36 – 11.25	27.10	[a]
3	$C_{21}H_{35}ClN_2O_3$	398.97	63.22 – 63.32	8.84 – 8.96	7.02 – 6.95	69.76	[a]

[a] Since they are obtained in the form of a solid oily wax, their melting point was not observed.

FT-IR ANALYSIS




Amide N-H
Aromatic C-H
Aliphatic C-H
Ester C=O
Amide C=O
Ester C-O
3353.71cm-1
3066.73cm-1
2955.38cm-1
2916.22cm-1
2850.43cm-1
1727.67cm-1
1593.66cm-1
1576.93cm-1
1689.39cm-1
1619.68cm-1
1470.63cm-1
1457.48cm-1
1431.86cm-1
1412.06cm-1
1379.49cm-1
1360.86cm-1
1328.58cm-1
1305.92cm-1
1293.26cm-1
1278.73cm-1
1234.59cm-1
1209.81cm-1
1171.02cm-1
1150.97cm-1
1145.10cm-1
1113.10cm-1
1081.36cm-1
1058.00cm-1
955.97cm-1
894.95cm-1
848.79cm-1
839.43cm-1
772.01cm-1
743.98cm-1
717.15cm-1
700.72cm-1
668.04cm-1
628.79cm-1
602.99cm-1
572.13cm-1
520.41cm-1
500.75cm-1
412.91cm-1
%T
cm-1
100
95
90
85
80
75
70
65
60
55
50
46
4000
3500
3000
2500
2000
1500
1000
500
400

2) Sentezlenen bileşiklerin 1M HCl çözeltisinde meydana gelen metal korozyonuna karşı korozyon inhibisyon etkinliklerinin test edilmesi
(Testing the corrosion inhibition activity of the synthesised compounds against metal corrosion in 1M HCl solution)

1- Testlerde aşağıdaki tabloda elementel bileşimi verilen düşük karbon çeliği kullanılmıştır.

(Low carbon steel, whose elemental composition is given in the table below, was used in the tests.)

Table 2
Elemental composition percentages of the steel material used in corrosion tests

Elemental Composition Percentages (%)				
C	Mn	P	S	Fe
0.07	0.35	0.015	0.015	the rest

2- Korozyon testlerinde kullanılan metal plakalar, sırasıyla 2.2 cm genişliğinde 5 cm uzunluğunda ve 0.1 cm kalınlığında kesilmiştir.

(The metal plates used in the corrosion tests were cut 2.2 cm wide, 5 cm long and 0.1 cm thick, respectively.)

3- Metal plakalar, oda sıcaklığında 24 süreyle, inhibitör içermeyen ve farklı konsantrasyonlarda (5,25,50,100,250 ppm) inhibitör içeren 1.0 M HCl çözeltilerine daldırılarak bekletilmiştir.

[The metal plates were immersed in 1.0 M HCl solutions containing different concentrations of inhibitors (5,25,50,100,250 ppm) and without inhibitors for 24 h at room temperature.]

4- Bileşiklerin inhibisyon etkinlikleri belirlenirken, 24 saat sonunda asit çözeltisinden çıkarılan metal plakalardaki kütle kayıpları dikkate alınmıştır.

(In determining the inhibition efficiency of the compounds, the weight loss in the metal plates removed from the acid solution at the end of 24 hours were taken into account.)

5- Kütle kaybı değerlerinden yararlanılarak aşağıdaki formüllerle korozyon hızı (C.R.) ve yüzde inhibisyon etkinliği (İ.E %) hesaplanmıştır.

(Corrosion rate (C.R.) and percentage inhibition efficiency (I.E %) were calculated by using the following formulae based on weight loss values.)

$$C.R. = \frac{\Delta W}{A\ x\ t}$$

$$\text{İ}.E.(\%) = \left(\frac{W_0 - W}{W_0}\right) x100$$

Table 3

Corrosion rate and corrosion inhibition efficiencies (%IE) calculated by weight loss measurement in metal coupons exposed for 24 hours at room temperature for different concentrations of surfactants in 1.0 M HCl medium.

Inhibitor Concentration (ppm)	**Corrosion Rate (mg cm^{-2} h^{-1}) x 10^{-2}**		**Inhibition Efficiency (η_{WL} %)**	
	2	**3**	**2**	**3**
0	21.06	21.06	-	-
5	3.79	3.07	82.01	85.43
25	3.11	2.69	85.25	87.23
50	2.42	2.27	88.49	89.21
100	2.95	2.12	85.97	89.93
250	1.48	1.55	92.98	92.63

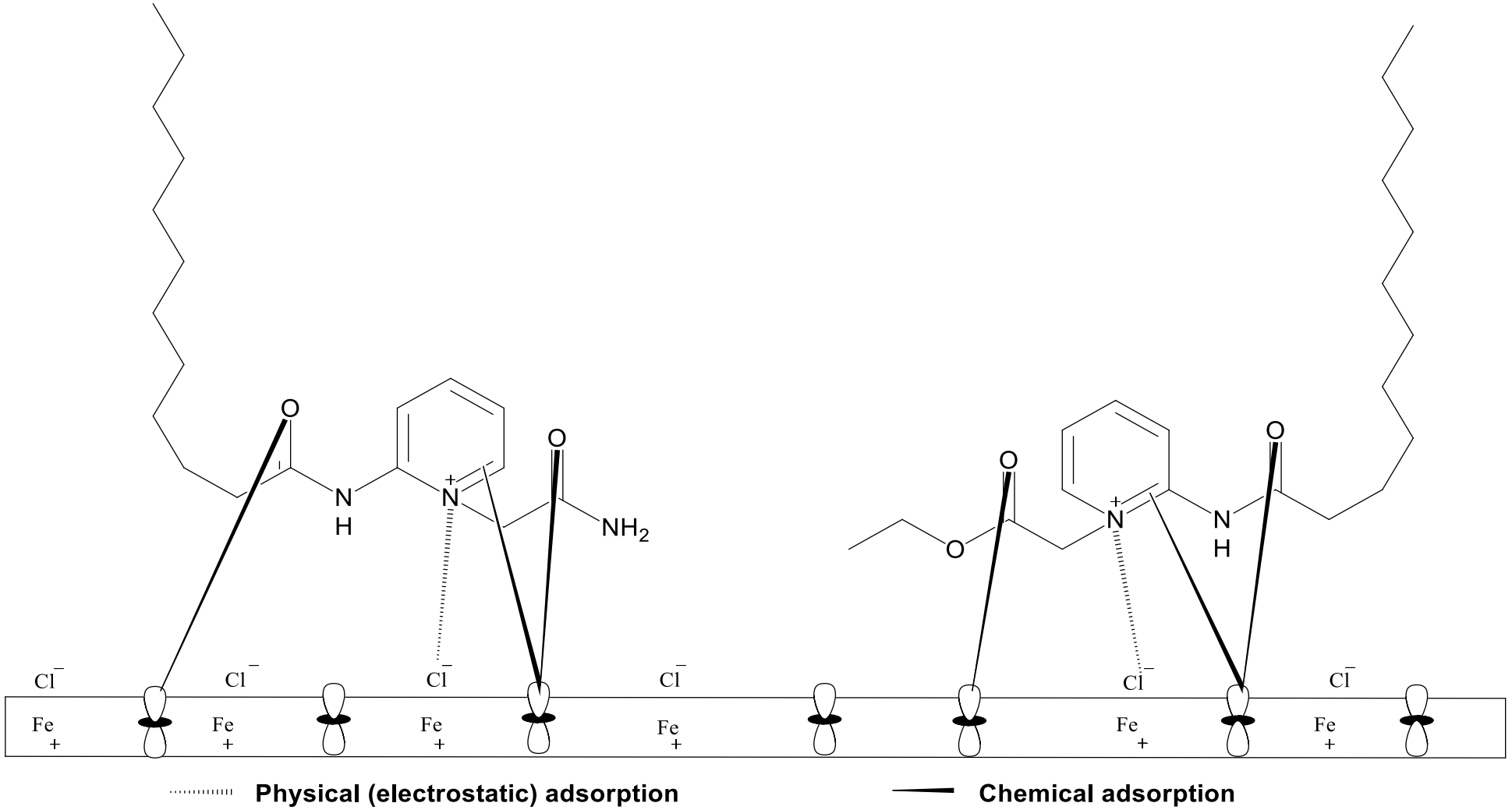
3) Adsorpsiyon İzoterm Çalışmalarının Yapılması (Langmuir İzotermi) [Adsorption isotherm studies (Langmuir Isotherm)]

Adsorpsiyon izotermleri neden yapıldı?
(Why were adsorption isotherms performed?)

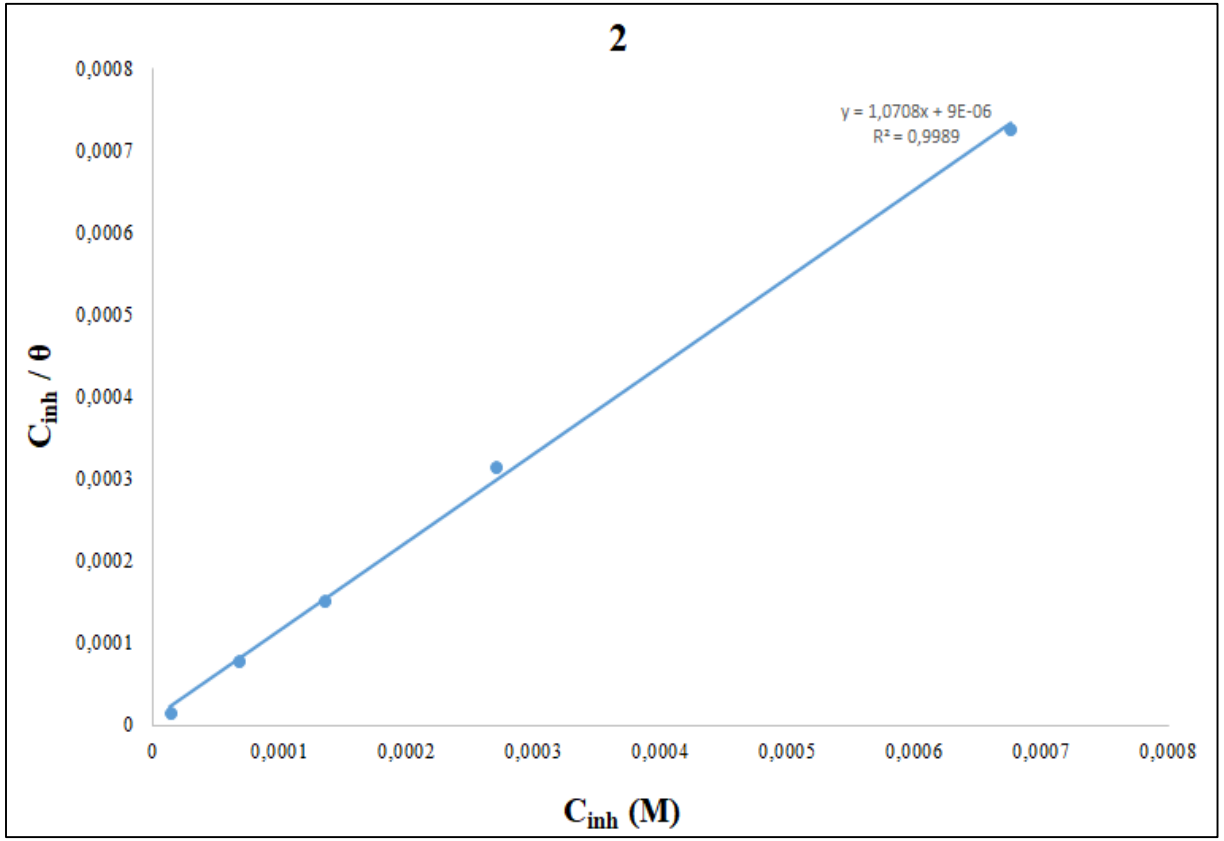
- İnhibitörlerin metal korozyonuna karşı etkinlik gösterebilmesi için metal yüzeyine adsorbe olmaları gerekir.
  (In order for inhibitors to be effective against metal corrosion, they must be adsorbed on the metal surface.)

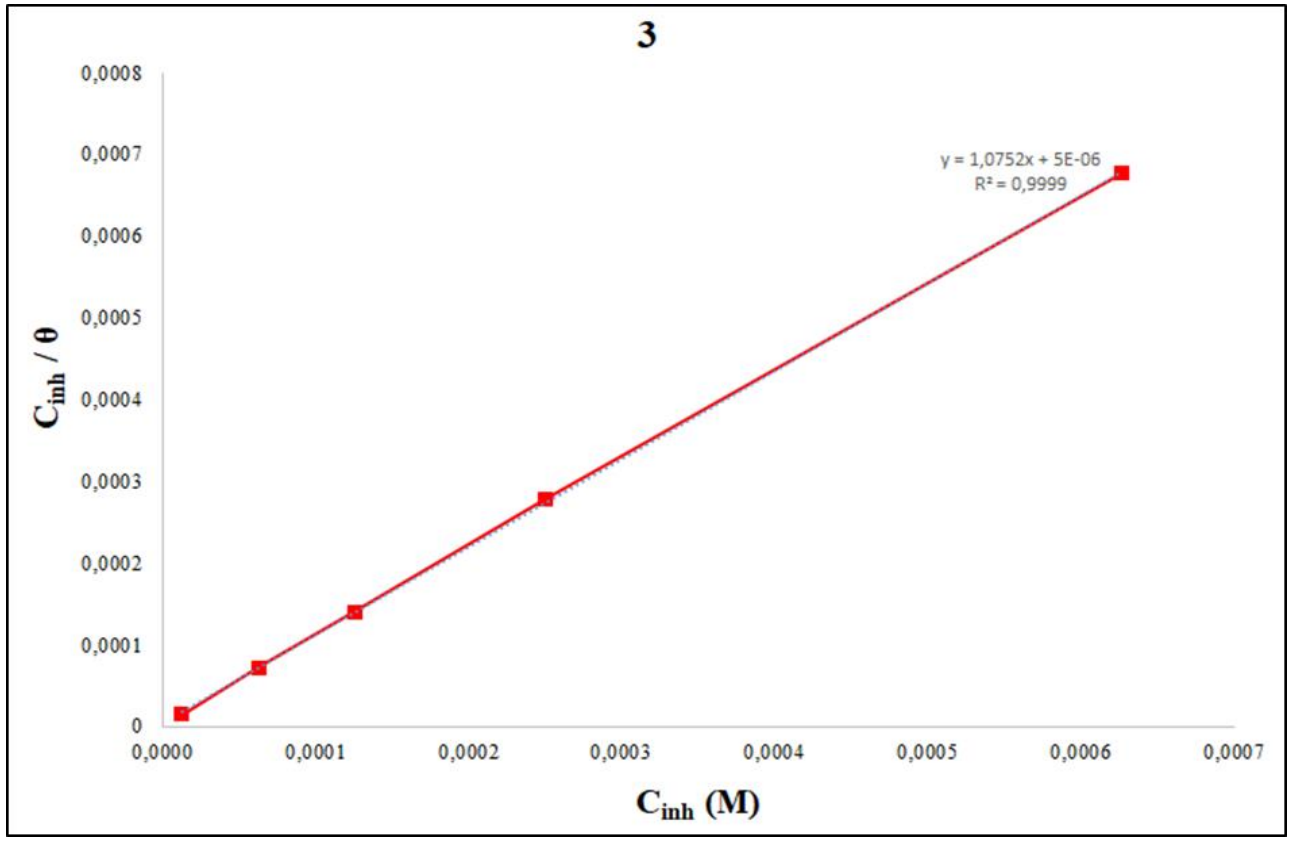
- Yüzey aktif maddeler metal yüzeyine fiziksel ve kimyasal olmak üzere iki şekilde adsorbe olabilirler.
  (Surfactants can adsorb to the metal surface in two ways, physical and chemical.)

- Hangi adsorpsiyon türünün daha baskın olduğunu belirlemek için adsorpsiyon izoterm çalışmaları yapılmıştır.
  (Adsorption isotherm studies were carried out to determine which adsorption type is more dominant.)


O
N
H
N
+
O
NH2
Cl−
Cl−
Cl−
Cl−
Fe
+
Fe
+
Fe
+
Fe
+
O
O
N
+
N
H
O
Cl−
Cl−
Fe
+
Fe
+
Physical (electrostatic) adsorption
Chemical adsorption

Langmuir Adsorpsiyon İzotermi Grafikleri (Langmuir Adsorption Isotherm Plots)





Langmuir İzotermi Grafiklerinden Hesaplanan K_{ads} ve ΔG_{ads} Değerleri

Table 4
Adsorption equilibrium constants (K_{ads}) and Gibbs free energy values (ΔG^0_{ads}) of **2** and **3** compounds determined according to the Langmuir isotherm

Compounds	K_{ads} ($\times 10^4$ M^{-1})[a]	ΔG^0_{ads} (kj mol^{-1})
2	11.90	- 38.91
3	21.50	- 40.37

4) Korozyon inhibisyon etkinliği sonuçlarını desteklemek için optik mikroskop ile metal yüzeyi görüntülerinin alınması
(Taking images of the metal surface with an optical microscope to support the corrosion inhibition activity results)

2 nolu yüzey aktif madde için:



İnhibitörsüz



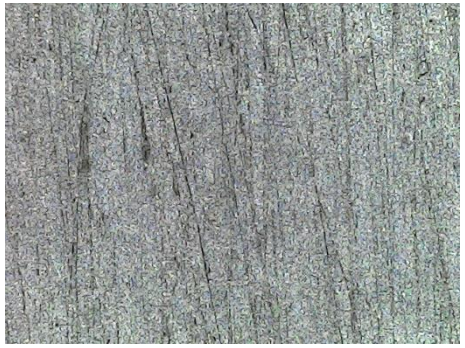
5 ppm



25 ppm



50 ppm



100 ppm



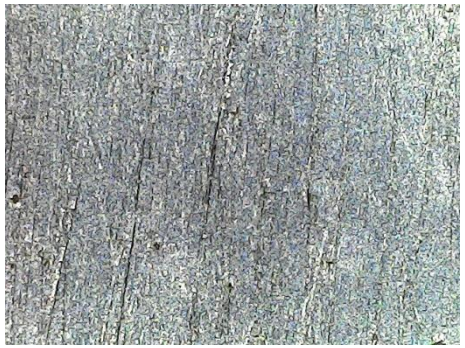
250 ppm

4) Korozyon inhibisyon etkinliği sonuçlarını desteklemek için optik mikroskop ile metal yüzeyi görüntülerinin alınması
(Taking images of the metal surface with an optical microscope to support the corrosion inhibition activity results)

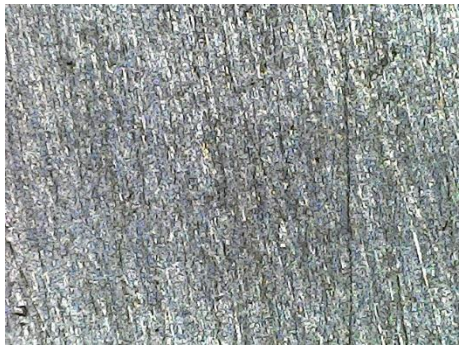
3 nolu yüzey aktif madde için:



İnhibitörsüz



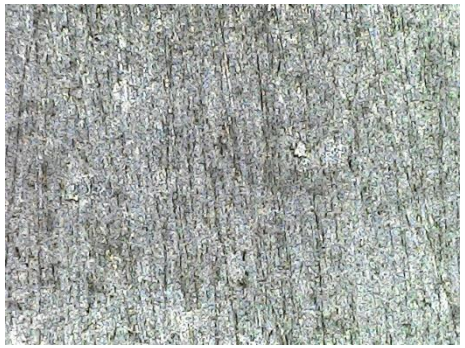
5 ppm



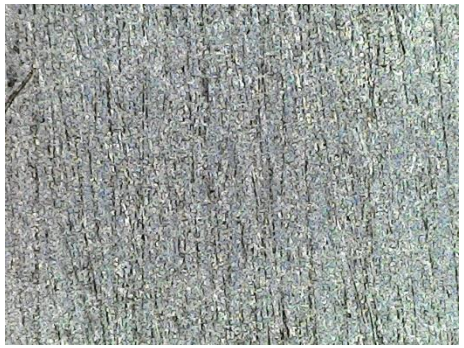
25 ppm



50 ppm



100 ppm



250 ppm

SONUÇ
(CONCLUSION)

1-Piridin azotuna bağlı birinde amit fonksiyonel grubu diğerinde ester fonksiyonel grubu içeren iki adet mono katyonik yüzey aktif madde sentezlendi ve yapıları spektroskopik yöntemle aydınlatıldı.

(Two mono cationic surfactants containing one amide functional group and the other ester functional group attached to pyridine nitrogen were synthesized and their structures were elucidated by spectroscopic method.)

2-Bu iki maddenin, metal plakalardaki kütle kaybı değerlerinden yola çıkılarak, farklı inhibitör konsantrasyonlarındaki korozyon hızları ve inhibisyon etkinlikleri hesaplanmıştır. Hesaplamalar sonucunda ester fonksiyonel grubu içeren bileşiğin (3), diğerine göre korozyon hızını biraz daha fazla düşürdüğünü, buna bağlı olarak da daha iyi inhibisyon etkinliği gösterdiği tespit edilmiştir.

(Based on the mass loss values of these two substances on metal plates, corrosion rates and inhibition efficiencies at different inhibitor concentrations were calculated. As a result of the calculations, it was found that the compound containing ester functional group (3) decreased the corrosion rate slightly more than the other one and accordingly showed better inhibition efficiency.)

3-Bu sonucu destekler nitelikte, 3 nolu bileşiğin metal yüzeyine daha baskın bir şekilde kimyasal adsorpsiyonla tutunduğu, Langmuir izoterm çalışmalarından anlaşılmıştır. Kimyasal adsorpsiyon türü daha sağlam bir tutunmayı ortaya koyduğundan, ester fonksiyonel grubu içeren inhibitörün metal yüzeyine daha sağlam adsorbe olduğunu söylemek mümkündür.

(In support of this result, it was understood from Langmuir isotherm studies that compound 3 was more dominantly adsorbed to the metal surface by chemical adsorption. Since the chemical adsorption type reveals a more robust adsorption, it is possible to say that the inhibitor containing ester functional group adsorbs more robustly to the metal surface.)

4-İnhibitörlerin korozyon inhibisyon etkinlikleri, optik mikroskop kamerayla metal yüzeyi görüntüleri alınarak görsel olarak da kanıtlanmıştır.

(The corrosion inhibition activities of the inhibitors were also visually proven by taking images of the metal surface with an optical microscope camera.)

Beni dinlediğiniz için teşekkür ederim.

(Thank you for listening to me.)