
UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2010/2011 Academic Session

April/May 2011

KIE 358 – Current Topics In Industrial Chemistry
[Tajuk Semasa Kimia Industri]

Duration : 3 hours
[Masa : 3 jam]

Please check that this examination paper consists of EIGHT printed pages before you begin the examination.

Instructions:

Answer any **FIVE** (5) questions.

You may answer the questions either in Bahasa Malaysia or in English.

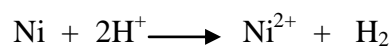
If a candidate answers more than five questions, only the answers to the first five questions in the answer sheet will be graded.

In the event of any discrepancies, the English version shall be used.

Answer **Five (5)** questions.

1. (a) The air-conditioner copper tube is connected to each other by using steel connectors. What types of electrochemical cells might develop due to this connection? Which of the materials would you expect to serve as anode and suffer the most extensive damage due to corrosion? Explain.
(8 marks)
- (b) What are meant by anodic and cathodic inhibitors? Briefly explain by using a potentiodynamic polarization curve the effects of anodic and cathodic inhibitors on the corrosion potential and the corrosion current density.
(8 marks)
- (c) What is Galvanic corrosion and pitting corrosion? Describe briefly under which conditions these corrosion occurs
(4 marks)

2. (a) Nickel experiences corrosion in an acid solution according to the reaction



The rate of both oxidation and reduction half-reactions are controlled by activation polarization.

- (i) Compute the rate of corrosion of Ni (in $\text{mol cm}^{-2} \text{ s}^{-1}$) given the following activation data:

Nickel	Hydrogen
$E_{\text{rev}}^{\circ} = -0.25 \text{ V}$	$E_{\text{rev}}^{\circ} = 0.00 \text{ V}$
$i_a = 1 \times 10^{-8} \text{ A cm}^{-2}$	$i_c = 6 \times 10^{-7} \text{ A cm}^{-2}$
$\beta_a = 0.12 \text{ V decade}^{-1}$	$\beta_c = -0.10 \text{ V decade}^{-1}$

- (ii) Compute the value of the corrosion potential.

(12 marks)

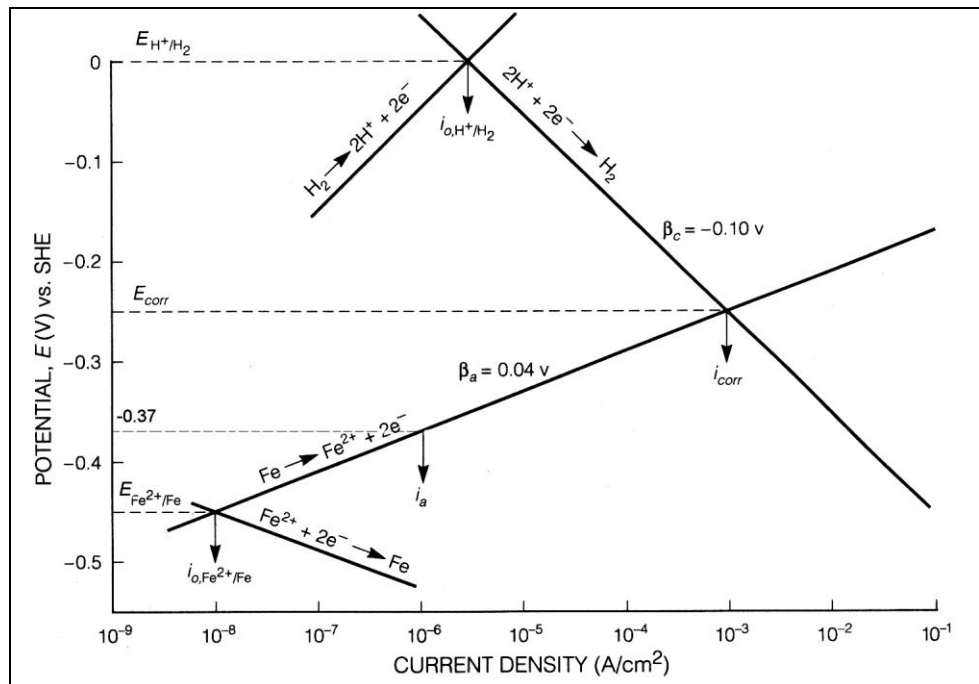
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- (b) Briefly describe the phenomenon of passivity. Why does chromium and nickel in stainless steels make them more corrosion resistant in many environments than plain carbon steels?

(8 marks)

3. The figure given below shows the anodic and cathodic polarization of iron in 0.5 M HCl at 30 °C. If the density and the equivalent weight of iron are 7.60 g cm^{-3} and 27.95 g eq^{-1} , respectively, determine:

- The corrosion current and corrosion rate of iron in 0.5 M HCl.
- The corrosion current and corrosion rate if the iron is cathodically polarized to -0.37 V .
- The polarization potential to reduce the corrosion rate of iron to one tenth ($1/10$) of the original corrosion rate.
- Briefly explain the effectiveness of cathodic protection method for the corrosion prevention of iron in 0.5 M HCl.



(20 marks)

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4. (a) Corrosion of iron in acidic solution with and without the presence of inhibitor can be studied by means of electrochemical impedance spectroscopy (EIS).
- (i) Draw the equivalent circuits which reflect the corrosion process.
 - (ii) Using the Nyquist plot, show the effects of inhibitor concentrations which indicate the increase of inhibitor efficiency.
 - (iii) What are the advantages of EIS as compared to concentrations which indicate the increase of inhibitor efficiency.
- (10 marks)
- (b) Electrical conductive adhesives (ECAs) are widely used in electronics packaging applications. ECAs can be divided into THREE categories. Name the three categories and describe their features.
- (10 marks)
5. Identify and briefly discuss ANY FOUR challenges on the application of intrinsic conductive adhesives (ICAs) technology. Give suggestion(s) to address each of your identified challenges.
- (20 marks)
6. Marine organisms employ biological adhesives as a means of survival within their life-cycle. Barnacles and mussels are examples. The barnacles applied the attunual organs while mussels used byssus threads as the mean to attach themselves to surfaces. Elaborate the functional origin, source/type of adhesive and the mechanism of adhesion in EITHER the barnacles or the mussels.
- (20 marks)
7. Silicone is widely used as industrial adhesives. Explain briefly the preparation chemistry, formulation and the mechanism of adhesion of silicone-based adhesives.
- (20 marks)

TERJEMAHAN

Arahan:

Jawab **LIMA** (5) soalan.

Anda dibenarkan menjawab soalan ini sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.

Jika calon menjawab lebih daripada lima soalan, hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.

Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.

Jawab **Lima (5)** soalan

1. (a) Paip kuprum penghawa dingin telah disambungkan satu dengan yang lain menggunakan penyambung keluli. Apakah jenis sel elektrokimia yang mungkin terbentuk akibat daripada penyambungan ini? Bahan yang manakah yang anda jangka bertindak sebagai anod dan mengalami kerosakan yang teruk akibat kakisan? Jelaskan.
- (8 markah)
- (b) Apakah yang dimaksudkan dengan perencat anodik dan katodik? Jelaskan dengan ringkas dengan menggunakan keluk pengutuban potensiodinamik kesan perencat anodik dan katodik terhadap keupayaan kakisan dan ketumpatan arus kakisan.
- (8 markah)
- (c) Apakah kakisan Galvani dan kakisan liang? Nyatakan dengan ringkas keadaan yang menyebabkan kakisan tersebut berlaku.
- (4 markah)
2. (a) Nikel mengalami kakisan dalam larutan asid menurut tindak balas



Kadar tindak balas setengah bagi pengoksidaan dan penurunan adalah dikawal oleh pengkutuban pengaktifan.

- (i) Hitunglah kadar kakisan Ni (dalam unit $\text{mol cm}^{-2} \text{ s}^{-1}$) daripada data pengaktifan berikut:

Nickel	Hydrogen
$E_{\text{rev}}^{\circ} = -0.25 \text{ V}$	$E_{\text{rev}}^{\circ} = 0.00 \text{ V}$
$i_a = 1 \times 10^{-8} \text{ A cm}^{-2}$	$i_c = 6 \times 10^{-7} \text{ A cm}^{-2}$
$\beta_a = 0.12 \text{ V decade}^{-1}$	$\beta_c = -0.10 \text{ V decade}^{-1}$

- (ii) Hitunglah nilai bagi keupayaan kakisan.

(12 markah)

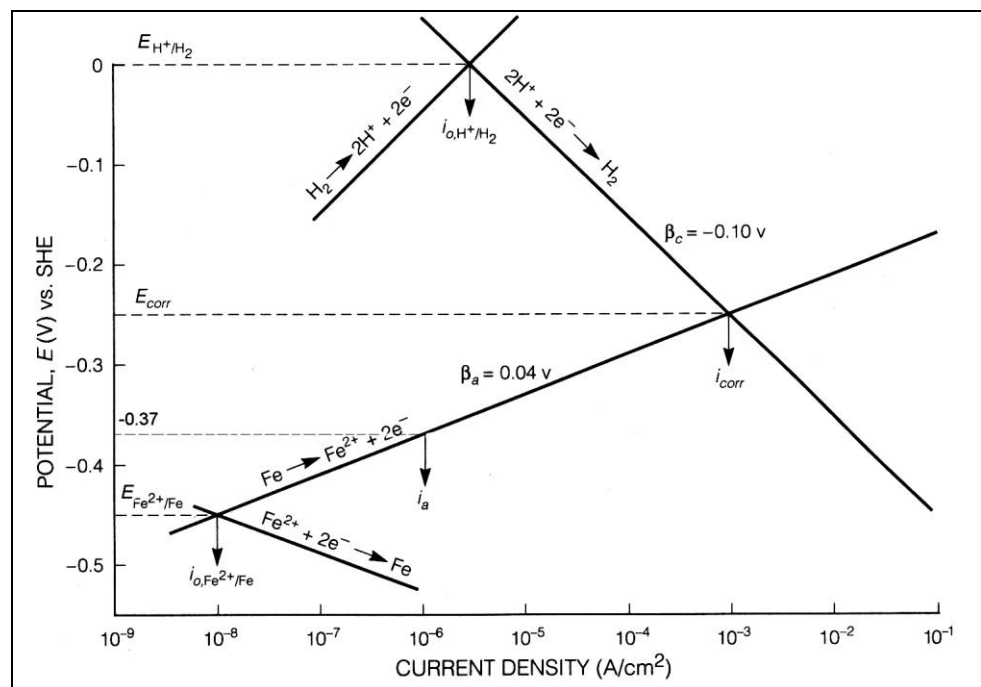
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- (b) Jelaskan dengan ringkas fenomena kepasifan. Mengapa kromium dan nikel di dalam keluli kalis karat menyebabkan keluli tersebut lebih tahan kakisan dalam banyak persekitaran berbanding dengan keluli karbon?

(8 markah)

3. Rajah dibawah ini menunjukkan pengutuban anodik dan katodik bagi besi dalam 0.5 M HCl pada 30 °C. Jika ketumpatan dan berat ekuivalen besi masing-masing ialah 7.60 g cm^{-1} dan 27.95 g eq^{-1} , tentukan:

- Ketumpatan arus dan kadar kakisan besi di dalam 0.5 M HCl.
- Ketumpatan arus dan kadar kakisan jika besi dikutubkan secara katodik kepada -0.37 V.
- Keupayaan pengutuban bagi mengurangkan kadar kakisan besi kepada satu persepuluh (1/10) daripada kadar kakisan asal.
- Jelaskan dengan ringkas keberkesanan kaedah pencegahan katodik bagi mengawal kakisan besi di dalam 0.5 M HCl.



(20 markah)

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4. (a) Kakisan besi dalam larutan asid dengan dan tanpa kehadiran perencat dapat dikaji dengan menggunakan spektroskopi elektrokimia impedan (EIS).
- (i) Lakarkan litar setara yang menggambarkan proses kakisan.
 - (ii) Dengan menggunakan plot Nyquist, tunjukkan kesan kepekatan perencat yang menunjukkan pertambahan keberkesanan perencatan.
 - (iii) Apakah kelebihan EIS berbanding dengan kajian pengutuban potensiodinamik?
- (10 markah)
- (b) Perekat pengalir elektrik (ECA) digunakan secara meluas dalam aplikasi pembungkusan elektronik. ECA boleh dibahagikan kepada TIGA kategori. Namakan TIGA kategori itu dan nyatakan ciri-cirinya.
- (10 markah)
5. Kenalpasti dan bincang secara ringkas MANA-MANA EMPAT cabaran ke atas aplikasi teknologi perekat pengalir intrinsik (ICA). Berikan cadangan untuk mengatasi cabaran yang telah anda kenalpasti.
- (20 markah)
6. Organisme marin menggunakan perekat biologi sebagai salah satu tahap kewujudan dalam kitaran-hidupnya. Contoh adalah teritip dan kupang. Teritip mengaplikasikan organ nipis manakala kupang menggunakan bebenang byssus sebagai penghubung kepada permukaan. Huraikan asal-usul, sumber/jenis perekat dan mekanisme perekatan bagi SAMA ADA teritip atau kupang.
- (20 markah)
7. Silikona adalah perekat industri yang digunakan secara meluas. Terangkan secara ringkas kimia penyediaan, formulasi dan mekanisme perekatan perekat berasaskan silikona.
- (20 markah)