
UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2012/2013 Academic Session

June 2013

EKC 377 – Renewable and Alternative Energies
[Tenaga-Tenaga Alternatif dan Boleh Diperbaharu]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains SIX printed pages before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi ENAM muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

Instruction: Answer **ALL** questions.

Arahan: Jawab **SEMUA** soalan.]

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

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai].

Answer ALL questions.

Jawab SEMUA soalan.

1. The abstract below was taken from the journal 'Energy'. Read the abstract and answer the following questions:

Abstrak di bawah adalah diambil daripada jurnal 'Energy'. Baca abstrak di bawah dan jawab soalan-soalan berikut:

"In recent years prices on global food markets showed large fluctuations. The use of biomass as energy source (biofuel) in the developed world is frequently mentioned as one of the reasons for this instability. This paper compares the need for biofuel and needs for food and feed on global scale. A simple model is developed to estimate present and near future global needs for food, livestock feed and energy. We distinguish between developing countries, transition countries and the developed countries. The first group of countries needs extra food for their growing population, the second one needs extra feed, since the increased incomes among their population lead to increased demands for animal products. The developed countries require biomass to reduce the CO₂ emissions of their energy use. On global scale the extra needs for biomass as a fuel (1100 MT) turn out to be larger than the extra needs for food and feed (800 MT each). At present the developed countries are food exporters, their produce is essential for several food insecure countries in Africa and Asia. The increased need for biomass for energy is likely to affect these exports and therefore affect food security in parts of the world." by Sanderine Nonhebel, *Energy*, Volume 37, Issue 1, January 2012, Pages 115-121.

- [a] Briefly explain 5 advantages of using biofuel.
Terangkan secara ringkas, terangkan 5 kelebihan menggunakan bahan api bio.
[5 marks/markah]
- [b] Give 5 different types of biofuel and briefly explain the process for its production.
Berikan 5 jenis bahan api bio dan terangkan secara ringkas proses bagi penghasilan kelima-lima jenis bahan api bio tersebut.
[10 marks/markah]
- [c] From Malaysia's perspective, as a transition country, do you think the conversion of food sources to biofuel is the main reason for the increase of food prices?
Daripada persektif Malaysia sebagai sebuah negara peralihan, adakah anda setuju bahawa penukaran sumber makanan kepada bahan api bio merupakan sebab utama peningkatan harga makanan.
[5 marks/markah]
- [d] Food sources can be a sustainable source of food and energy simultaneously. Please justify if you agree or don't agree with the statement.
Sumber makanan boleh menjadi sumber mampan bagi makanan dan tenaga serentak. Sila berikan justifikasi sama ada anda setuju atau tidak setuju dengan kenyataan di atas.
[5 marks/markah]

2. [a] Define petro-diesel, green-diesel and bio-diesel.
Takrifkan diesel-petrol, diesel-hijau dan diesel-bio.
[6 marks/markah]
- [b] Using your chemical engineering knowledge, draw a process flow diagram for the production of bio-diesel from crude palm oil. Briefly explain the process occurring in each major unit operation.
Dengan menggunakan pengetahuan kejuruteraan kimia anda, lukiskan satu gambarajah aliran proses bagi penghasilan diesel-bio daripada minyak kelapa sawit mentah. Terangkan secara ringkas proses yang berlaku di dalam setiap unit operasi utama.
[10 marks/markah]
- [c] Lately, microalgae has been hailed as the future feedstock for biodiesel production. Discuss the advantages and disadvantages of using microalgae as biodiesel feedstock.
Baru-baru ini, mikroalga dianggap sebagai bahan mentah masa hadapan untuk penghasilan diesel-bio. Bincangkan kelebihan dan kekurangan menggunakan mikroalga sebagai bahan mentah bagi penghasilan diesel-bio.
[5 marks/markah]
- [d] Perlis is a small state in north Malaysia which produces sugar. Every year, Perlis produces 300,000 ton of sugar, and uses 300,000 ton of fossil petroleum fuel. If all this sugar were converted to ethanol (C_2H_5OH), what proportion of petroleum imports could it replace?
Perlis adalah sebuah negeri kecil di sebelah utara Malaysia yang menghasilkan gula. Setiap tahun Perlis menghasilkan 300,000 tan gula dan menggunakan 300,000 tan bahan api petroleum fosil. Sekiranya semua gula yang dihasilkan ditukarkan kepada etanol, berapa peratuskah penggunaan petroleum boleh dikurangkan?
- The following information may be required;
Data berikut mungkin diperlukan;
- Sugar may be represented by glucose ($C_6H_{12}O_6$)
Gula boleh diwakili oleh glukosa ($C_6H_{12}O_6$)
 - Molecular weight of C = 12, O = 16, H = 1
Jisim molekul C = 12, O = 16, H = 1
 - Caloric value of ethanol = 26.7 MJ/kg and crude oil = 45 MJ/kg
Nilai kalori etanol = 26.7 MJ/kg dan minyak mentah = 45 MJ/kg
[4 marks/markah]

3. [a] What are thermal energy storage? What are the two types of thermal energy storage commonly used in a solar harvesting plant and describe the working concept of one of them.

Apakah yang dimaksudkan dengan simpanan tenaga terma? Namakan dua jenis tenaga terma storan yang biasa diguna dalam satu loji penuaian suria dan terangkan cara kerja konsep salah satu daripadanya.

[3 marks/markah]

- [b] Fresnel lens reflector is a variation towards the parabolic troughs system. Discuss the differences between the two solar collection systems.

Kanta pantulan Fresnel adalah variasi kepada sistem paluh parabola. Bincangkan perbezaan di antara dua sistem koleksi solar tersebut.

[3 marks/markah]

- [c] What are the major differences between a dish-stirling engine solar concentrator with a typical solar concentration plant. Give a situation of where dish-stirling engine is suitable to be applied.

Apakah perbezaan utama antara penumpu suria enjin dish-stirling dengan loji penumpu suria yang biasa. Berikan satu situasi yang sesuai di mana enjin dish-stirling dapat diaplikasikan.

[3 marks/markah]

- [d] Explain how an electric current is generated in a photovoltaic cell.

Terangkan bagaimana arus elektrik dijana dalam sel fotovolt.

[4 marks/markah]

- [e] What are the impacts of photovoltaic cell towards our environment?

Apakah kesan sel fotovolt kepada persekitaran kita?

[4 marks/markah]

- [f] A house owner plans to install a solar heating system for his indoor swimming pool. Peak insolation by direct sunlight is taken to be 1800 W/m^2 at this latitude in Italy.

Seorang pemilik rumah merancang untuk memasang sistem pemanasan suria untuk kolam renang dalaman. Puncak insolasi oleh cahaya matahari diambil sebagai 1800 W/m^2 pada latitud ini di Itali.

- [i] Describe the main characteristics of the type of water heater you would advise to be installed to provide heating for the swimming pool. Give the reasons for your choice.

Jelaskan ciri-ciri utama jenis pemanas air yang anda syorkan untuk dipasang bagi pemanasan kolam renang. Beri sebab-sebab untuk pilihan anda.

[3 marks/markah]

- [ii] With a diagram, describe the working concept of the proposed solar water heating system to provide heating for the swimming pool.

Dengan bantuan gambarajah, jelaskan konsep kerja sistem pemanasan air suria yang dicadangkan untuk memanaskan air kolam renang.

[5 marks/markah]

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4. [a] Draw a schematic diagram of a Molten Core Fuel Cell (MCFC). Explain how electricity is generated. Label as many of the features as possible including: the gas diffusion electrodes, the electrolyte, the fuel supply (H_2), the air supply (O_2), the formation of water and the load. Use arrows to indicate the direction of flows of electrons, gases and water. Indicate the flow of ionic species in the electrolyte.

Lukiskan gambarajah skematik sel Bahan Api Teras Leburan (MCFC). Jelaskan bagaimana elektrik dihasilkan. Labelkan sebanyak mungkin ciri-ciri termasuk: elektrod penyebaran gas, elektrolit, bekalan bahan api (H_2), bekalan udara (O_2), pembentukan air dan beban. Gunakan anak panah untuk menunjukkan arah aliran elektron, gas dan air. Tunjukkan aliran spesis ionik dalam elektrolit.

[4 marks/markah]

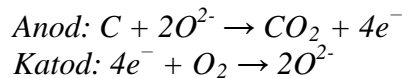
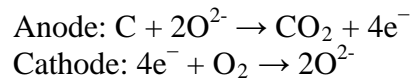
- [b] Why in practical fuel cells has lower efficiency than ideal? Briefly explain each point presented.

Mengapa secara praktikal sel-sel bahan api mempunyai kecekapan yang lebih rendah daripada yang ideal? Terangkan secara ringkas setiap hujah yang dibentangkan.

[4 marks/markah]

- [c] A fuel cell has the following reactions:

Satu sel bahan api mempunyai tindak balas berikut:



Changes of enthalpy and free energy, per kmole of CO_2 , are:
Perubahan entalpi dan tenaga bebas, per kmol CO_2 , adalah:

$$\begin{aligned} \Delta h_f^\circ &= -393.5 \text{ MJ} \\ \Delta g_f^\circ &= -394.5 \text{ MJ} \end{aligned}$$

- [i] What is the overall reaction equation?
Apakah persamaan tindak balas keseluruhan? [2 marks/markah]

- [ii] What type of electrolyte can be used for this cell?
Apakah elektrolit yang sesuai digunakan untuk sel ini? [1 mark/markah]

- [iii] What is the ideal emf (V_{rev})?
Apakah emf yang ideal (V_{rev})?

Given:
Diberi:

$$\begin{aligned} q &= 1.6 \times 10^{-19} \text{ coulomb} \\ N_o &= 6.022 \times 10^{26} \end{aligned} \quad [2 \text{ marks/markah}]$$

...6/-

- [iv] What is the difference in entropy between reactants and products at room temperature, and the significant of the calculated value?

Apakah perbezaan entropi antara bahan tindak balas dan produk pada suhu bilik serta maksud kepada nilai yang dikira?

[4 marks/markah]

- [d] Which type of fuel cell is suitable for power plant of large capacity (say up to 1 GW). Justify your answers with several reasons.

Apakah jenis sel bahan api yang sesuai untuk loji kuasa kapasiti besar (sehingga 1 GW). Jelaskan jawapan anda dengan beberapa sebab.

[4 marks/markah]

- [e] What is cogeneration? Using a diagram, describe how can it be achieved in high temperature fuel cells such as Molten Core Fuel Cells (MCFCs) and Solid Oxide Fuel Cells (SOFCs)?

Apakah kogenarasi? Dengan menggunakan gambarajah, terangkan bagaimana ia boleh dilaksanakan dalam sel-sel bahan api bersuhu tinggi seperti Sel Bahan Api Teras Leburan (MCFCs) dan Sel Bahan Api Pepejal Oksida (SOFCs)?

[4 marks/markah]