
UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2010/2011 Academic Session

April/May 2011

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].

1.

Malaysia details plans for two nuclear plants

MALAYSIA'S energy minister has confirmed that the country plans to build its first two nuclear power plants with a capacity of 1000 MW each by 2022.

The minister, Peter Chin, told the news agency *Bernama* that he hopes to finish evaluating the requirements for the new power plants "by 2013 or 2014". He previously suggested that South Korea, France, Japan or China could provide the necessary technology, while the Malaysian state energy company Tenaga estimates it could build a plant for \$3.1b.

The country's cabinet last year agreed in principle to invest in nuclear power in a bid to diversify the country's energy supply. At present, 64% of Malaysia's power is generated in gas-fired power plants, with coal supplying the rest.

The decision to push ahead with the construction of nuclear power plants was met with criticism from environmentalists. They are worried that the plants may not be safe, and have accused the government of not giving serious thought to renewables. Prime minister Najib Razak has promised to evaluate the potential for expanding its renewable power, but Chin warned that the scope for this is limited, and the cost beyond consumers' ability to pay.

february 2011 www.tcetoday.com 15

The article above was taken from "The Chemical Engineer", issue 836 dated February 2011. Read the article and answer the following questions:

Petikan di atas adalah diambil daripada "The Chemical Engineer", jilid 836 bertarikh Februari 2011. Baca petikan tersebut dan jawab soalan-soalan berikut:

- [a] Discuss the importance of diversifying a country's energy supply.
Bincangkan kepentingan mempelbagaikan sumber tenaga sesebuah negara.
[5 marks/markah]
- [b] As a citizen of Malaysia, would you agree with the construction of nuclear power plant as energy source in Malaysia?
Sebagai rakyat Malaysia, adakah anda setuju dengan pembinaan loji tenaga nuklear sebagai sumber tenaga di Malaysia?
[5 marks/markah]
- [c] Do you agree with the claim made in the article by environmentalist that the government is not giving serious thought to renewables?
Adakah anda setuju dengan kritikan di dalam petikan yang dibuat oleh ahli alam sekitar bahawa pihak kerajaan tidak memberikan tumpuan yang sewajarnya bagi tenaga boleh diperbaharui.
[5 marks/markah]

...3/-

- [d] List and discuss three other alternative energies that would be feasible in Malaysia.

Senarai dan bincangkan tiga tenaga alternatif lain yang mungkin sesuai di Malaysia.

[5 marks/markah]

- [e] If you are a Minister of Energy, how can you promote the use of renewable energies in Malaysia.

Sekiranya anda adalah Menteri Tenaga, bagaimana anda boleh menggalakkan penggunaan tenaga boleh diperbaharui di Malaysia.

[5 marks/markah]

2. [a] Operating at 25 bar, a fixed-bed gasifier consumes 500kg/min (dry-ash-free basis) of biomass with 786.6 kg/min of steam and 106.4Nm³/min of oxygen to produce syngas. Ultimate analysis (dry basis) of biomass is given as carbon: 38.5%, hydrogen: 5.7%, nitrogen: 0.5%, oxygen: 39.8% and ash: 15.5%. Besides that, the proximate analysis of biomass shows that the selected biomass contains 4.0% of moisture by weight. The product contains dry gas, condensable moisture and tar. The tar with heating value of 42,000 kJ/kg is produced at the rate of 1.3 kg/s. The tar contains 85% of carbon and 15% of hydrogen, while the product gas contains 44.8% of moisture by weight.

Beroperasi pada 25bar, penggas lapisan tetap menggunakan 500kg/min (asas kering-abu bebas) biojisim dengan 786.6kg/min stim dan 106.4Nm³/min dan oksigen untuk menghasilkan gas sintesis. Analisis muktamad (asas kering) biojisim dalam peratus jisim diberikan sebagai karbon: 38.5%, hidrogen: 5.7%, nitrogen: 0.5%, oksigen: 39.8% dan abu: 15.5%. Selain itu, analisis hampiran biojisim menunjukkan bahawa biojisim yang dipilih mengandungi 4.0% kelembapan daripada jisim keseluruhan. Produk penggasan mengandungi gas kering, wap air dan tar. Tar dengan nilai pemanasan 42,000kJ /kg dihasilkan pada kadar 1.3kg/s. Tar ini mengandungi 85% karbon dan 15% hidrogen, sedangkan produk gas mengandungi 44.8% kelembapan mengikut berat.

- [i] Based on the analysis of biomass content (dry basis), determine steam to carbon molar ratio (S/C), oxygen to carbon molar ratio (O/C) and equivalent ratio (ER) for this biomass conversion process.

Berdasarkan analisis kandungan biojisim (asas kering), tentukan nisbah molar stim kepada karbon (S/C), oksigen kepada karbon (O/C) dan nisbah seimbang (ER) untuk proses penukaran biojisim ini.

[10 marks/markah]

- [ii] Based on mass balance, determine the amount of product gas produced and the fraction of unutilized steam.

Berdasarkanimbangan jisim, tentukan jumlah produk gas yang dihasilkan dan pecahan stim yang tidak digunakan.

[10 marks/markah]

...4/-

- [b] Biomass liquefaction can be achieved via fast pyrolysis. What are the essential features of a fast pyrolysis process for biomass to be converted into liquid fuel? What are the important factors which influence the average molecular weight of products in fast pyrolysis?

Pencecairan biojisim dapat dicapai melalui pirolisis pantas. Apakah ciri-ciri penting daripada proses pirolisis pantas untuk biojisim untuk ditukar menjadi bahan bakar cecair? Apa faktor-faktor penting yang mempengaruhi berat molekul purata produk dalam pirolisis pantas?

[5 marks/markah]

3. [a] In the recent years, the rise in oil prices and concern on climate change has shifted the attention from carbon based fuel economy to hydrogen based economy. Researchers are exploring the possibility of using hydrogen fuel cell where transportation no longer relies on the internal combustion engine. In a fuel cell, the hydrogen reacts with oxygen to produce water and electricity.

Kini kenaikan harga minyak dan kesedaran mengenai perubahan iklim telah mengalih perhatian daripada ekonomi berasaskan bahan bakar karbon kepada ekonomi berasaskan hidrogen. Para penyelidik mengkaji kemungkinan menggunakan sel bahan bakar hidrogen di mana pengangkutan tidak lagi bergantung pada enjin pembakaran dalaman. Dalam sel bahan bakar, hidrogen bertindak balas dengan oksigen untuk menghasilkan air dan elektrik.

- [i] Describe two problems which make it necessary to explore an alternative to fossil fuels for powering vehicles. For each explain how hydrogen would solve the problem.

Jelaskan dua masalah yang memerlukan penemuan bahan alternatif untuk menggantikan bahan bakar fosil dalam menggerakkan kenderaan. Untuk setiap satu jelaskan bagaimana hidrogen akan menyelesaikan masalah tersebut.

[6 marks/markah]

- [ii] What is meant by “hydrogen economy”? Briefly explain the challenges in achieving hydrogen economy.

Apa yang dimaksudkan dengan "ekonomi hidrogen"? Jelaskan secara ringkas cabaran dalam mencapai ekonomi hidrogen.

[6 marks/markah]

- [iii] State two advantages of fuel cells over internal combustion engines. Nyatakan dua kelebihan sel bahan bakar berbanding enjin pembakaran dalaman.

[4 marks/markah]

- [iv] Give your opinion on some of the implications for Malaysia if we were to adopt hydrogen or electricity as the main vehicle fuel.

Berikan pendapat anda mengenai implikasi kepada Malaysia jika kita menggunakan hidrogen atau elektrik sebagai bahan api utama kenderaan.

[4 marks/markah]

- [b] Assume a 100 cm^2 hydrogen/air fuel cell is operating under typical conditions of 1 atmosphere pressure and 80°C , at 0.7 V and generating 0.6 A/cm^2 of current, for a total current of 60 A. Estimate the electrical energy generated (in kJ/min) and the excess heat generated (in kJ/min) by this cell. The Gibbs free energy change is -228 kJ/mol and Faraday's constant is 96,487 coulombs.

Anggapkan sebuah sel bahan bakar hidrogen/udara 100 cm^2 beroperasi dalam keadaan lazim pada tekanan 1 atmosfera dan 80°C , pada 0.7 V dan menghasilkan arus sebanyak 0.6 A/cm^2 , dengan jumlah arus 60 A. Anggarkan tenaga elektrik yang dihasilkan (dalam kJ / minit) dan haba berlebihan yang dihasilkan (dalam kJ / minit) oleh sel ini. Tenaga bebas Gibbs ialah -228 kJ/mol dan pekali Faraday ialah 96,487 coulombs.

[5 marks/markah]

4. [a] The Intergovernmental Panel on Climate Change, adopted in Paris at the beginning of February 2007, states that: 'Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increased in anthropogenic greenhouse gas concentrations'. Suggest steps to curb global warming besides emissions control. Briefly discuss the feasibility of the suggested steps.

Suatu pernyataan daripada Panel Antara Kerajaan mengenai perubahan iklim yang ditubuhkan di Paris pada awal Februari 2007, menyatakan: "Sebahagian besar peningkatan suhu purata global sejak pertengahan abad ke-20 adalah berkemungkinan besar disebabkan oleh peningkatan kepekatan gas rumah hijau antropogen. Cadangkan langkah-langkah untuk mengawal pemanasan global selain kawalan pembebasan gas rumah hijau. Secara ringkas, bincangkan keboleh-laksanaan langkah-langkah yang dicadangkan.

[6 marks/markah]

- [b] The primary cause of global warming is carbon dioxide emission. Using absorption, adsorption or membrane separation, carbon dioxide capture can be achieved. Explain the basic principles of absorption, adsorption and membrane separation in the capture of CO_2 .

Punca utama pemanasan global adalah pembebasan karbon dioksida. Dengan menggunakan kaedah penyerapan, penjerapan atau pemisahan membran, penangkapan karbon dioksida dapat dicapai. Jelaskan prinsip-prinsip asas penyerapan, penjerapan dan pemisahan membran dalam penangkapan CO_2 .

[6 marks/markah]

- [c] "...if Germany with such a low sunshine can be a global solar market, then it is a crying shame why Malaysia cannot be better, with our all-year-round sunshine...,"

"...jika Jerman dengan sinaran matahari yang rendah boleh menjadi pasaran suria global, maka ia mengaibkan mengapa Malaysia tidak boleh dengan sinaran matahari sepanjang tahun....,"

Minister of Energy, Green Technology and Water, Datuk Seri Peter Chin in his keynote address at the Sixth National Utilities Summit 2009.

Menteri Tenaga, Teknologi Hijau dan Air, Datuk Seri Peter Chin dalam ucaptamanya di Sixth National Utilities Summit 2009.

- [i] The higher cost of electricity generated by solar thermal power plants than that of electricity produced by burning fossil fuels could be one of the reasons why solar power is not the preference of Malaysians. Given this economic fact, suggest some strategies that might be used to promote the use of cleaner electricity from photovoltaics.

Kos tinggi elektrik yang dihasilkan oleh loji suria berbanding elektrik yang dihasilkan oleh pembakaran bahan bakar fosil mungkin merupakan salah satu alasan mengapa tenaga suria bukanlah keutamaan rakyat Malaysia. Berdasarkan fakta ekonomi ini, cadangkan beberapa strategi yang mungkin digunakan untuk mempromosikan penggunaan elektrik bersih dari fotovolt.

[4 marks/markah]

- [ii] The above statement of the minister might suggest that photovoltaics technology does not need bright sunshine to work efficiently. Briefly discuss your comment.

Kenyataan menteri di atas mungkin memberi anggapan bahawa teknologi fotovolt tidak perlu sinaran matahari yang cerah untuk berfungsi dengan baik. Bincangkan secara ringkas komen anda.

[4 marks/markah]

- [iii] Estimate that area of collector needed to heat 250 litres of water in Penang by 20°C in two hours. Penang receives 500 w/m² of solar radiation. Assume that the solar panels are 15% efficient and that they are illuminated for 8 hours in a day. The specific heat and density of water are 4.186 J/g°C and 1000 kg/m³, respectively.

Berapakah luas pengumpul yang mungkin diperlukan untuk memanaskan 250 liter air di Pulau Pinang sebanyak 20 ° C dalam dua jam? Pulau Pinang menerima sinaran matahari sebanyak 500 w/m². Andaikan kecekapan panel suria tersebut ialah 15% dan menerima sinaran selama 8 jam sehari. Haba tentu dan ketumpatan air masing-masing 4.186 J/g °C and 1000 kg/m³.

[5 marks/markah]