



# KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

## FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (ENERGY ENGINEERING)

### SET 330: ENERGY FROM WASTES

**DATE:** Tuesday 20<sup>th</sup> December, 2011

**TIME:** 2.00 – 4.00 p.m.

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### INSTRUCTIONS:

**There are FIVE Questions in this paper.**

**Answer Any THREE Questions. All Questions carry equal Marks.**

- Q.1) Wastes generated in a sugarcane farm and sugar factory are good for energy recovery.
- (a) (i) Show the broad name of wastes generated in a sugarcane farm, and name examples of specific wastes. Clearly explain what these wastes are, and how they are generated. (3 marks)
  - (ii) Outline, describe in details, the wastes generated in a sugar factory indicating the nature of the waste and at what point each is generated. (5 marks)
  - (b) Describe, in details, the techniques/technologies for energy recovery from the wastes generated, and where the energy can be utilized. (12 marks)
- Q.2) Virtually every human activity, in-houses, office, farm, industries, etc; generates wastes of various forms; differing in physical and chemical characteristics. The more wastes we generate, the more we have to dispose; and by all means, waste disposal should be done in a manner which will cause least harm to the environment. This can be achieved by adopting the **4-R Philosophy** of good/efficient waste management.

(a) Name the **4-R Philosophy** of good waste management, and explain/discuss each in details. (10 marks)

(b) **Energy Recovery** is more – less one of the waste disposal methods.

(i) Discuss in details, giving examples and sources, the wastes suitable for energy recovery. (5 marks)

(ii) “Today, Energy Recovery would be the most preferred method of disposal of suitable wastes”

Outline and discuss, in details, the reasons why energy recovery would be the most preferred technique/method of waste disposal. (5 marks)

Q.3) There are several methods of waste disposal, of which selection will be based on some factors.

(a) Describe, in details, the following methods of waste disposal and name their environmental impacts.

(i) Open-dumping

(ii) Traditional sanitary Landfill

Draw a well-labelled illustration of “Traditional Sanitary Landfill”.

(18 marks)

(iii) Name the advantages of waste disposal through Landfills as opposed to Open Dumping.

(2 marks)

Q.4) There are various methods of **energy recovery** from suitable wastes, many well developed today.

(a) (i) Name the biochemical method, other than Landfill, which produces a gaseous fuel; and examples of suitable wastes for this method. (2 marks)

(ii) Name the final product gaseous fuel, the specific gases in it, and its potential utilizations. (2 marks)

- (b) (i) Describe the process in details, and name the process essentials/conditions. (6 marks)
- (ii) Name the converter system in this process and use a well-labelled suitable engineering illustration to demonstrate one of them. (3 marks)
- (c) (i) Name the thermochemical conversion process which produces a gaseous fuel, and examples of suitable wastes for the method. (2 marks)
- (ii) Name the final product gaseous fuel form this method, the specific gases in it, and its potential utilizations. (2 marks)
- (iii) Name the converter system in this process, and use a well-labelled engineering illustration to demonstrate it. (3 marks)
- Q.5) Wastes are generated by various human activities, and animals. A good fraction of wastes is suitable for energy recovery, and there are several methods/technologies for that purpose.
- (a) In Europe, North America, and a number of developing countries, due to the immense waste generated (especially in their cities), and the growing energy demands; they have started what is known as “**waste-to-energy**” technology, an industry growing considerably fast. Define and explain, what is “**waste-to-energy**” technology, and explain why “waste-to-energy” is **clean, renewable**, and what makes it **reliable**. (7 marks)
- (b) **Fluidized bed** combustion is the technique/method of direct heat-energy recovery from suitable wastes.
- (i) Explain the nature of wastes suitable for energy recovery through fluidized bed combustion and name examples of such wastes. (1½ marks)
- (ii) Describe in details, stage-by-stage, the **combustion process** of bio-wastes; showing all chemical reactions at each stage. Draw a well-labelled schematic

illustration of a “Fluidized-Bed combustion Boiler”, showing the energy-recovery systems. (12 Marks)