National Examination, May 2010

04-Env-A6 – Solid Waste Engineering and Management

3 hours duration

NOTES:

1. There are 12 questions for a total possible examination mark is 100.

2. This examination is a CLOSED BOOK EXAM.

3. Candidates are permitted ONE (1) letter sized aid sheet (8.5 “x 11”) both sides.

4. Candidates may use one of two calculators, a Casio or Sharp approved models.

5. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
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13 points 1. Landfill mining is likely to play an important role in the future of waste management. Please provide concise answers to the following items:
   1.1 List four (4) reasons why one would consider landfill mining.
   1.2 Provide a list of health and safety requirements.
   1.3 Briefly describe items to be considered in the work plan.
   1.4 Show a layout with labels of the equipment use in landfill mining.

10 points 2. Outline the steps in composting source-separated organic waste in a high-tech central composting facility from: receiving the waste to refining the compost. Use a block diagram to illustrate the various equipment components and process stages. Clearly label each piece of equipment.

10 points 3. Define or describe briefly the following terms:
   3.1 turbulence factor in combustion processes
   3.2 at-site time
   3.3 compost
   3.4 hazardous waste
   3.5 moisture content
   3.6 pyrolysis
   3.7 integrated solid waste management
   3.8 three T’s in incineration
   3.9 vadose zone
   3.10 anaerobic digestion

5 points 4. The chemical composition of a typical residential MSW was determined to be:

\[ C_{760}H_{1980}O_{875}N_{13}S \]

Determine the energy content of this waste.

10 points 5. The household waste generation rates given below were observed over a period of time on a typical collection route. Assuming that curbside density of the waste is 120 kg/m\(^3\), estimate the percentage of the time a 24m\(^3\) collection truck with a compaction ratio of 2.5 will need more than one trip to service 82 households. The observed waste generation rates are: 42, 60, 35, 27, 50, 94 and 72 kg/household.week.

48 points
5 points  6. Estimate the theoretical amount of gas (methane and carbon dioxide) that could be produced under anaerobic conditions from waste with the following chemical composition: $\text{C}_{60}\text{H}_{56}\text{O}_{38}\text{N}$. 

10 points 7. A landfill has a compacted density of 600 kg/m$^3$, a refuse depth of 9 m, a moisture content of 20% by volume and a 1 m thick clay cover with a 2% slope. Estimate:

7.1 The quantity of leachate that would be generated each year
7.2 How long will it be before each year’s deposit of refuse is saturated and leachate flows from that section make and state your assumptions about rainfall and evapo-transpiraton values.

5 points 8. For a population of 25,000, estimate the annual area requirements (excluding buffer zone) for a normally compacted landfill having a refuse depth of 4 m (excluding cover material). State any assumptions.

20 points 9. List:

9.1 Five (5) steps to be considered in the preparation of solid waste for composting
9.2 Three (3) factors to consider in controlling leachate from a landfill
9.3 Briefly describe three (3) strategies you would consider in devising a leachate treatment solution
9.4 Six (6) important factors to be considered in the site selection of a sanitary landfill site.
9.5 Three (3) common problems with landfill sites that you must be able to respond to.

5 points 10. Illustrate how you calculate compacted density.

3 points 11. What are the key parameters that you must consider in the design of a composting operation?

4 points 12. Sketch a cross section through a sanitary landfill and name all associated components.