

**MODULE 5**

**SOLVED NUMERICAL PROBLEMS**

**Problem 1:** A landfill area of (150 m x 100 m) is available for handling 25 years’ municipal solid waste (MSW) for a town of 5,00,000 people. Out of the total landfill area only 80% is actually available for land fill and other is used for auxiliary services. Assuming that average per capita MSW discard per year in town is 0.05 tonne, landfill density is 500 kg/m<sup>3</sup>, and that the 15 percent of the actual landfill cell volume is used for soil cover, estimate

- (a) the landfill lift in one year.
- (b) number of years for which the land fill can be used if the landfill can’t be increased beyond 25 m.

**Solution:** Volume of MSW generated by town per year =  $(0.05 \times 1000) \times 500000 / 500 = 50000 \text{ m}^3$

Land fill lift per year =  $[50000 / (0.85)] / (0.8 \times 150 \times 100) = 4.902 \text{ m}$

No. of years for which the land fill can be used =  $25 / 4.902 = 5.1 \text{ year}$

**SOLVED THEORETICAL PROBLEMS**

**Ques. 1:** Given at least three differences between combustion, gasification & pyrolysis.

Solution:

<b>Combustion</b>	<b>Gasification</b>	<b>Pyrolysis</b>
<ul style="list-style-type: none"> <li>➤ Thermal processing of solid waste by chemical oxidation with stoichiometric or excess amounts of air.</li> <li>➤ End products-hot gases, water vapour (flue gas), and non-combustible residue (ash).</li> <li>➤ Energy can be</li> </ul>	<ul style="list-style-type: none"> <li>➤ Process of partial combustion of solid waste in which air is supplied less than stoichiometric air.</li> <li>➤ End products-Flue gases (carbon monoxide, hydrogen, carbon dioxide, hydrocarbons (methane), condensable liquids, solid residue (char).</li> <li>➤ Energy efficient technique for reducing the volume of</li> </ul>	<ul style="list-style-type: none"> <li>➤ Thermal processing of waste in the complete absence of air.</li> <li>➤ End products-solids (char), liquids (tar/oil) and gases (hydrogen, methane, carbon monoxide, carbon dioxide etc.)</li> <li>➤ Endothermic process, external source of heat is required.</li> </ul>

<p>recovered by heat exchange from the hot combustion gases.</p>	<p>solid waste and the recovery of energy.                  ➤ The gas generated can be used to generate electricity using gas turbines or can be used in boilers as fuel.</p>	
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**Ques. 2:** Name the six characteristics of the waste because of which any waste can be classified as hazardous waste (regardless of their concentration limits).

**Solution:**

- E1 Flammable:** Flammable wastes with flash point 65.6 °C or below.
- E2 Explosive:** Wastes which may explode under the effect of flame heat and photochemical conditions. Any other waste of explosive materials included in the Indian Explosive Act.
- E3 Corrosive:** Wastes which may be corrosive, by chemical action will cause severe damage when in contact with living tissue.
- E4 Toxic:** Wastes containing or contaminated with established toxic and or eco-toxic constituents.
- E5 Carcinogenicity, Mutagenicity and endocrine disruptivity:** Wastes contaminated or containing established carcinogens, mutagens and endocrine disruptors.

**UNSOLVED PROBLEMS**

1. A landfill area of (150 m x 100 m) is available for handling one years’ municipal solid waste (MSW) for a town of 5,00,000 people. Assuming that average per capita MSW discard per year in town is 0.05 tonne, landfill density is 500 kg/m<sup>3</sup>, and that the 15 percent of the landfill cell volume is used for soil cover, estimate the landfill lift in one year.
2. Define MSW and classify it into various types. Discuss various problems associated with unsound disposal of MSW.
3. Discuss standards methods for managing MSW in short. Discuss various methods for generation of energy from MSW.
4. What are the various sources of plastic waste? Discuss various problems related to plastic wastes with special emphasis on Indian scenario.

5. Discuss various acts, rules and legislations related to plastic wastes in India.
6. Explain various methods for reducing the impacts of plastic waste. Classify plastic waste recycling and discuss various phases of plastic waste recycling.
7. What is composting? Discuss various processes and phases of composting. Write about various factors which affect composting.
8. Discuss human health risks due to composting and possible preventive measures.
9. Discuss various issues related to landfilling. Explain waste decomposition process in a landfill.
10. Discuss landfill gas recovery and landfill reclamation.
11. Discuss various processes for thermal treatment of solid wastes. Discuss necessary conditions for MSW incineration.
12. Explain each of the steps or processes involved during MSW incineration.
13. Write full forms of
  - a. MSW
  - b. ISWM
  - c. CBA
  - d. SEA
  - e. SoEA
  - f. LCA
  - g. LCI
  - h. IMS
  - i. RDF
  - j. PET
  - k. LDPE
  - l. GHG
  - m. PAH
  - n. PCB
  - o. PCCD
  - p. PCCF
14. Write short notes on the following:
  - a. Degradable plastics
  - b. Processes for plastic waste degradation
  - c. GHG emissions due to composting
  - d. Management of closed landfill
  - e. Refuse derived fuel
15. Differentiate between the followings:
  - a. System engineering models and system analysis tools in ISWM
  - b. Bubbling and circulating fluidized bed incinerators
  - c. Pyrolysis, combustion and gasification
16. Answer all questions:
  - a. Hazardous waste could be incinerated in cement/textile Industry. Choose the correct one.

- b. Amount of liquid obtained in pyrolysis is higher than that obtained in gasification. (True / False)

17. Multiple Choice

- (i) Which of the following physical property of MSW is not important in its transportation?
- (a) Specific weight or unit weight
  - (b) Heating value**
  - (c) Moisture content
  - (d) Particle size and size distribution
- (ii) Which of the following factors does not affects the composting process:
- (a) C:N Ratio
  - (b) Moisture
  - (c) Particle Size
  - (d) None of the above**
- (iii) Biological reactions in landfills occur in four stages: 1. Methanogenesis (steady), 2. Acid Phase, 3. Aerobic Phase, 4. Methanogenesis (unsteady). Which of the following is correct order:
- (a) 1-2-3-4
  - (b) 2-3-1-4
  - (c) 3-2-4-1**
  - (d) 3-2-1-4
- (iv) Hazardous waste could be incinerated in
- (a) Pulp and paper industry
  - (b) Electroplating industry
  - (c) Cement industry**
  - (d) Petrochemical industry