Numerical 1.

For a particular community, assume that refuse has the following components and bulk densities:

Component	Percentage (by weight)	Uncompacted bulk density (lb/ft^3)
Miscellaneous paper	50	3.81
Garden waste	25	4.45
Glass	25	18.45

Assume that the compaction in the landfill is 1200 lb/yd^3 (44.4 lb/ft^3). Estimate the percent volume reduction achieved during compaction of the waste. Estimate the overall uncompacted bulk density if the miscellaneous paper is removed.

Solution

1) Given: components and bulk densities.
2) The overall bulk density prior to compaction is.

$$\rho_{(A+B+C+D)} = \frac{M_A + M_B + M_C + M_D}{\frac{M_A}{\rho_A} + \frac{M_B}{\rho_B} + \frac{M_C}{\rho_C} + \frac{M_D}{\rho_D}} = \frac{50 + 25 + 25}{\frac{50}{3.81} + \frac{25}{4.45} + \frac{25}{18.45}} = 4.98\ lb/ft^3$$

3) The volume reduction achieved during compaction is

$$F = \frac{\rho_O}{\rho_C} = \frac{4.98\ lb/ft^3}{44.4\ lb/ft^3} = 0.11$$

4) So the required landfill volume is approximately 11% of the volume required without compaction. If the mixed paper is removed, the uncompacted density is

$$\rho_{(A+B+D)} = \frac{M_A + M_B + M_D}{\frac{M_A}{\rho_A} + \frac{M_B}{\rho_B} + \frac{M_D}{\rho_D}} = \frac{25 + 25}{\frac{25}{4.45} + \frac{25}{18.45}} = 7.18\ lb/ft^3$$

$$F = \frac{\rho_O}{\rho_C} = \frac{7.17\ lb/ft^3}{44.4\ lb/ft^3} = 0.16$$

Energy values of solid waste and garbage can be estimated by using **DuLong equation** as shown in equation

$$\frac{KJ}{kg} = 337C + 1428\left[H - \frac{O}{8}\right] + 9S$$

Where:
C = Carbon, (%).
H = Hydrogen, (%).
O = Oxygen, (%).
S = Sulfur, (%).

Q. No. 2
The sample composition of a solid waste as set out in the following table. Use this chemical composition obtained to estimate energy content of this solid waste using Dulong formula

Component	Mass, kg
Carbon	33.73
Hydrogen	7.69
Oxygen	51.92
Nitrogen	0.61
Sulfur	310.
Ash	4.08
Total	98.16

Solution :

Component	Mass, kg	Percent (by mass)
Carbon	33.73	33.73/98.16= 34.36%
Hydrogen	7.69	7.83%
Oxygen	51.92	52.89%
Nitrogen	0.61	0.62%
Sulfur	0.13	0.13%
Ash	4.08	4.16%
Total	98.16	100

$$\frac{KJ}{kg} = 337C + 1428\left\{H - \frac{O}{8}\right\} + 9S$$

$$\frac{KJ}{kg} = 337 \times 34.36 + 1428\ 7.83 - \frac{52.893}{8} + 9 \times 0.13 = 13320.9$$

Q. No. 3

A family of six people generates solid waste at a rate of 2.5 lb./cap/day and the bulk density of refuse in a typical garbage can is about 230 lb./yd^3. If collection is once a week, how many 30-gallon garbage cans will they need, or the alternative, how many compacted 20-lb blocks would the family produce if they had a home compactor? How many cans would they need in that case?

Solution

1) Given: P = 6, generated waste = 2.5 lb./cap/day, r = 230 lb./yd^3.
2) Weight of SW generated = 2.5 lb./cap/day x 6 persons x 7 days/week = 105 Lb.

3) Volume of SW = Weight/density = 105 lb./230 lb./yd^3 = 0.457 yd^3

   Volume (convert to gallons) = 0.457 yd^3 x 202 gal/yd^3 =
   92.3 gal They will require four 30-gallon cans.

4) If the refuse is compacted into 20-lb blocks, they would need to produce such compacted blocks to take care of the week's refuse

   If each block of compacted refuse is 1400 lb./yd^3, the necessary volume is
   105 lb./1400 lb./yd^3) x 202 gal/yd^3 = 15.15 gal
   They would need only one 30-gal can.

Problem 4: 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/m³, 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 = (0.05x1000) x500000/500 = 50000 m^3

Land fill lift per year = [50000/(0.85)]/(0.8x150x100)= 4.902 m

No. of years for which the land fill can be used=25/4.902=5.1 year