9-1 Solid waste container sizes

Given: High school population = 881; 30 class rooms; 0.11 kg/cap.d plus 3.6 kg/room; density = 120 kg/m^3 ; Wednesday & Friday pickup; containers: 1.5; 2.3, 3.0, 4.6 m

Solution:

a. Daily solid waste generation

(30 rooms)(3.6 kg/room) = 108.0 kg/d

(881 students)(0.11 kg/student) = 96.91 kg/d

Total = 108.0 + 96.91 = 204.91 kg/d

b. Daily volume

$$V = \frac{204.91 \text{ kg/d}}{120 \text{ kg/m}^3} = 1.71 \text{ m}^3/\text{d}$$

c. Collection schedule

Wednesday pickup includes Friday, Monday and Tuesday

Friday pickup includes Wednesday and Thursday

Therefore,

Total Volume = (3 d)(1.71 m^3/d) = 5.12 m^3

d. Number and size of containers

Many combinations possible:

One of 1.5 m^3 and one of 4.6 m^3 = 6.10 m^3 okay

One of 2.3 m^3 and one of 3.0 m^3 = 5.30 m^3 okay

Two of 3.0 m^3 = 6.0 m^3 okay

9-6 Density of Davis, CA MSW

Given: Table 9-3 with paper, cardboard, plastics, glass, and tin cans removed

Solution:

a. Tabular computation showing fractions removed

Component	Mass (kg)	Volume (m^3)
Total	45.4	0.429
Paper	-19.6	-0.240
Cardboard	-2.98	-0.0297
Plastics	-0.82	-0.013
Glass	-3.4	-0.018
Tin cans	-2.36	-0.0268
NEW TOTAL	**16.27**	**0.1015**

$$\text{New Density} = \frac{16.27\text{kg}}{0.1015\text{m}^3} = 160.29\,\text{kg/m}^3$$

11-7

a. Calculate mean time per collection stop

(3 cans/wk = 1.5 can per collection for twice a week pickup)

$t_p = 18.00\text{ s} + (12.60\text{ s/can})(1.5\text{ can}) + 0$

$t_p = 36.90$ s/stop or 0.615 min or 0.0103 h

b. Number of pickup locations per crew (Eqn. 9-3). The average haul speed(s) is determined from Figure 9-6: 48.0 km/h

$$N_p = \frac{\frac{8.0}{2} - \frac{2(24)}{48} - (2)\frac{20}{60} - \frac{7.5}{60} - \frac{0.5}{2}}{0.0103} = \frac{1.9583}{0.0103} = 190 \text{ pickups per load}$$

c. Volume per pickup

Waste generation rate = (1.17 kg/cap d)(4 people) = 4.68 kg/d

For twice a week pickup assume 4 days between pickups

(4.68 kg/d)(4 d) = 18.72 kg

$$V_p = \frac{18.72\text{kg}}{144.7\,\text{kg/m}^3} = 0.1294\text{m}^3$$

d. Compute compaction ratio

$$r = \frac{475\,\text{kg/m}^3}{144.7\,\text{kg/m}^3} = 3.2827$$

e. Volume of truck (note numerator of N_p is same as bracket of Eqn. 9-1)

$$V_T = \frac{0.1294}{(3.2827)(0.0103)}(1.9583) = 7.49\text{m}^3$$

Since the smallest volume truck is 9.0 m^3, Volume of truck = 9.0 m^3

f. Number of trucks

The number of trucks required is a function of the population that must be served. An assumption must be made about the number of work days, i.e. pickup days per week. I have assumed 5 days/wk.

$$\frac{44000\text{people}}{4\text{people / residence}} = 11000\text{stops}$$

11,000 stops x 2 pickups/wk = 22,000 stops/wk

$$\frac{22000\text{stops / week}}{5\text{days / week}} = 4400\text{stops / d}$$

$$\frac{4400\text{stops / d}}{(190\text{stops / load})(2\text{loads / d})} = 11.57 \text{ or } 12 \text{ trucks}$$

Theoretical production of CH_4

Given: 20.3 kg of rapidly decomposing MSW, density of methane = 0.7167 kg/m^3 at STP

Solution:

a. From the text –the chemical formula for rapidly decomposing MSW is

$C_{68}H_{111}O_{50}N$

b. From the reaction equation (9-8)

$$C_{68}H_{111}O_{50}N + \left(\frac{4(68)-111-2(50)+3(1)}{4}\right)H_2O \rightarrow \left(\frac{4(68)+111-2(50)-3(1)}{8}\right)CH_4 + \ldots$$

OR

$$C_{68}H_{111}O_9N + \left(\frac{64}{4}\right)H_2O \rightarrow \left(\frac{280}{8}\right)CH_4 + \ldots$$

$$C_{68}H_{111}O_9N + (16)H_2O \rightarrow (35)CH_4 + \ldots$$

c. Calculate GMW of reactant and product

$C_{68}H_{111}O_9N = 1741$

$35\ CH_4 = 560$

d. Ratio of GMW times mass of waste

$$\frac{560}{1741}(20.3\text{kg}) = 6.53\text{kg}$$

e. Estimate volume of gas at STP

$$\frac{6.53\text{kg}}{0.7167\ \text{kg/m}^3} = 9.11\ \text{m}^3 \text{ of } CH_4$$