SOLID WASTE MANAGEMENT (15CV651)
Solution

1. **Transfer station:**
A facility where solid waste materials including yard waste, demolition materials and household refuse are transferred from small vehicles to large trucks for efficient transport to landfills, recycling centers and other disposal sites.
OR
A transfer station is a location that facilitates the intermediate transport of waste which serves to temporarily store of refuse collected through out the city before a larger truck is ready to pick it up and transport it for long haul to the nearest land fill.

Depending on the method used to load the transport vehicles, transfer stations may be classified into three general types.

1. Direct discharge.
2. Storage discharge.
3. Combined direct and storage discharge.

Factors to be considered in the design of transfer station

1. Weighed centre of waste production area
2. Access of arterial highway routes
3. Minimum of public and environmental objections
4. Construction and operation should be economical
5. Transfer station site is used for proccessing, operating, material recovery and energy production should be considered.

2. Factors affecting aerobic composting

(i)Particle size: For optimum results the size of solid waste should be between 25 and 75mm (1 to 3inch)Particle size influences the bulk density, internal friction and flow characteristcs and drag forces of materials. A reduced particle size increases the biochemical reaction rate during aerobic composting process.
(ii)Carbon-to-Nitrogen Ratio: Initial carbon to nitrogen ratios (by mass) between 20 and 30 are optimum for anaerobic composting. At lower ratios, ammonia is given off. Biological activity is impeded at lower ratios. At higher ratios, nitrogen may be a limiting nutrient.
(iii)Blending and Seeding: If the organic fraction of MSW contains significant amounts of paper or other substrates rich in carbon, other organic materials such as yard wastes, manure, or sludge from waste water treatment plants can be blended to produce a near optimum C/N ratio. Seeding involves the addition of a volume of microbial culture sufficiently large to effect the decomposition of the receiving material at a faster rate. Composting time can be reduced by seeding with partially decomposed solid wastes to the extend of about 1 to 5 percent by weight.
(iv)Moisture Content: The optimum moisture content for aerobic composting is in the range of 50 to 60percent. Moisture can be adjusted by blending the components or addition of water.

(v)Mixing/Turning: To prevent drying, caking and air channeling, material in the process of being composted should be mixed or turned on regular schedule. Initial mixing of organic wastes is essential to increase or decrease moisture content to an optimum level. Mixing is used to achieve a uniform distribution of nutrients and microorganisms. Turning of the organic material is important to maintain aerobic activity.
(vii)Temperature: For best results, temperature should be maintained between 122 to 130°F(50 and 55°C) for the first few days and between 131 and 140°F (55 and 60°C) for the remainder of the active composting period. If temperature goes beyond 151°C (66°C) biological activity is reduced.
(viii)Control of pathogens: If properly conducted, it is possible to kill all the pathogens, weeds, and seeds during the composting process. To do this, the temperature must be between 140 and 158°F(60 and 70°C) for 24 hour.
(ix)Air requirement: Air with at least 50 percent of the initial oxygen concentration remaining should reach all parts of the composting material for optimum results, especially in mechanised systems.
(x)pH Control: To achieve an optimum aerobic decomposition, pH should remain at 7 to 7.5 range. To minimize the loss of nitrogen in the form ammonia gas, pH should not rise above 8.5.
(xi)Degree of decomposition: The degree of decomposition can be estimated by measuring degree of self heating capacity, amount of decomposable and resistant organic matter in the composted material, rise in redox potential, oxygen uptake and starch-iodide test.
(xii)Land Requirement: The land requirements for a plant with a capacity of 50 ton/day will be 1.5 to 2 acres. The land required for a larger plant will be less on a ton/day basis.

3. The various methods used to estimate waste quantities

The quantity and general composition of the waste material that is generated is of critical importance in the design and operation of solid waste management.

The load-count Analysis: In this method the quantity and composition of solid wastes are determined by recording the estimated volume and general composition of each load of waste delivered to a landfill or transfer station during a specified period of time. The total mass and mass distribution by composition is determined using average density data for each waste category.

Mass volume analysis is another method that is similar to the above method with the added feature that the mass of each load is also recorded. Unless the density of each waste category is determined separately, the mass distribution by composition must be derived using average density values.

The factors that influence generation rate of municipal wastes include: geographic location, season of the year, collection frequency, use of kitchen waste grinders, extent of recycling, public attitude and legislation.

4. **Types of collection systems**:
Based on their mode of operation collection system are classified into 2 categories.

a) Hauled container systems
b) Stationary container systems.

Hauled container system (HCS):

Containers used for the storage of wastes are hauled to the disposal site, emptied and returned to either their original location or some other location. Hauled containers systems are ideally suited for the removal of wastes from sources, where the rate of generation is high. In this system containers of different sizes and shapes can be used and the use of such large containers reduce handling time. Hauled container systems have the advantage of requiring only truck and driver to accomplish the collection cycle. These are three main types hauled container system:

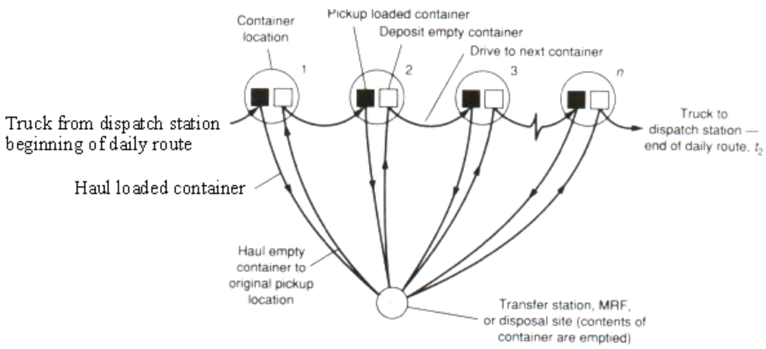
1. **Hoist truck systems**: It is used for the collection of wastes by a collector who has a small operation and collects from only a few pick up points at which considerable amounts of wastes are generated.
2. **Tilt Frame container system**
3. **Trash – trailer systems**

Stationary container systems (SCS)

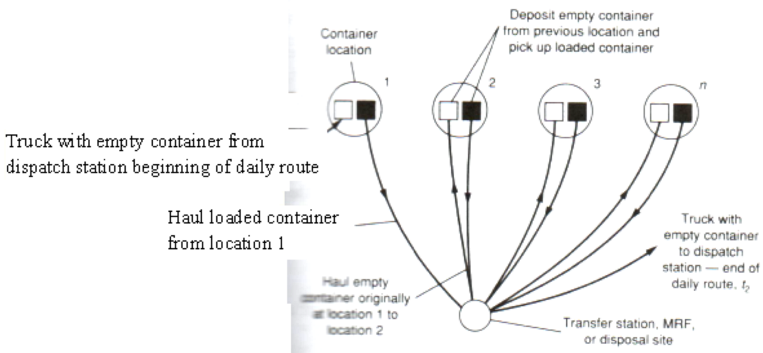
Stationary container system may be used for the collection of all types of wastes. The systems vary according to the type and quantity of wastes to be handled, as well as the number of generation points. These are two main types.

This system is not suited for the collection of heavy industrial wastes and bulk rubbish like construction and demolition waste.

System with manually loaded collection vehicles:- In this system the collector manually empties the contents of a container into a collection vehicle. The major application of this system is in the collection of residential wastes and litter. Manual methods are used for residential collection because many individual pick up points are inaccessible to mechanized self loading collection vehicle.



(a)



(b)

Figure Schematic of operational sequence for hauled container system a) conventional mode and b) exchange container mode

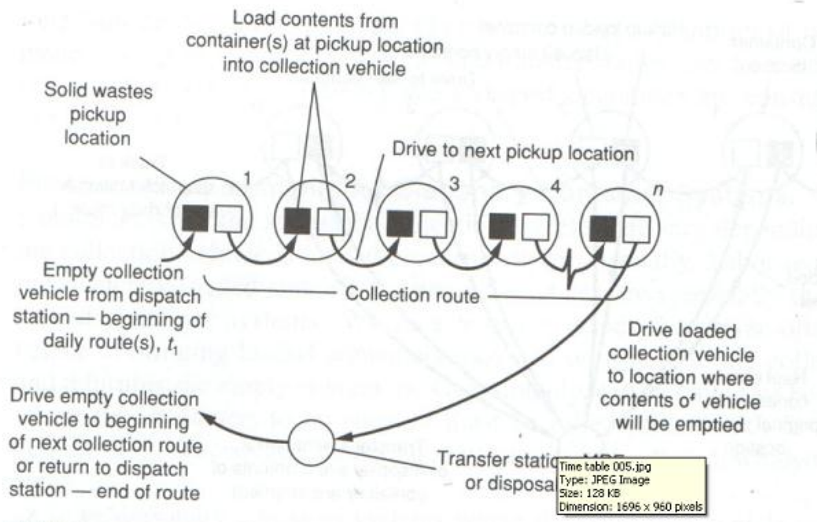


FIGURE
Schematic of operational sequence for stationary container system.

Q5) Total no of houses = 800

no of persons per house = 6

Observation period = 1 week

Vehicle type	No of loads	Volume of vehicle	Density or specific weight (kg/m^3)	Weight (kg)
Self compacting trucks	10	15	295	44250
Flat bed trucks	20	1.25	110	2750
				47000

Total weight of solid waste generated from the residential area = 47000 kg/week

$$\text{Weight per day} = \frac{47000}{7} = 6714.286 \text{ kg/day}$$

$$\text{Per capita generation rate} = \frac{6714.286}{800 \times 6}$$

$$= 1.399 \text{ kg/capita/day}$$

Q6)

Component	% by mass	Moisture Content (%)	Density (kg/m³)	Energy (KJ/kg)	mass (kg)	dry mass (kg)	volume (m³)	Energy (kJ)
food waste	12	70	290	4000	120	36	0.414	480000
paper	40	06	85	16000	400	376	4.706	6400000
cardboard	08	05	50	16000	80	76	1.6	1280000
Plastics	04	02	65	32000	40	39.2	0.615	1280000
Garden trimmings	15	60	105	6500	150	60	1.429	975000
Wood	05	20	240	18000	50	40	0.208	900000
Tin Cans	16	03	90	700	160	155.2	1.78	112000
						782.4	10.752	11427000

$$\text{Moisture Content} = \left(\frac{1000 - 782.4}{1000}\right) \times 100$$

$$= 21.76\,\%$$

$$\text{Density} = \frac{1000}{10.752} = 93.01\ kg/m^3$$

$$\text{Unit Energy Content} = \frac{11427000}{1000} = 11427\ kJ/kg$$

$$\text{Energy Content (dry basis)} = 11427 \times \left[\frac{100}{100-21.76} \right]$$

$$= 14605.061\ kJ/kg$$

$$\text{Energy content (ash free basis)} = 11427 \times \left[\frac{100}{100-21.76-5} \right]$$

$$= 15602.13\ kJ/kg$$