AL-KARKH UNIVERSITY OF SCIENCE

COLLEGE OF ENERGY AND ENVIRONMENTAL SCIENCE

DEPARTMENT OF ENVIRONMENTAL SCIENCE

WASTE MANAGEMENT

THIRD LEVEL

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INTRODUCTION

Solid waste is any solid material that is disposed of because it has no further use to society in its present form. In more specific terms, the U.S. EPA has defined solid waste as "any discarded material resulting from industrial, commercial, mining, agricultural operations and from community activities.

Other authors define solid wastes as all the wastes arising from human and animal activities that are normally solid and that are discarded as useless or unwanted. It encompasses the heterogeneous mass of throwaways from residences and commercial activities as well as the more homogeneous accumulation of a single agricultural or industrial activity.

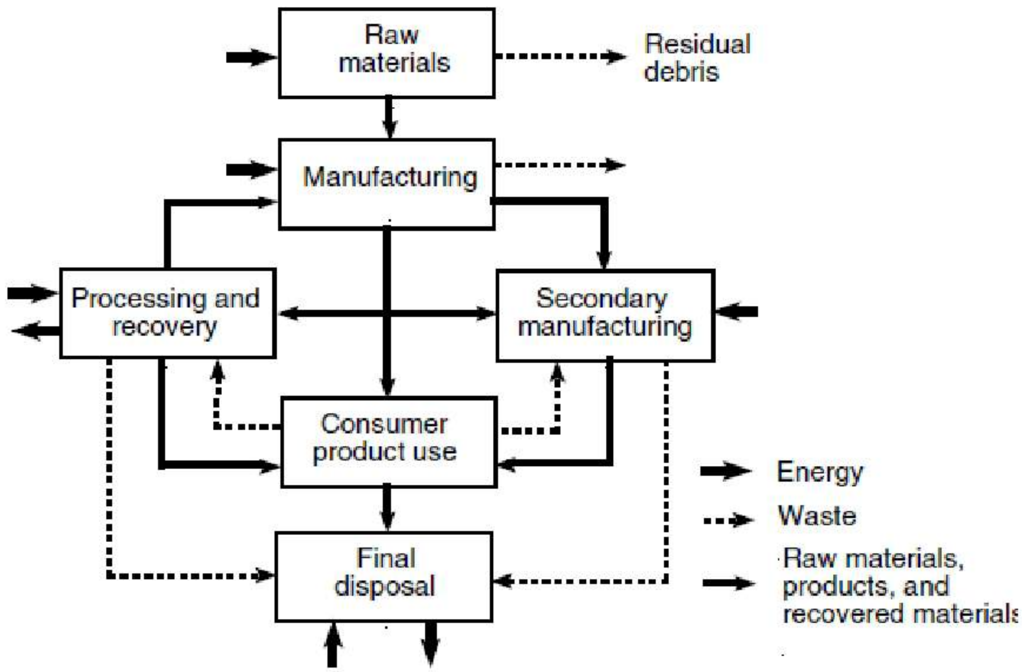
Solids wastes are produced wherever man is found: farms, mines, stores, offices factories, homes, hospitals, streets, and even the primitive encampments of traditional nomads.

Municipal solid waste, commonly known as trash or garbage (US), refuse or rubbish (UK) is a waste type consisting of everyday items we consume and throw away. It predominantly includes food wastes, yard wastes, containers and product packaging, and other miscellaneous inorganic wastes from residential, commercial, institutional, and industrial sources.

Integrated Solid Waste Management (ISWM) can be defined as the selection and application of suitable technique, technologies, and management programs to achieve specific waste management objectives and goals.

MATERIALS FLOW AND WASTE GENERATION

An indication of how and where solid wastes are generated in our society is shown in the simplified materials flow diagram

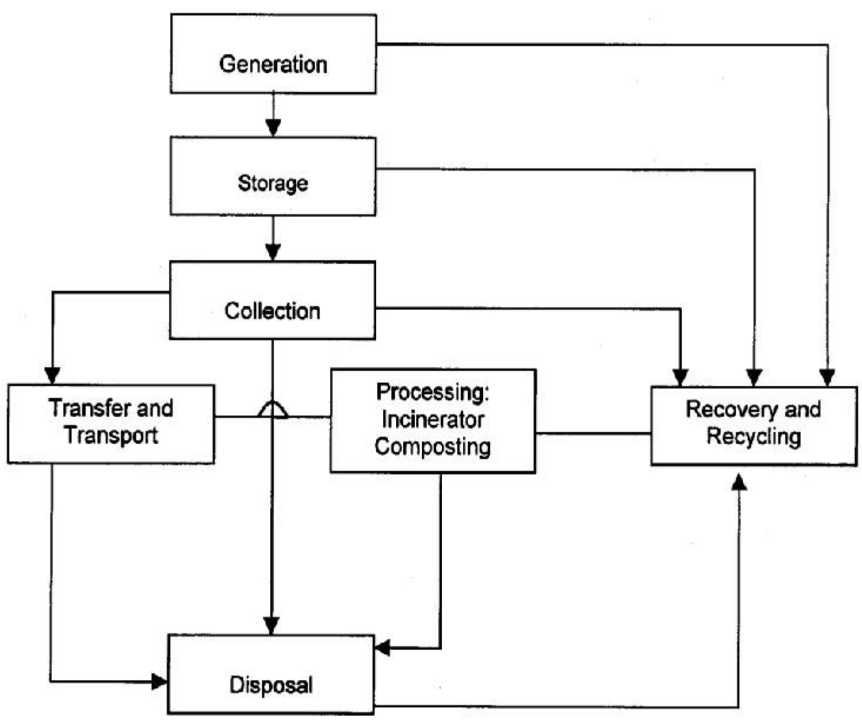


SOLID WASTE MANAGEMENT SYSTEM

System refers to a combination of various functional elements associated with the management of solid waste. The system, when put in place, facilitates the collection and disposal of solid wastes in the community at minimal costs, while preserving public health and ensuring little or minimal adverse impact on the environment.

The functional elements that constitute the system are:

1. Waste generation
2. Waste storage
3. Waste collection
4. Transfer and transport
5. Processing
6. Recovery and recycling
7. Waste disposal



Waste Generation

Encompasses activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal. For example the wrapping of a candy bar is usually considered to be of little value to the owner once the candy is consumed.

Waste Handling and Separation, Storage, and Processing at the Source.

Waste handling and separation involves the activities associated with the management of wastes until they are placed in storage containers for collection. Handling also encompasses the movement of loaded containers to the point of collection.

On site storage is of primary importance because of public health concerns and aesthetics consideration

Collection

The functional element of collection includes not only the gathering of solid wastes and recyclable materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be a materials processing facility, a transfer station, or a landfill disposal site. In small cities where the final disposal sites are nearby, the hauling of wastes is not a serious problem. In large cities, however where the haul distance to the point of disposal is often more than 15 miles (about 25. km) the haul may have significant economic implications. Where long distances are involved, transfer and transport facilities are normally used.

Separation, Processing, and Transformation of Solid Waste.

The fourth of the functional elements is recovery of separated materials that occurs primarily in locations away from the source of waste generation.

Transfer and Transport. The functional element of transfer and transport involves two steps: (1) the transfer of wastes from the smaller collection vehicle to the larger transport equipment and (2) the subsequent transport of the wastes, usually over long distances, to a processing or disposal site.

Disposal. (Ultimate destination) The final functional element in the solid waste management system is disposal. Today the disposal of wastes by landfilling or land spreading is the ultimate fate of all solid wastes. A modern sanitary landfill is not a dump it is an engineered facility used for disposing of solid waste on land or within the earth's mantle without creating nuisance or hazards to public health or to the surrounding environment, such as the breeding of rats and insects and the contamination of ground water.

**The source of municipal solid waste has historically been consistent. The sources and types of municipal solid waste are reported in Table below.

Source	Typical facilities, activities or locations where wastes are generated	Types of solid wastes
Residential	Single-family, multi-family dwelling; low-, medium-, and high-rise apartments...etc.	Food wastes, rubbish, ashes, Special wastes. 
Commercial	Stores, restaurants, markets, office buildings, hotels, demolition and construction, print shops, auto repair shops. medical facilities and institutions etc.	Food wastes, rubbish, ashes, special wastes. 
Municipal	As above	As above

Industrial	Construction fabrication, light and heavy manufacturing, refineries, chemical plant	Waste, special waste, hazardous waste 
Open areas	Streets, alleys, parks, vacant lots, playground, beaches, roads, recreational areas etc.	Rubbish, special wastes. 
Treatment plants	Water, waste water, industrial treatment processes etc.	Treatment plants, residual sludge.
Agricultural	Resulting from diverse agricultural activities such as planting, field harvesting, tree and vine crops. The production of milk, production of animals for slaughters and the operation of feed lots are collectively called agricultural wastes.	Food wastes , wastes, rubbish, hazardous wastes 

TYPES OF SOLID WASTE

Food waste is the animal fruit or vegetable residue resulting from the handling, preparation, cooking, and eating of foods (all called garbage). The most important characteristic of these wastes is that they are highly putrescible and will decompose rapidly, especially in warm weather. (Often. decomposition will lead to the development of offensive odors.

Rubbish consists of combustible and non - combustible solid wastes or other highly putrescible material, typically, combustible, rubbish consists of material such as paper, cardboard, plastic, textiles, rubber, leather, and garden trimmings. Non- combustible rubbish consists of items such as glass, crockery, tin cans, aluminum cans, ferrous and other non-ferrous metals and dirt

Ashes and residues Materials remaining from the burning of wood, coal and other combustible wastes at homes, stores institutions, and industrial and municipal facilities for purposes of heating, cooking and disposing of combustible waste are categorized as ashes and residues. Residues from power plants normally are not included in this category.

Demolition and construction wastes Wastes from razed building and other structures are classified as demolition wastes, wastes from the construction, remodeling, and repairing of individuals residences, commercial buildings and otherstructures are classified as construction wastes. The quantities produced are difficultto estimate and variable in composition, but may include dirt, stones, concrete bricks,and plumbing, heating and electrical parts.

Special wastes such as street sweeping, roadside litter, from municipal litter containers, debris, dead animals, and an abandoned vehicles are classified as specialwastes.

Treatment plants The solid and semisolid wastes from water, wastewater, and industrial waste treatment facilities are included in this classification. The specific characteristics of these materials vary, depending on the nature of the treatment process.

Hazardous wastes They are any waste or combination of waste that pose substantial danger now or in the future, to human, plant or animal life otherwise theycannot be handled or disposed of without special precautions.

Hazardous wastes are the wastes with at least one hazardous characteristic (explosive, flammable, liable to oxidation organic peroxide, acutely poisonous, infectious, and liable to corrosion releases poisonous gases in contact with air or water

Examples of hazardous solid waste:

Example 1. Household batteries come in a variety of types, including alkaline, mercury, silver, zinc, nickel, and cadmium. The metals found in household batteries can cause groundwater contamination by their presence in leachate; they can also contaminate air emissions and ash from waste combustion facilities. Many states now prohibit the land filling of household batteries. Automobiles use lead-acid batteries, each of which contains approximately 8 g of lead and a 3.7 L of sulfuric acid, both are hazardous materials.

Example 2. The principal source of used oil is from the servicing of automobiles and other moving vehicles by their owners. Waste oil, not collected for recycling, is often poured onto the ground; down sanitary, combined, and storm water sewers; or into trash containers.

Waste oil discharged onto the ground or into municipal sewers

1. Often contaminates surface water and groundwater as well as the soil.
2. Waste oil placed in the same container as other solid waste components tends to contaminate the waste components and thus reduces their value as recycled materials.

CLASSIFICATION OF MATERIALS COMPRISING MUNICIPAL SOLID WASTES.

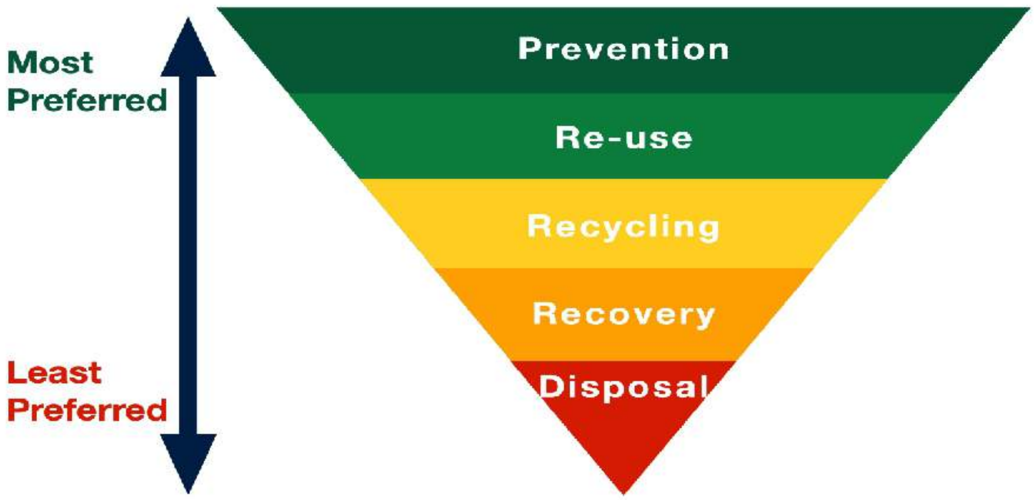
Type	Description
Garbage	Results from food marketing, preparation and consumption (also called food wastes). It contains putrescible organic materials and will decompose rapidly, especially in warm weather. It needs especial consideration due to its nature of attracting vermin and of producing very strong odors.
Rubbish	This category consists of paper and paper products, plastics, cans, bottles, glass, metals, ceramics, dirt, dust, yard and garden wastes…etc. It also includes park and beach refuse. Except for garden wastes, these materials are no putrescible.
Ashes	This is the residue from any combustion process (i.e. fireplaces, wood or coal heating units etc,) resulting from households activity and onsite incineration.
Bulky waste	This category includes furniture, appliances, mattresses, springs, and similar large items. They require special handling and collection.
Demolition/ construction	This class of refuse include the lumber, bricks, concrete, plumbing, waste electrical wiring etc. associated with the destruction of old buildings and the construction of new ones.
Special wastes *	Wastes resulting from normal street cleaning operations such as, street sweeping, roadside litter, catch-basin debris, deadanimals and abandoned vehicles.
Treatment plant wastes	Include the solid and semi-solid wastes from water, wastewater and industrial waste treatment facilities.

Industrial wastes

Industrial wastes are wastes arising from activities. They include rubbish, process wastes, ashes, demolition and construction wastes, special wastes and hazardous wastes**.** Industries create refuse trash, and garbage just as municipalities do, but there is no one number represent industrial waste generation, yet there is wastegeneration rate for each kind of industrial process still more specific grouping foreach industry would give more precise data. Industrial waste generation in generalreported as average weight generation rates per employee per day for industry group. Many solid wastes generated by industry are utilized directly. They contain significant amount of valuable materials like steel, aluminum, copper and other metal which, if they are recovered and reused would reduce the volume of the wastes to becollected and at the same time would yield significant salvage and resale income and will help to save valuable natural resources.

Waste Management Hierarchy

A Hierarchy (arrangement in order of rank) in waste management can be used to rank actions to implement programs within the community. The ISWM hierarchy adopted by the U.S. Environmental Protection Agency (EPA) is composed of the following elements: source reduction (waste minimization or Prevention), Reuse, Recycling, Resource Recovery (waste combustion), and landfilling.



This hierarchy directs society to develop their solid waste management plans by first seeking to prevent the production of solid waste, for example, by encouraging the use of fabric bags in grocery stores (thus eliminating the use of one-time plastic bags). When further elimination is not feasible, the states should consider actions that promote reuse, such as the use of heavy-duty plastic grocery bags that can be reused. Next, the recycling option should be considered, such as the collection and remanufacturing of onetime plastic bags. The fourth option would be to burn the collected bags for energy production. Finally, when all else fails, the bags will be disposed in landfills.

Prevention, Source Reduction (Waste Minimization)

The highest rank of the ISWM hierarchy, is source reduction, involves reducing the amount and/or toxicity of the wastes that arc now generated. Source reduction is first in the hierarchy because it is the most effective way to reduce the quantity of waste, to reduce the cost associated with its handling, and its environmental impacts.

Waste reduction can be achieved in three basic ways:

1. Reducing the amount of material used per product without sacrificing the utility of that product.

2. Increasing the lifetime of a product.

3. Eliminating the need for the product.

Waste reduction in industry is called **pollution prevention**—an attractive concept to industry because in many cases the cost of treating waste is greater than the cost of changing the process so that the waste is not produced in the first place.

For example, automobile manufacturers for years painted new cars using spray enamel paint. The cars were then dried in special ovens that gave them a glossy finish. Unfortunately, such operations produced large amounts of volatile organic compounds (VOCs) that had to be controlled, and control measures were increasingly expensive. The manufacturers then developed a new method of painting, using dry powders applied under great pressure. Not only did this result in better finishes, but it all but eliminated the problem with the VOCs. Pollution prevention is the process of changing the operation in such a manner that pollutants are not even generated.

Reduction of waste on the household level is called waste reduction (sometimes referred to as source reduction by the EPA). Typical alternative actions that result in a reduction of the amount of municipal solid waste being produced include: using laundry detergent refills instead of purchasing new containers, bringing one's own bags to grocery stores, stopping junk mail deliveries, and using cloth diapers. Unfortunately, the level of participation in source reduction is low compared to recycling activities. Even though source reduction is the first solid waste alternative for the EPA,

Laundry detergent refills

TAKE HOME WORK FOR:

Reuse, Recycle, Recover, Disposal

PROSPERITIES OF SOLID WASTE

Physical Properties

- Constituent (Composition)
- Particle size
- Density
- Moisture content

Physical composition

Information and data on the physical composition of solid waste are important in the selection and operation of equipment and facilities, in assessing the feasibility of resource, energy recovery, and in the analysis and design of disposal facilities.

a) Individual components (Composition)

The percentages of municipal solid waste components vary with location, season and economic conditions. Table below shows typical solid waste composition.

Component	Percent by mass
Food waste	15
Paper	40
Cardboard	4
Plastics	3
Textile	2
Rubber	0.5
Leather	0.5
Garden trimming	12
Wood	2
Glass	8
Tin cans	6
Non ferrous materials	1
Ferrous materials	2
Dirt, ashes, Bricks	4
Total	100

Determination of Components in the field (Sampling procedures)

Because of the heterogeneous nature of solid wastes, determination of the composition is not an easy task. Strict statistical procedures are difficult, if not impossible, to implement. For this reason, a more generalized field procedure, based on common sense and random-sampling techniques, has been developed for determining composition.

1. Unload a truck of wastes in a controlled area away from other operations.
2. Quarter the waste load.
3. Select one of the quarters and quarter that quarter.
4. Select one of the quartered quarters and separate all of the individual components of the waste into pre-selected component such as those listed in the table.
5. Place the separated components in a container and weight.
6. Determine the weight percentages of each component by mass.
7. Place the separated components in a container and weight.
8. Determine the weight percentages of each component by mass.

Moisture content of solid wastes usually is expressed as the mass of moisture per unit mass of wet or dry material

In equation form, the wet mass moisture content is expressed as follows:

Moisture content (%) = $\{(a-b)/a\}\times 100$

Where a=initial mass of sample as delivered

b=mass of sample after drying

To obtain the dry mass the solid waste material is dried in an oven at 77 ºC (170 F) for 24 hour. This temperature and time is used to dehydrate the material completely and to limit the vaporization of volatile materials.

Example 1:

Estimate the overall moisture content with the typical municipal solid wastes (assume the total weight is 100 Kg).

Component	Percent by mass	Mass (Kg)	Moisture content %	Moisture weight (Kg)	Dry weight (Kg)
Food waste	15	15	70	10.5	4.5
Paper	40	40	6	2.4	37.6
Cardboard	4		5		
Plastics	3		2		
Textile	2		10		
Rubber	0.5		2		
Leather	0.5		10		
Garden trimming	12		60		
Wood	2		20		
Glass	8		2		
Tin cans	6		3		
Nonferrous materials	1		2		
Ferrous materials	2		3		
Dirt, ashes, Bricks	4		8		
Total	100%				

Ans: 21.76%

Density

Density data are often needed to assess the total mass and volume of waste that must be managed. The density of solid waste varies with its composition, its moisture content and its degree of compaction. Density of municipal solid waste as delivered in compaction vehicles has been found to vary from 180 to 450 kg/m^3 depending on the type of compaction equipment. A typical value is about 300 kg/m^3. Typical non-compacted municipal solid waste is 130 kg/m^3. For normally compacted landfill, thedensity is 450 kg/m^3 and 600 kg/m^3 for well-compacted landfill.

Example 2:

Estimate the overall density with the typical municipal solid wastes in the below Table. Assume the basis 100 Kg and 1 lb/ft^3 = 16.018463 kg/m^3

Component	% Mass	Density 1b/ft^3	Density kg/m^3	Volume (m^3)
Food waste	15	18.0	288.324	
Paper	40	15.1	241.8718	
Cardboard	4	3.1	49.6558	
Plastics	3	4	64.072	
Textile	2	4	64.072	
Rubber	0.5	8	128.144	
Leather	0.5	10	160.18	
Garden trimming	12	6.5	104.117	
Wood	2	15.0	240.27	
Glass	8	12.1	193.8178	
Tin cans	6	5.5	88.099	
Nonferrous materials	1	10	160.18	
Ferrous materials	2	20	320.36	
Dirt, ashes, Bricks	4	30	480.54	
Total	100			

Chemical composition

Information on the chemical composition of solid waste is important in evaluating alternative processing and recovery options. For example, for the incineration process the following chemical properties need to be known to assess the selection and design of the process:

a. Moisture (loss at 105 ˚C for 1 hr)
b. Volatile matter (additional loss on ignition at 950˚C)
c. Ash (residue after burning)
d. Fixed carbon (remainder)
e. Fusing point of ash
f. Heating value (Calorific value)
g. Ultimate analysis: percent of carbon, hydrogen, oxygen, nitrogensulfur, and ash.

Representative data on the ultimate analysis of typical municipal waste components are presented in the Table A. If BTU values are not available, the approximate BTU value can be determined by using equation 1, known as the modified Dulong formula and the data in Table.

Btu/lb = 145.4C+ 620 (H – ½ O) + 41S …… (1)

Where C = carbon, percent H = hydrogen, percent, O= oxygen, percent S = sulfur, in percent
The Btu values may be converted to a dry basis by using Eq. 2

Btu/lb (dry basis) = Btu/lb (as discarded) *(100/100-%moisture) …….. (2)

The corresponding equation for the Btu per pound on an ash-free dry basis is:

Btu/lb (ash-free dry basis) = Btu/lb (as discarded)*(100/100 - % ash - % moisture) …. (3)

Table A : Ultimate analysis of typical municipal waste components

Percent by weight on dry basis						
Component	Carbon	Hydrogen	Oxygen	Nitrogen	Sulfur	Ash
Food wastes	40.0	6.4	37.6	26	0.4	50
Paper	43.5	6.0	44.0	0.3	0.2	6.0
Cardboard	44,0	5.9	44 6	0.3	0.2	5.0
Plastics	G0.0	7.2	22.0	—	—	100
Textile	55.0	6.6	31.2	4.6	0.15	2.5
Rubber	78.0	10 0	—	2.0	—	10.0
Leather	600	8.0	.11.6	10.0	0.4	10.0
Garden trimmings	47.8	6.0	,38.0	3.4	0.3	4.5
Wood	49.5	6.0	427	02	0.1	1.5
Dirt, ashes, brick, etc.	26.3	30	2.0	0.5	0.2	68.0

Table B: Typical data on energy contents of municipal solid waste

Components	Energy BTU/1b	Typical
Food wastes	1,500- 3,000	2,000
Paper	5,000- 8000	7,200
Cardboard	6,000- 7,500	7,000
Plastics	12,000-16,000	14,000
Textile	6,500- 8,000	7,500
Rubber	9,000-12,000	10,000
Leather	6,500- 8,500	7,500
Garden trimmings	1.000- 8,000	2,800
Wood	7,500- 8,500	8,000
Glass	50-100	60
Tin cans	100-500	300
Non ferrous	—	-.
Ferrous	100-500	300
Dirt, Ash, Brick	1,000- 5.000	3.000
Municipal solid wastes	4,000- 5,500	4,500

Note(1): BTU/1bX 2.320 = KJ/Kg

Example 3: Determine the energy Value of typical municipal solid wastes withthe average composition shown in Table below

Solution

1. Assume the heating value will be computed on an as-discarded basis.

2. Determine the energy value using a computation table

Component	Solid Wastes %1b.	Energy Btu/1b	Total energy Btu
Food waste	15	2,000	30000
Paper	40	7,200	
Cardboard	4	7,000	
Plastics	3	14.000	
Textile	2	7,500	
Rubber	0.5	10,000	
Leather	0.5	7,500	
Garden trimming	12	2,800	
Wood	2	8,000	
Glass	8	60	
Tin cans	6	300	
Non ferrous	1	—	
Ferrous	2	300	
Dirt, Ash,and brick	4	3,000	

Ans: 4762Btu/1b

Generation Rates

The reason for measuring generation rates is to obtain data that can be used to determine the total amount of wastes to be managed. Therefore, in any solid waste management study extreme care must be exercised in allocating funds and deciding what actually needs to be known.

Measures of Quantities

Both volume and weight are used for the measurement of solid waste quantities. Unfortunately, the use of volume as a measure of quantity can be extremely misleading. For example, a cubic yard (0.764 m^3) of loose waste represents different quantity than a cubic yard of wastes that have been compacted in a packer truck, and each of these is different from a cubic yard of wastes that have been compacted further in a landfill. Accordingly, if volume measurements are to be used, the volume measured must be related to the degree of compaction of the wastes.

Methods Used to Determine Generation Rates

Methods commonly used to assess the per capita generation of solid wastes are (1) load-count analysis, (2) weight – volume analysis and 3) materials-balance analysis.

Load-count analysis: The number of individual loads and corresponding vehicles characteristics are reported over a specified time period. If scales are available, weight data are also recorded. Unit generation rates are determined by using (the field data and, where necessary, published data.

Example 4

The following data estimate the unit waste generation rate for a residential area consisting of approximately 1,000 homes. The observation location is a local transfer station, and the observation period is 1 week.

1. Number of compactor truck kinds = 10
2. Average size of compactor truck = 20 yd^3
3. Number of flatbed loads = 10
4. Average flatbed volume = 1.5 yd^3
5. Number of loads from individual resident private cars and trucks = 20
6. Estimated volume per domestic vehicle = 8 ft^3 (1 yd^3= 27 ft^3)

Solution

1. Set up the computation table (see Table below).
2. Determine the unit waste generation based on the assumption that eachhousehold is comprised of 3.5 people.

Estimation of unit solid waste generation rates

Item	No. of loads	Ave. vol.	Unit wt. Ib/yd^3	Total wt (Ib)
Compactor truck	10	20 yd^3	350	70000
Flatbed truck	10	1.5 yd^3	150	2250
Individual private vehicle	20	0.30 yd^3	100	

lb= 0.454 kg

Ans: 3.0 Ib /capita/day

Weight-volume Analysis the use of detailed weight-volume data obtained by weighing and measuring each load will certainly provide better information on the density and generation rates at a given location.

Materials-Balance Analysis

The only way to determine the generation and movement of solid wastes with any degree of reliability is to perform a detailed material balance analysis for each generation source such as an individual home or a commercial or industrial activity. Because of the high expense and the large amount of work involved, however, this method of analysis should be used only in special situations. The approach to be followed in the preparation of a materials balance analysis is as follows:

First: draw a system boundary around the unit to be studied.

Second: Identify all the activities that cross or occur within the boundary and affect the generation of wastes.

Third: If possible, identify the rate of generation associated with these activities.

Fourth: using a material balance, determine the quantity of wastes generated, collected, and stored.

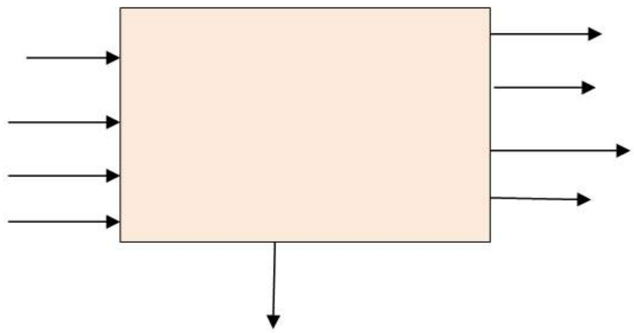
Example: Material Balance Analysis

A cannery receives on a given day: 12 tons of raw produce, 5 tons of cans, 0.5 ton of cartons, and 0.3 ton of miscellaneous materials.

Its output includes: 10 tons of processed product, the remaining becoming part of waste, four tons of the cans are stored for future use and the remainder are used to packagethe produce. About 3 percent of the cans used are damaged and recycled. The cartons are also used for packaging, except for 3 percent which become damaged and are incinerated with other paper wastes.

Of the miscellaneous materials, 75 percent become paper wastes that are incinerated, and the remainder are disposed of by the municipal collection agency. Draw a materials flow diagram for this activity.

Solution



Factors that affect the generation rates

1. Geographic location

In the warmer southern areas where the growing season is considerably longer than in the northern areas, yard wastes are collected not only in considerably greateramounts but also over a longer period of time.

2. Season of the year

The quantities of certain types of solid wastes are also affected by the season of the year. For example, the quantities of food wastes are affected by the growing season for vegetables and fruits

3. Frequency of Collection

In general, it has been observed that where unlimited service is provided, more wastes are collected. This observation should not be used as more waste is generated.

4. Use of home grinders

While the use of home grinders definitely reduces the quantity of food wastes collected, it is not clear whether they affect quantities of wastes generated. Because the use of home grinders varies widely throughout the country, the effects of their use must be evaluated separately in each situation if such information is warranted.

5. Characteristics of population

It has been observed that the characteristics of the population influence the quantity of solid wastes generated. For example, the quantities of yard wastes generated on a per capita basis are considerably greater in many of the wealthier neighborhoods than in other parts of town.

6. The Extent of Salvage and Recycling

The existence of salvage and recycling operations within a community definitely affects the quantities of wastes collected. Whether such operations affect the quantities generated is another question. Until more information is available, no definite statement can be made on this issue.

7. Legislation

Perhaps the most important factor affecting the generation of certain types of wastes is the existence of local, state, and world regulations concerning the use and disposal of specific materials. Legislation dealing with packaging and beverage container materials is an example.

8. Public attitudes

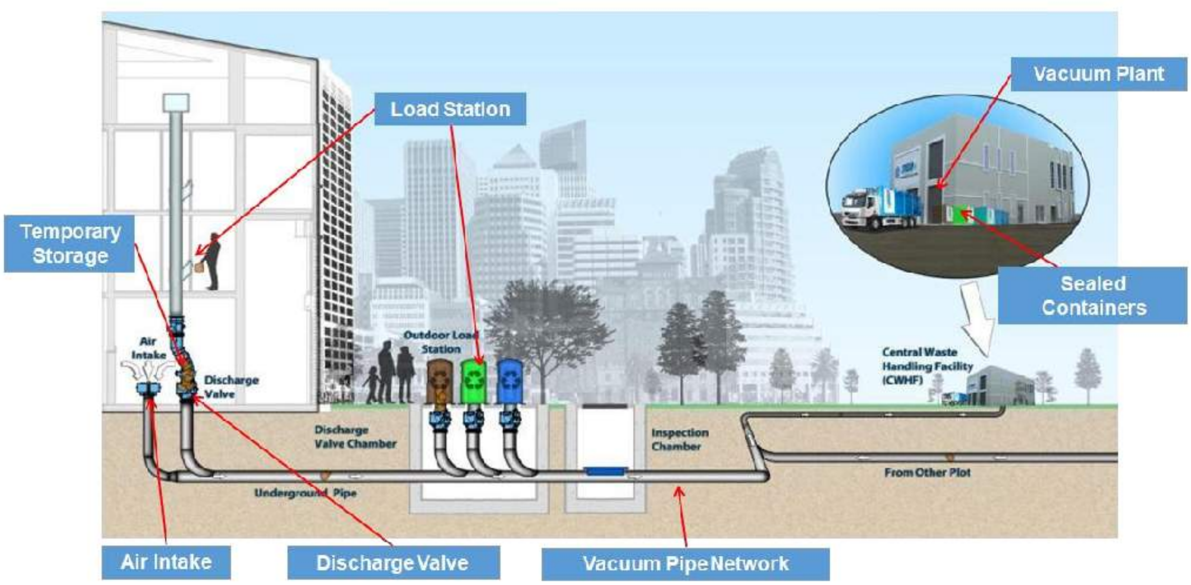
Significant reductions in the quantities of solid wastes that are generated will occur, if people are willing to change—on their own volition—their habits and life style to conserve national resources.

Onsite Handling

Onsite handling refers to the activities associated with the handling of solid waste until they are placed in the containers used for their storage before collection. Depending on the type of collection service, handling may also be required to move the loaded containers to the collection point and to return the empty containers to the point where they are stored between collections.

Chutes for use in apartment buildings are available in, diameters from 12 to 36 in. The most common size is 24 inches in diameter. All the available chutes can be furnished with suitable intake doors.

In some of the more recent apartment building developments underground pneumatic transport systems have been used in conjunction with the individual underground pneumatics systems are used to transport the wastes from the chute discharge points m each building to a central location for storage in large containers or onsite processing. Both air pressure and Vacuum transport systems have been used in this application.



Where kitchen grinders are used, food wastes and other grind able materials are ground and discharged to the waste-water collection system.

Newspapers may be bundled and put out for pickup by salvage handlers or city crews, or (they may be taken by the tenants, bundled or loose, to the service area for pickup or disposal. Bulky items usually are taken to the service area by the tenants.

On Site Storage

Factors that must be considered in the onsite storage of solid wastes include (1) the type of container to be used, (2) the container location, (3) public health and aesthetics, and (4) the collection methods to be used.

Containers

Types and capacities of containers depend onto (1) the characteristics of solid waste to be collected (2) The collection frequency (3) The available space for the placement of containers.

Note: Because solid waste is collected manually from most residential low-rise detached dwellings, the container should be light enough to be handled easily by one collector when full.

Limitations for containers used for onsite storage for solid waste:

Container type	Limitations
Galvanized	Containers are damaged over time and degraded in appearance and capacity; containers add extra weight that must be lifted during collection operations, tend to be noisy when being emptied and, in time can be damaged so that a proper lid seal cannot be achieved.
Plastic	Containers are damaged over time and degraded in appearance, some containers constructed of plastic materials tend to crack under exposure to the ultraviolet rays of the sun and to freezing temperatures, but the more expensive plastic containers apparently do not present these problems.
Disposal paper bags	Bag storage is more costly: if bags are set out on streets or curbside, dogs or other animals tear them and spread their contents: paper bags themselves add to the waste load. Paper and cardboard containers tend to disintegrate because of the leakage of liquids.

Disposal plastic bags	Bag storage is more costly; bags tear easily, causing litter and unsightly conditions: bags become brittle in very cold weather, causing breakage; plastic lightness and durability causes later disposal problems. In extremely warm areas where disposable plastic bags are used for lawn trimmings, plastic containers frequently stretch or break at the seams when the collector lifts the loaded bag. Such breakage is potentially hazardous and may lead to injuries to the collector because of the presence of glass and sharp or otherwise dangerous items in the wastes.

ON-SITE PROCESSING OF SOLID WASTE

Grinding, sorting, compaction, shredding, composting, and hydropulpery are all onsite processing methods used to (1) reduce the volume, (2) alter the physical form, or (3) recover usable materials from solid wastes.

Grinding: Home grinders are used primarily for waste from the preparation, cooking, and serving foods, and they cannot be used for large bones or other bulky items. Functionally, grinders render the material that passes through them suitable for transport through the sewer system. However, because the organic material added to sewage has resulted in overloading many treatment facilities, it has been necessary, in some communities, to forbid the installation of grinders in new developments until additional treatment capacity becomes available.

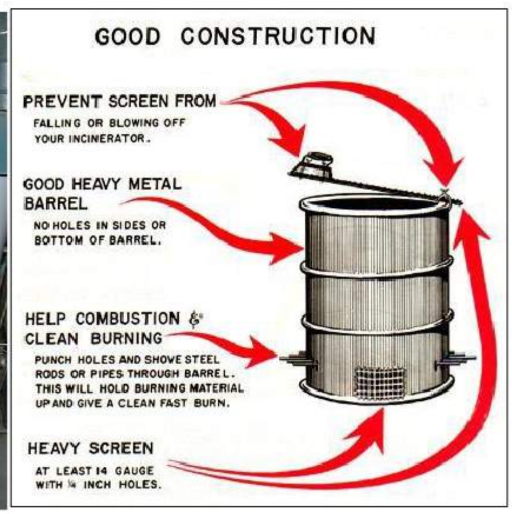
In terms of the collection operation, the use of home grinders does not have significant impact on the volume of solid wastes collected. In some cases where grinders are used, it has been possible to increase the time period between collections pickups because wastes that might readily decay are not stored.

Sorting: The sorting or separation of waste materials into newspapers, aluminum cans, and glass and others by hand at the household is one of the most positive ways to achieve the recovery and reuse materials

Compaction: Within the past few years, a number of small compactors designed for home use have appeared on the market for compaction of loose paper and cardboard. Although it is possible to reduce the original volume of wastes placed in them by up to 70 percent, they can be used only for a small proportion of the wastes actually generated.

Composting: It is an effective way of reducing the volume and altering the physical composition of solid waste while at the same time producing a useful by- product.

Home incineration: Until recently, home incineration, burning combustible materials in fireplaces and burning rubbish in crude backyard incinerators was a common practice. Backyard incineration is now banned in many countries. The design of small outdoor and indoor incinerators has improved. The simplest outdoor incinerator consists of a metal drum with holes punched near the bottom. The more elaborated units are lined with refractory brick and are equipped with cast-iron grates and small chimneys.





<u>Shredding and Pulping:</u> are alternative processing operations that have been used, both in conjunction with the previous methods and by themselves, for reducing the volume of wastes that must be handled. Where shredding is used alone without the addition of water, the volume of wastes has often been observed to increase. Although the system works well and the volume of solid wastes is reduced, it is expensive. Special equipment may be required to remove and empty the full pulp containers. An alternative is to discharge the pulped material to the local sewer. This is often done in small operations where a pulper is used to destroy outdated confidential documents. Because the discharge of pulped material increases the organic loading on local treatment facilities, the use of pulverizes may be restricted if the treatment capacity is limited.

Solid waste shredders

Example: Effect of Home Recovery on Energy Content of Collected Solid Wastes. Using the typical percentage distribution data given in the third lecture, estimate the number of British thermal units per pound (Btu/lb) of the remaining solid wastes if 90 percent of the cardboard and 60 percent of the paper were recovered by the homeowner.

Answer: = 3,843 Btu/lb (8,939 KJ/kg) vs. 4,762 Btu/lb (11,076 kJ/kg) in original sample

Waste Management 3R Concept

The waste hierarchy refers to the 3 (or 4) R's of reduce, reuse, recycle, (recovery) which classify waste management strategies according to their desirability. The R's are meant to be a hierarchy, in order of importance. However in Europe the waste hierarchy has 5 steps: reduce, reuse, recycle, recovery, and disposal. The waste hierarchy has taken many forms over the past decade, but the basic concept has remained the cornerstone of most waste minimization strategies.

The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste.

Some waste management experts have recently incorporated an additional R: "Re-think", with the implied meaning that the present system may have fundamental flaws, and that a thoroughly effective system of waste management may need an entirely new way of looking at waste. Source reduction involves efforts to reduce hazardous waste and other materials by modifying industrial production. Source reduction methods involve changes in manufacturing technology, raw material inputs, and product formulation. At times, the term "pollution prevention" may refer to source reduction.

Hazardous Waste Management

The Concern about Hazardous Waste Management are:

1. Cause of mass life and material damage and loss (disability, death, fire, explosion);

2. Cause of environmental damages: potential water, solid, and air pollution (underground and surface drinking water);

3. Cause of potential increased chemical bioaccumulation that is hard for biodegradability (chlorine-containing chemicals);

4. Cause of long-term irreversible health risks (mutagenicity, teratogenicity, and carcinogenicity)

5. High concern of trans-boundary movement of toxic wastes;

6. Cause of massive toxic health damages.

Characteristics of Hazardous Waste

The Environmental Protection Agency of America (EPA) defines the characteristics of hazardous waste as:

1. Flammability and Ignitability

The waste burns or explodes with the application of fire, friction, electricity spark, or any source of heat; wastes with high ignitable potential and/or which burn vigorously and persistently. Such wastes have a flash point of less than 600 ºC. Examples: solvent washes, waste oil, alcohols, aldehydes, paint wastes, petroleum wastes, cleaning solvents, etc. Flash point of a liquid is the lowest temperature at which it gives off enough vapor to form an ignitable mixture with the air in its surface.

2. Corrosivity

It is the ability of the waste to cause skin and mucosal membrane damages: burns and erosions, and dissolves or corrodes metallic surfaces. Such wastes have pH value of: 2.5<pH>12.5 at normal room temperatures (250 ºC). The corrosion rate for material damage is at 0.625 meters per year at 550 ºC. Examples: acid sludge, battery acid wastes, caustic waste water, alkaline cleaning wastes, rust remover waste, etc.

3. Reactivity

A waste that reacts violently with water with the formation of toxic fumes, gases, or aerosols (Strong acids and HCN when mixed with water); and explodes when mixed with water. Such incidents can also occur when the waste is mixed with other chemicals producing the same effect. Wastes containing unstable chemicals are also in this category. Examples: Cyanide plating wastes, wastes containing strong oxidizers such as chlorine, ozone, peroxides, permanganates, HCl, etc.

4. Toxicity

A waste that is likely to produce mass acute and chronic poisoning; long-term health effects (mutagenicity, teratogenicity, carcinogenicity). The following guideline can be used for determining whether acute and chronic toxicity may occur: if a waste contains an amount greater than ten times its standard in drinking water, or a hundred times more than in its standard in drinking water, or a hundred times more than in its standard for water used for recreational purposes.

5. Infectivity

A waste with a potential cause for infectious diseases, such as hepatitis B. Example: medical wastes containing microbial cultures, pathological wastes, contaminated human blood and its products, sharps, skin-piercing objects, contaminated animal wastes, contaminated exudates and secretions.

6. Radioactivity

Wastes containing radioactive elements. Such wastes are mainly from biomedical training and research institutes. Wastes may include radioactive elements of uranium, molybdenum, cobalt, iodine.

7. Bioaccumulation effect

Wastes that are not easily degraded when exposed with the environment. Examples: polychlorinated biphenyls (PCB), dioxin.

List of Hazardous Chemicals

The following hazardous chemicals selected as require priority consideration:

1. Arsenic and its compounds;

2) Mercury and its compounds;

3) Cadmium and its compounds;

4) Thallium and its compounds;

5) Beryllium and its compounds;

6) Chromium (VI) compounds;

7) Lead and its compounds;

8) Phenolic compounds;

9) Antimony and its compounds;

10) Cyanide compounds;

11) Isocyanates;

12) Organohalogenated compounds except inert polymeric materials;

13) Chlorinated solvents;

14) Organic solvents;

15) Biocides and phytopharmaceutical substances;

16) Tarry materials from refining and tar residues from distilling;

17) Pharmaceutical compounds;

18) Peroxides, chlorates, perchlorates, and azides;

19) Ethers;

20) Chemical laboratory materials, not identifiable and/or new, with unknown effects on the environment;

21) Asbestos;

22) Selenium and compounds;

23) Tellurium and compounds;

24) Polycyclic aromatic hydrocarbons;

25) Metal carbonyls;

26) Soluble copper compounds;

27) Acids and/or basic substances used in the surface treatment and finishing of metals.

Transportation and Disposal of Hazardous Waste

The transportation of hazardous waste can pose a threat to the public. To promote safety and protect the public's health, companies follow four basic control measures for the movement of hazardous waste from a source to disposal site;

1. Hazardous waste manifest:

The concept of a cradle-to-grave tracking system is considered key to proper management of hazardous waste. Manifest copies accompany each barrel of waste that leaves the site where it is generated, and are signed and mailed to the receiving sites to indicate the transfer of waste from one location to another.

2. Labeling:

Each container is labeled and marked. The transporting vehicle is labelled before waste is transported from the generating site. Companies post warning labels such as: explosive, strong oxidizer, compressed gas, flammable liquid, corrosive material, and poisonous or toxic substances.

3. Haulers:

Because of the dangers involved, haulers of hazardous waste are subject to operator training, insurance coverage, and special registration of vehicles transporting hazardous waste. Handling precautions include restrictive use of the transport trucks and the use of gloves, face masks, and coveralls for the workers' protection.

4. Incident and accident reporting:

Accidents involving hazardous waste must be reported immediately to the state regulatory agency, as well as local health departments. Necessary information that will help responders contains the material that should be made available.

Hazardous Waste Treatment

Different technical options and alternative methods can be employed for the treatment. The end result needs to focus on making the waste non-harmful or less hazardous, reduce its volume and texture, separate for re-use, and isolate it for final disposal. Treatment methods include:

A. Physical methods: drying, screening, grinding, evaporation, sedimentation, filtration, fixation, etc.

B. Chemical methods: Oxidation, reduction, neutralization, hydrolysis, etc.

C. Biological methods: composting, aerobic and anaerobic decomposition, activated sludge, enzyme treatment, etc.

D. Thermal methods: incineration, boiling, autoclaving, UV treatment, microwave use, etc.

Hazardous Waste Disposal

The hazardous waste, after treatment, can be ultimately disposed using the following methods:

a) Land farming: the treated waste can be used as a fertilizer or soil conditioner with the approval of concerned regulatory entities;

b) Deep well injection: a special kind of drilled well is prepared for such purposes. Brine (40% salt solution) is usually disposed in this manner. Precautions for water pollution need to be a concern.

c) Surface impediment: encapsulation, fixation, or containment of the waste. This method involves arresting or demobilizing the movement or migration of the waste by containing it in a hard core: clay soil, thermoplastics polymers, non-corrosive metallic containers (carbon-steel tanks), cement, lime, fire glass, rocks.

d) Ocean dumping: was mostly practiced from 1945 to the 1970s. Despite the existing public protest, this method continuous to be an alternative for the waste generators.