Solid –Waste Management

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Waste management is the collection, transport, processing, recycling or disposal, and monitoring of waste materials.

The term usually relates to materials produced by human activity.

Waste management can involve solid, liquid, gaseous or radioactive substances, with different methods

Solid -Waste

Any material which is not needed by the owner, producer or processor.

Classification :Solid Waste

- **Domestic waste(MSW)** Solid waste- vegetable waste, kitchen waste, household waste etc.
- **Factory waste**
- **E-waste** discarded electronic devices like computer, TV, music systems etc.
- **Construction waste**
- **Agricultural waste**
- **Food processing waste**
- **Bio-medical waste**
- **Nuclear waste**

Municipal solid waste

- “Municipal solid waste” (MSW) is a term usually applied to a heterogeneous collection of wastes produced in urban areas,
- function of the living standard and lifestyle of the region's inhabitants, but also of the abundance and type of the region's natural resources.
- urban solid waste can be classified into three broad categories: putrescible, fermentable, and non-fermentable.

- A major source of putrescible waste is food preparation and consumption.
- As such, its nature varies with lifestyle, standard of living, and seasonality of foods.

- Fermentable wastes are typified by crop and market debris.

Composition:

Factors influencing the composition of MSW:

- Climate
- Frequency of collection
- Social customs
- Per capita income
- Acceptability of packaged and convenience foods
- Degree of urbanization and industrialization

- Municipal waste include:
- *Biodegradable waste component*
- Green waste
- Kitchen waste
- Paper

- *Other recyclable components*
- Plastics (#1 PET, #2 HDPE natural and colored, #3 PVC narrow-necked containers, #4 LDPE, #5 PP, #7 other mixed resin plastics)
- Glass
- Metals (ferrous and non-ferrous)

- A **waste collection vehicle** (WCV), or colloquially called a 'Garbage Truck',

There are five basic models of waste collection vehicles:

- Front loaders
- Rear loaders
- Side loaders
- Pneumatic collection
- Grapple trucks

Front loaders

Front loaders generally service commercial and industrial businesses using large waste containers with lids (Dumpsters(US),orBiffa bins

Rear loaders

Rear loaders have an opening at the rear that a waste collect can throw waste bags or empty the contents of bins into. Often in many areas they have a lifting mechanism to automatically empty large carts without the operator having to lift the waste by hand.

Side loaders

These WCVs are loaded from the side, either manually, or with the assistance of an automated lift. Lift-equipped trucks are referred to as automated side loaders.

Pneumatic collection WCVs

Pneumatic collection WCVs have a crane with a tube and a mouthpiece that fits in a hole, usually hidden under a plate under the street.

Volvo pneumatic collector, "waste suction"

3R Concept

- **Recycling** involves processing used materials into new products to prevent waste of potentially useful materials,

- Recyclable materials include many kinds of glass, paper, metal, plastic, textiles, and electronics.

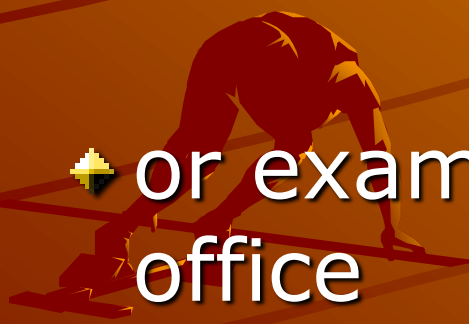
- **Early recycling:**

Process

- **Collection**
- he three main categories of collection are "drop-off centres", "buy-back centres" and "curbside collection
- Drop-off centres require the waste producer to carry the recyclates to a central location, either an installed or mobile collection station or the reprocessing plant itself.

- Buy-back centres differ in that the cleaned recyclates are purchased, thus providing a clear incentive for use and creating a stable supply
- Curbside collection encompasses many subtly different systems, which differ mostly on where in the process the recyclates are sorted and cleaned.

- Materials to be recycled are either brought to a collection center or picked up from the curbside, then sorted, cleaned, and reprocessed into new materials bound for manufacturing.



- or example used office paper to more office paper, or used foamed polystyrene to more polystyrene.


Papier

- **Sorting**

- Once recyclates are collected and delivered to a central collection facility, the different types of materials must be sorted.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Reuse

- **Reuse** is to use an item more than once. This includes conventional reuse where the item is used again for the same function, and new-life reuse where it is used for a new function.

- Reuse is the doorstep delivery of milk in refillable bottles; other examples include the retreading of tires

- Reuse has certain potential advantages which can be summarized:

- Energy and raw materials savings as replacing many single use products with one reusable one reduces the number that need to be manufactured.

- Reduced disposal needs and costs.

- Refurbishment can bring sophisticated, sustainable, well paid jobs to underdeveloped economies.

- Cost savings for business and consumers as a reusable product is often cheaper than the many single use products it replaces.

- Some older items were better handcrafted and appreciate in value.

Deposit Programs

Closed-loopPrograms

Tesco have established a series of nine recycling service units which wash returnable plastic trays50,000 tonnes of packaging per annum

Refilling Programs

- Refill packs of certain commodities (mainly soap powders and cleaning fluids), the contents being transferred before use into a reusable package kept by the customer, with the savings in packaging being passed onto the customer by lower shelf prices Printer Cartridges & Toners Reuse

Reduce

- In industries, using more efficient manufacturing processes and better materials will generally reduce the production of waste.
- Resource optimization
- Reuse of scrap material
- Improved quality control and process monitoring
- Waste exchanges This is where the waste product of one process becomes the raw material for a second process
- Ship to point of use
- Product design

- **Durability**

- Improving product durability, such as extending a vacuum cleaner's useful life to 15 years instead of 12, can reduce waste and usually much improves resource optimization.

In households

- Appropriate amounts and sizes can be chosen when purchasing goods;
- The amount of waste an individual produces is a small portion of all waste produced by society, and personal waste reduction can only make a small impact on overall waste volumes.
- Consumers can influence manufacturers and distributors by avoiding buying products that do not have eco-labeling

Table I-1. Comparison of solid waste characterisation worldwide (% wet wt)

Location	Putres-cibles	Paper	Metals	Glass	Plastics, Rubber, Leather	Tex-tiles	Ceramics, Dust,	Stones	Wt (g)/cap/ day
Bangalore, India [1]	75.2	1.5	0.1	0.2	0.9	3.1	19.0	400	
Manila, Philippines [2]	45.5	14.5	4.9	2.7	8.6	1.3	27.5	400	
Asunción, Paraguay [2]		60.8	12.2	2.3	4.6	4.4	2.5	13.2	460
Seoul, Korea [3]	22.3	16.2	4.1	10.6	9.6	3.8	33.4[a]	2,000[a]	
Vienna, Austria [4]	23.3	33.6	3.7	10.4	7.0	3.1	18.9[b]	1,180	
Mexico City, Mexico [5]		59.8[c]	11.9	1.1	3.3	3.5	0.4	20.0	680
Paris, France [4]	16.3	40.9	3.2	9.4	8.4	4.4	17.4	1,430	
Australia [7]	23.6	39.1	6.6	10.2	9.9	9.0	1,870		
Sunnyvale, California, USA [6]		39.4[d]	40.8	3.5	4.4	9.6	1.0	1.3	2,000
Bexar County, Texas, USA [6]		43.8[d]	34.0	4.3	5.5	7.5	2.0	2.9	1,816

- Key concepts in municipal waste reduction

- Action for waste reduction can take place at both the national and local levels. At the national level, some strategies for waste reduction include:

- • redesign of products or packaging.

- • promotion of consumer awareness.

- • promotion of producer responsibility for post-consumer wastes.

- At the local level, the main means of reducing waste are:

- • diversion of materials from the waste stream through source separation and trading;

- • recovery of materials from mixed waste;

- • pressure on national or regional governments for legislation on redesigning packaging or products; and

- • support of home composting, either centralized or small-scale.

- It involves the collection of the following data: 1) average density of waste, 2) number of loads collected per day, and 3) average volume per load.

- The latter quantity is obtained by measuring the vehicle body. The total daily weight is the product of all three, i.e., density, volume, and number of loads per day. For example, if the density is 300 kg/m^3, the average vehicle volume is 4 m^3, and the total number of loads per day is 100, then the total daily input to the disposal site is 120 T.

Figure I. Bags used to determine quantity of waste generated

- **Estimated quantity of waste collected in various cities and countries**
- **Location Estimated Quantity (kg/cap/day)[a]**
- India 0.3 to 0.55
- Bolivia 0.3 to 0.6
- Guatemala City, Guatemala 0.3 to 0.6
- Lima, Peru 0.3 to 0.8
- Philippines 0.4
- Asunción, Paraguay 0.46
- Malaysia 0.5
- Uruguay 0.5 to 0.9
- Tegucigalpa, Honduras 0.52
- Rio de Janeiro, Brazil 0.54
- Jakarta, Indonesia 0.6
- Buenos Aires, Argentina 0.6 to 1.0
- Mexico DF, Mexico 0.68
- San Salvador, El Salvador 0.6

- **Characteristics**

- Moisture Content :
- The percent moisture content is then obtained through the following formula:

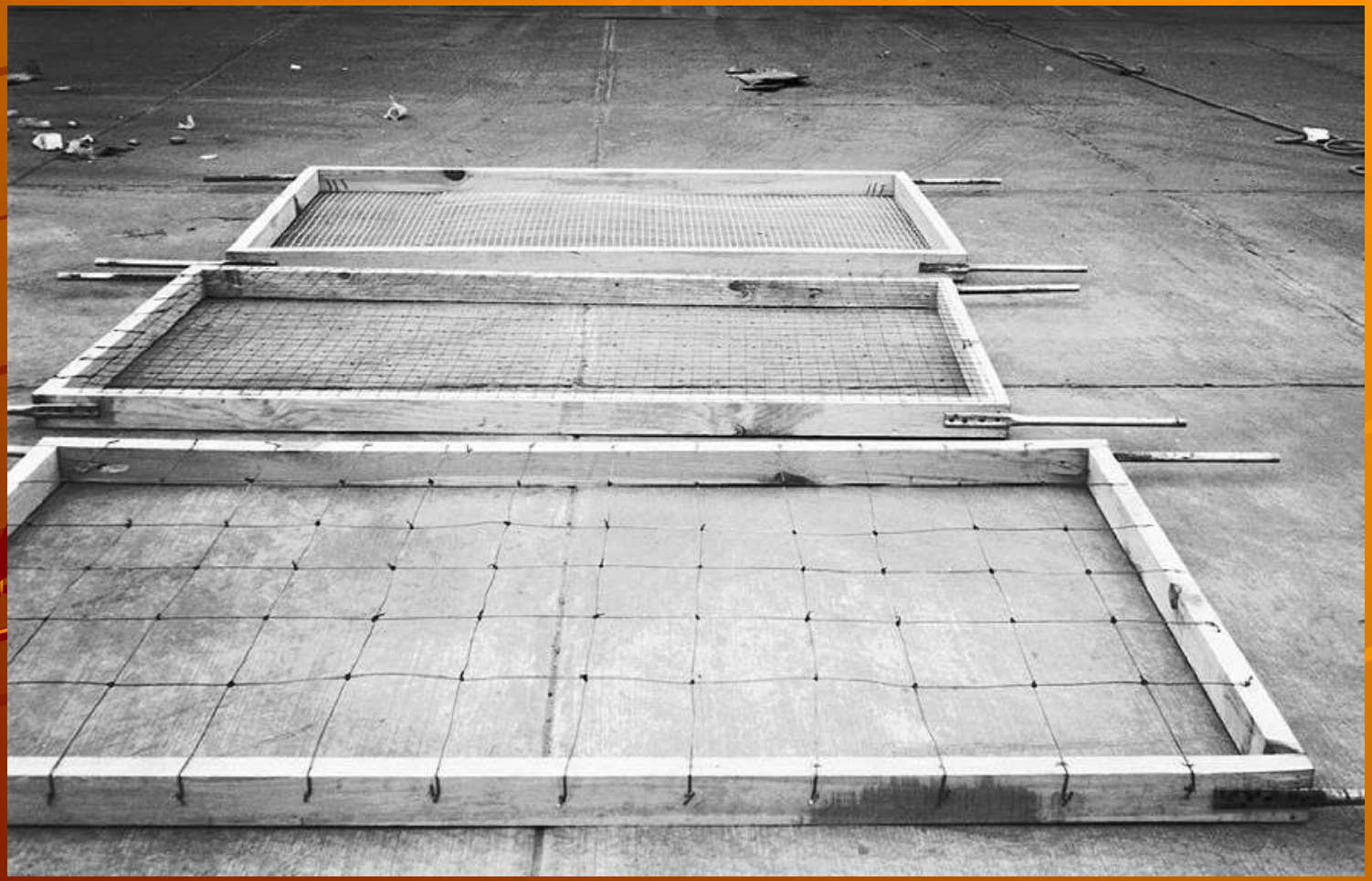
- Moist.Content= WW-WD/WW
- • WW = wet weight of sample, and
- • WD = dry weight of sample.

Determination of bulk density

- **Table III-2. Bulk densities of residential wastes for various countries**
- **Country Density (kg/m³)**
- United Kingdom 150
- United States 100
- Egypt 330
- Nigeria 250
- Singapore 175
- Tunisia 175
- Bangladesh 600
- Burma 400
- India 400 to 600
- Indonesia 400
- Mexico 300 to 500
- Nepal 600
- Pakistan 500
- Paraguay 390
- South Korea 200 to 450
- Sri Lanka 400
- Thailand 250

SIZE distribution

Size distribution may be determined with the use of a set of manually manipulated screens.



- CHEMICAL/thermal properties

Typical analyses include moisture and ash contents; calorific value; and the concentrations of carbon, nitrogen, hydrogen, oxygen, and some heavy metals if there are reasons to suspect that they may be present.

- Manual separation

- **Table VI-1. Manual sorting rates and efficiencies**

Material	**Sorting Rate (kg/hr/sorter)**	**Recovery Efficiency (%)**
Newspaper[a]	700 to 4,500	60 to 95
Corrugated[a]	700 to 4,500	60 to 95
Glass containers[b] (mixed colour)	400 to 800	70 to 95
Glass containers[b] (by colour)	200 to 400	80 to 95
Plastic containers[b] (PET, HDPE)	140 to 280	80 to 95
Aluminium cans	45 to 55	80 to 95

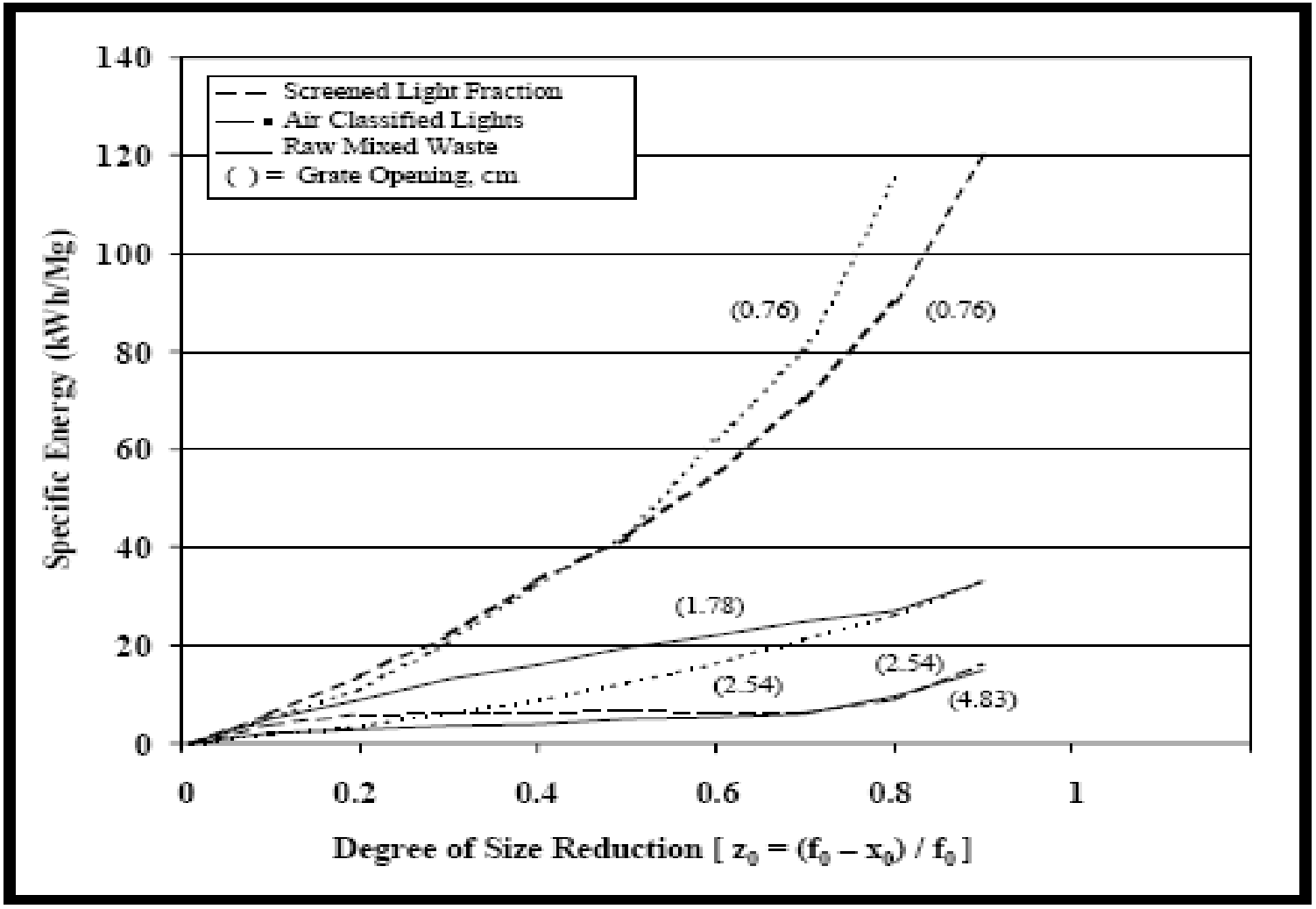
Mechanical separation

- Mechanical separation usually involves the use of several types of unit processes, five of which are size reduction, screening, air classification, magnetic separation, and non-ferrous (e.g., aluminium) separation

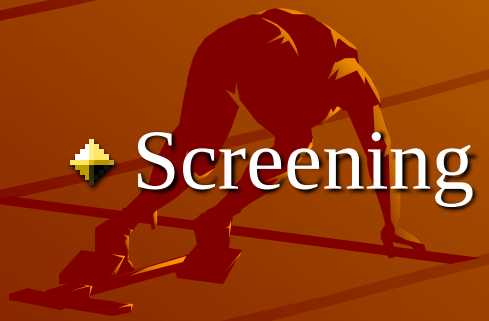
- “shredding” and “grinding”. The term “shredding” has been widely adopted in reference to size reducing mixed waste. In the case of processing source-separated materials, size reduction using granulators and grinders is sometimes practiced for certain types of plastics and for glass,

- Characteristics of size-reduction processes
- Size reduction of solid waste and its components is an energy- and maintenance-intensive operation.
- Energy requirements for size reducing some solid waste fractions in one type of hammermill shredder are indicated in Figure
- In the figure, specific energy (i.e., kWh/t processed) is plotted as a function of degree of size reduction. Degree of size reduction (zo) is defined as unity minus the ratio of characteristic product size (xo) to the feedstock characteristic size (fo) [3].
- The characteristic particle size is the screen size on a size

Energy requirements for various solid waste fractions using a 187 kW horizontal hammermill



- Central Separation and Processing:
- Air classification for lightweight components
- Magnetic for separation for ferrous metals.
- Screening for removal of nonferrous material.



AIR Classification

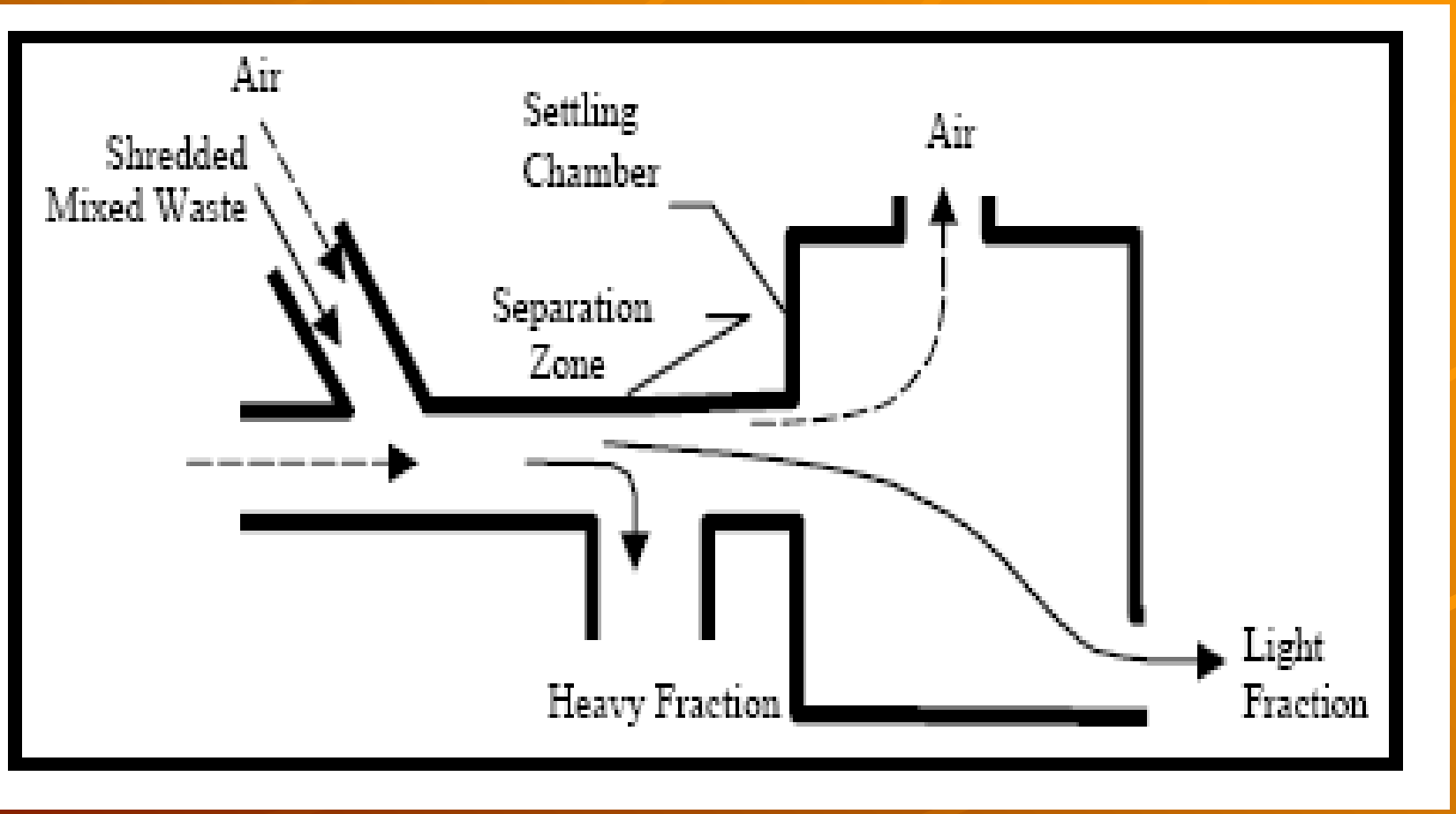
- Air classification is a process of separating categories of materials by way of differences in their respective aerodynamic characteristics.

- The aerodynamic characteristic of a particular material is primarily a function of the size, geometry, and density of the particles.
- The process consists of the interaction of a moving stream of air, shredded waste material, and the gravitational force within a confined volume.

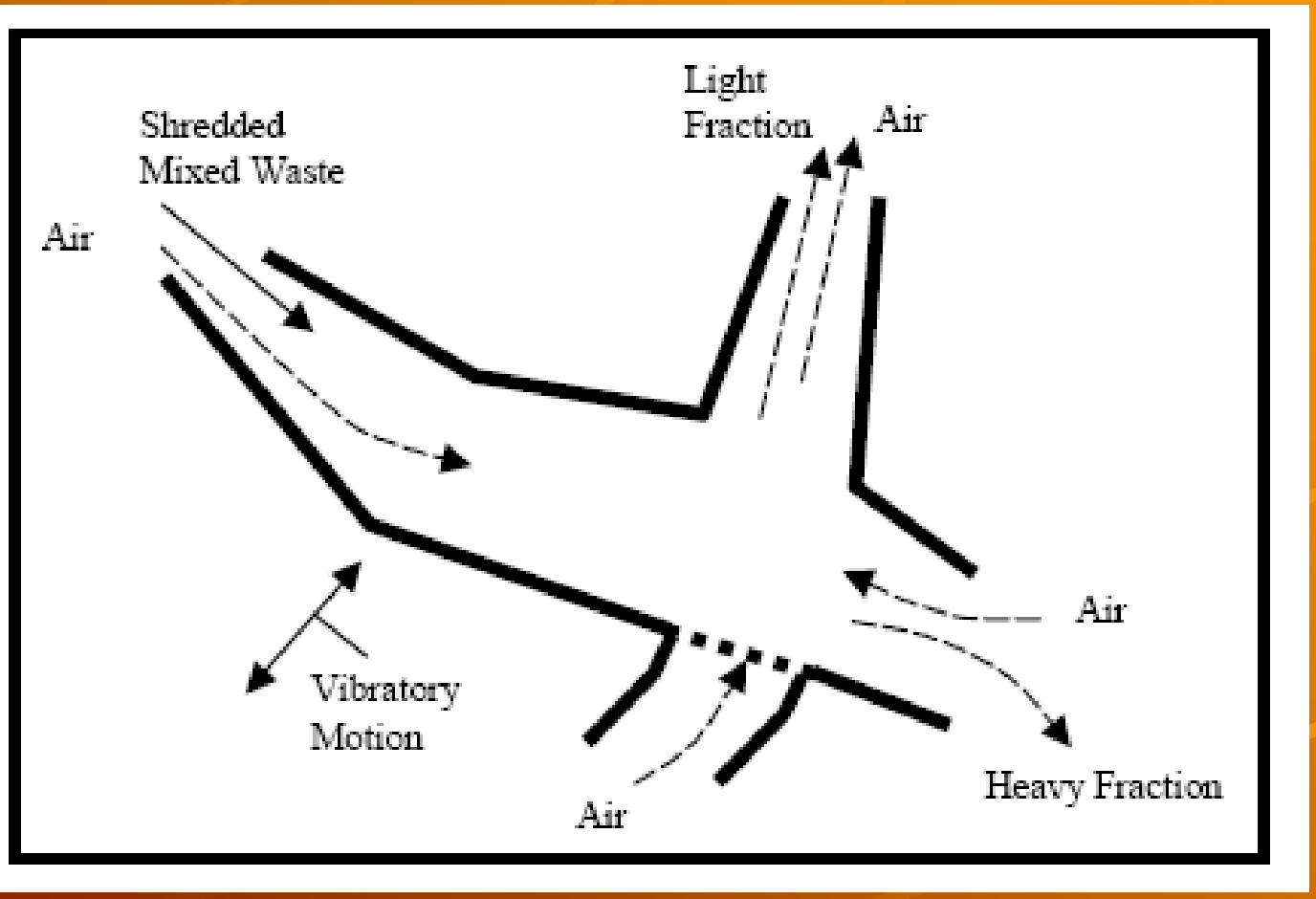
- In the interaction, the drag force and the gravitational force are exerted in different directions upon the particles. The result is that waste particles that have a large drag-to-weight ratio are suspended in the air stream, whereas components that have a small ratio tend to settle out of the air stream.

- In air classification of shredded mixed MSW, the paper and plastic materials tend to be concentrated in the light fraction, and metals and glass are the principal components of the heavy fraction.

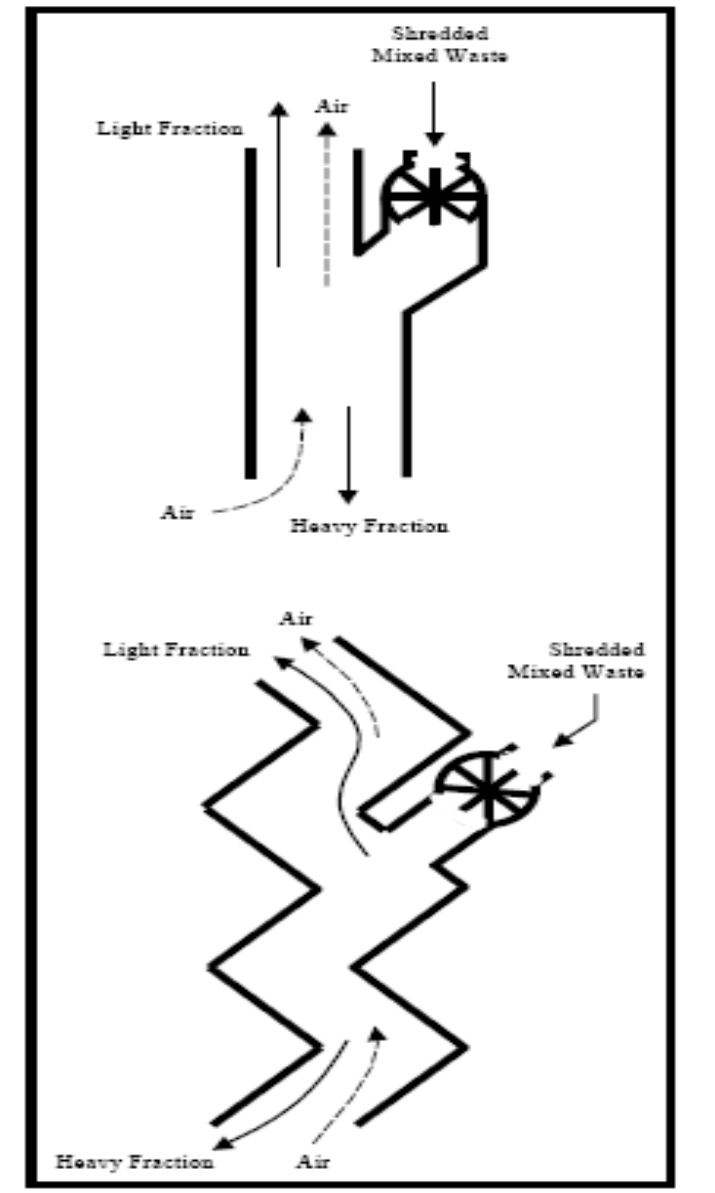
Horizontal air classifier



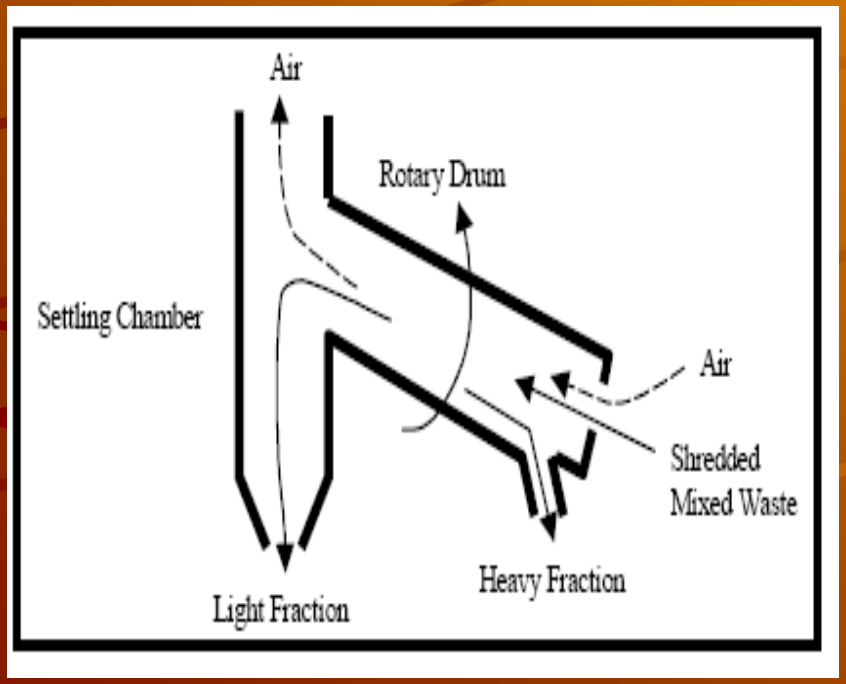
Vibrating inclined air classifier



vertical air classifiers

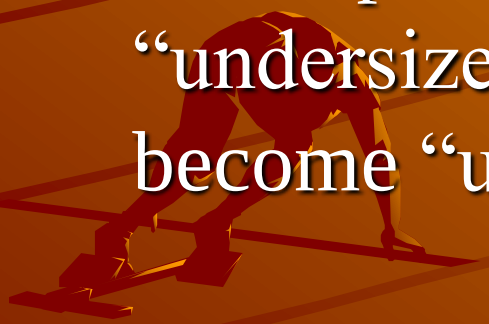


Inclined air classifier



SCREENING

- This fraction is termed “oversize”, and its constituent particles become “oversize particles”. The second fraction passes through the openings and accordingly is termed “undersize”, and its constituent particles become “undersize particles”.



Typical floating velocities for various components of shredded mixed waste

Waste Component	Moisture Content (%)	Density (kg/m^3)	Particle Geometry	Typical Floating Velocity (m/sec)
Paper				
Newsprint	10	560	Flake	0.9
	40	840	Flake	1.1
Ledger	10	758	Flake	1.1
	40	1,138	Flake	1.3
Corrugated	10	192	Flake	3.5
	40	320	Flake	4.4
Linerboard	10	650	Flake	1.8
	40	974	Flake	2.2
PE coated	10	746	Flake	3.0
	30	1,066	Flake	3.5
Plastic				
PE film	3	912	Flake	4.4
PE rigid	3	912	Irregular	8.7 to 15.3
Wood				
Lumber	12	480	Splinter	2.2 to 8.5
	30	603	Splinter	2.5 to 9.9
Plywood	12	552	Flake	5.9
Textile	5	242	Flake	2.3
Rubber	3	1,773	Irregular	18.0
	3	1,773	Flake	8.4 to 12.0
Aluminium				
Sheet	0	2,688	Flake	2.4 to 4.6
	0	2,688	Irregular	9.8 to 44.2
Can	0	58	Cylinder	6.6
Ferrous				
Sheet	0	7,840	Flake	4.0 to 5.9
	0	7,840	Irregular	16.6 to 75.0
Can	0	144	Cylinder	9.9
Glass	0	2,400	Irregular	2.9 to 22.5

Trommel

The trommel is a downwardly inclined, rotary, cylindrical screen. Its screening surface is either a wire mesh or a perforated plate.

- Processing at the source:
- Grinders
- Compactors
- Compostera

- Composting is another form of recycling. There are different methods of treating biodegradable materials.
- Composting is nature's way of recycling organic wastes. It is an aerobic process.
- in which biologically degradable wastes are broken down to form a stable, granular material, through self-heating.
- The process is a complex interaction between the waste and the micro-organisms within the waste. The micro-organisms that carry out this process fall into three groups: bacteria, fungi and actinomycetes.

- Actinomycetes is a form of fungi – like bacteria microscopic organisms that break down organic matter.

- The first stage of the biological activity is the consumption of easily available sugars by bacteria, which causes a fast rise in temperature.

- The second stage involves bacteria and actinomycetes that cause cellulose breakdown. As the compost cools there is the last stage which concerns the breakdown of the tougher lignins by fungi

- The suitable conditions for efficiently biological activity has to cover the following critical factors: **carbon to nitrogen ratio**, the ideal carbon to nitrogen

- (C:N) ratio, by weight is 30 parts carbon to 1 part nitrogen; **particle size** (~5cm)

- **Water pollution**
- includes heavy metals, different organic compounds, e.g. phenols, PAHs, PCBs,
- etc., and salts, e.g. NO3

- **Incineration**
- The reduction in available land for landfill and the growing amount of garbage

- Thermal treatment is a broad term used to describe a range of heating .

- combustion technologies used for the treatment of waste.

- The most common types are mass burn, Fluidized BedCombustion (FBC), pyrolysis and gasification.

- The efficiency of electricity recovery is about 21%. The waste is reduced to 24%
- of its original weight and only 10% of the original volume .

- Fluidized Bed:
- combustion of volatile compounds takes place. Temperatures generally remainbelow 10000 C, minimising the levels of NOx produced in the combustion

- Higher velocities are used so that the solid particles are transported with the flue gases.
- pyrolysis and gasification turn wastes into energy rich fuels by heating the waste under controlled conditions.
- Pyrolysis is a thermal decomposition of fuel in the absence of air.
- Gasification is a reaction between the fuel and oxidant (steam and oxygen)
- carried out in a restricted supply of oxygen so that complete combustion of thefuel does not take place.

- Instead the volatile gas comprising combustible components, such as hydrogen, carbon monoxide, methane and higher hydrocarbons is produced, which is subsequently burned to generate electricity.

- Gasification reactions include partial oxidation of the fuel and the water gas reaction

- **Environmental and health impacts**

- Small incineration plants lack the adequate filters to prevent releases of toxiccompounds to the environment.
- Releases of dioxins, heavy metals and other compounds (OCS, PCBs, HCBs)afterwards settle down on terrestrial and water systems systems.
- The principal emissions from a MSWI facility are particulate matter, gases contributing to the greenhouse effect and causing acid rain (SOx, H2S, CO,Volatile Organic Compounds (VOCs, including CFCs) and NOx), polycyclic aromatic hydrocarbons (PAHs), gases that affect the respiratory system.

- (Aldehydes, HCl and polycyclic aromatic compounds (PCAs)), dioxins,
- octachlorostyrene (OCS), heavy metals

- **DIOXINS:**

- The term dioxin is used for a high number of potential carcinogens and endocrine disrupters .

- Dioxins are persistent organic pollutants (POPs) .

- They are known to be extremely toxic even at low concentration levels .

- There are around 700 differentcompound

- **Landfilling:**

- Historically landfilling has been the major practice for municipal solid waste Disposal.

- Landfilling solid waste is a permanent disposal process by which we spread, compact, and cover (seal) waste with either ash from the Waste-to-Energy facility or soil.

- When designing landfill site the following characteristics must be considered: the geology, hydrogeology, topography,drainage, and permafrost of the site and transport facilities.

- In the **area method** waste is spread on the ground and then compacted to 2 meters. Waste can be stacked into different layers with this method.

- To cover compacted waste soil or synthetic material is used. It is usually put after each operation day or more often.

- The **ramp method** is a kind of the area method. It is mainly used for sloping land. Wastes are spread and compacted on a slope.

- The **trench method** is the preferred method for disposing waste by landfilling

- **Mechanical Biological treatment:**

- There are four stages of this process: waste input and control, mechanical conditioning, biological treatment and emplacement of treated waste at a landfill.

- The mechanical stage is to sort out the non-biodegradables and any recyclables. Next, the residual waste is prepared for biological treatment by comminution, mixing and, if necessary, moistening.

- The biological stage effects extensive biological stabilization of the waste.

- waste is exposed to atmospheric oxygen to induce aerobic decomposition, or by breaking it down in the absence of atmospheric oxygen in anaerobic fermentation process.

- The last step is deposition of the treated material.

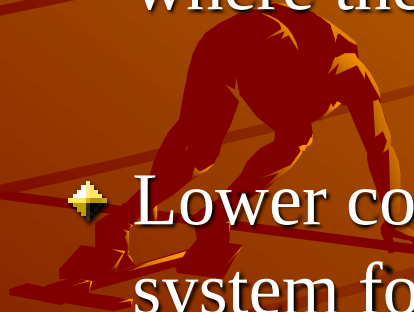
- **Landfill system**

- The main concept of dry tomb is to isolate waste from the environment in a compacted soil and plastic sheeting tomb.
- Plastic sheeting is a thin layer of HDPE (high –density polyethylene). It is combined with a
- compacted soil-clay layer to form composite liner.

- **Leachate collection and removal system:**
- Leachate is a noxious, mineralized liquid capable of transporting bacterial pollutants produced when water moves through the refuse.

- Leachate generated in the solid waste passes through a filter layer which underlines the waste.

- infiltrating to leachate collection system. This system usually consists of gravel.
- It allows leachate to flow across the top of the liner to the top of the HDPE liner.
- Then it flows across to the top of the liner to a collection pipe and is transported to a container, where the leachate can be pumped from the landfill.



- Lower composite liner represents a leak detection system for the upper liner.
- It is located between the two composite clay liners.

- Geosynthetic liners are thin layers of bentonite clay which is encased in a woven materialtogether with clay liners they minimise leachate formation through infiltration

- **Landfill cover:**

- Geomembranes, very flexiblpolyethylene (VFPE), or polyvinyl chloride (PVC), reduce the erosion of the landfill cover

- **Landfill gas**

- The anaerobic decomposition of organic materials in a municipal solid waste landfill will generate a combination of gases, mainly methane and carbondioxide.

- The migration of landfill gas under ground can pose safety risk for landfill construction. In smaller landfills the gas venting layer provides the effective collection and dispersion of landfill gas.

- The gas is passively released through vents installed in a landfills cover system.

- Landfill gas collection system should be installed. It should be designed to have at least 95% probability of collection all landfill gas generated at the landfill

- **Bioreactor landfill**

- A bioreactor landfill is a sanitary landfill that uses microbiological processes to transform and stabilise the decomposable organic waste within 5 to 10 years of implementation, compared to 30 to 100 years for dry Subtitle D landfills (those
- that accept MSW and so-called nonhazardous industrial waste).

- To promote waste stabilisation, moisture (usually leachate) is added. Stabilisation means that waste does not produce landfill gas any more through the biochemical reactions of bacteria utilising some of the organic components in wastes as a source of

  energy .

- There are three different types of bioreactor landfill configurations: **aerobic-**eachate is re-circulated into the landfill and air is injected, **anaerobic-** leachate

- **LANDFILL GASES**:

- The flora is also affected by the release of gases that move through the soil (in majority methane) in different ways: (i) landfill gas displaces oxygen, causing asphyxia in the roots. (ii) methane is oxidised by bacteria (methanotrophs) near the surface. This reaction depletes oxygen (asphyxia of the plants) and releases heat, and finally, (iii) this heat increases soil temperature again leading to asphyxia of the surrounding vegetation

- The presence of landfill gases also causes differences in the normal growth of the roots . The content in nitrogen and ammonia is quite high .

- That affects the surrounding vegetation due to a change in the competition abilities of the plants

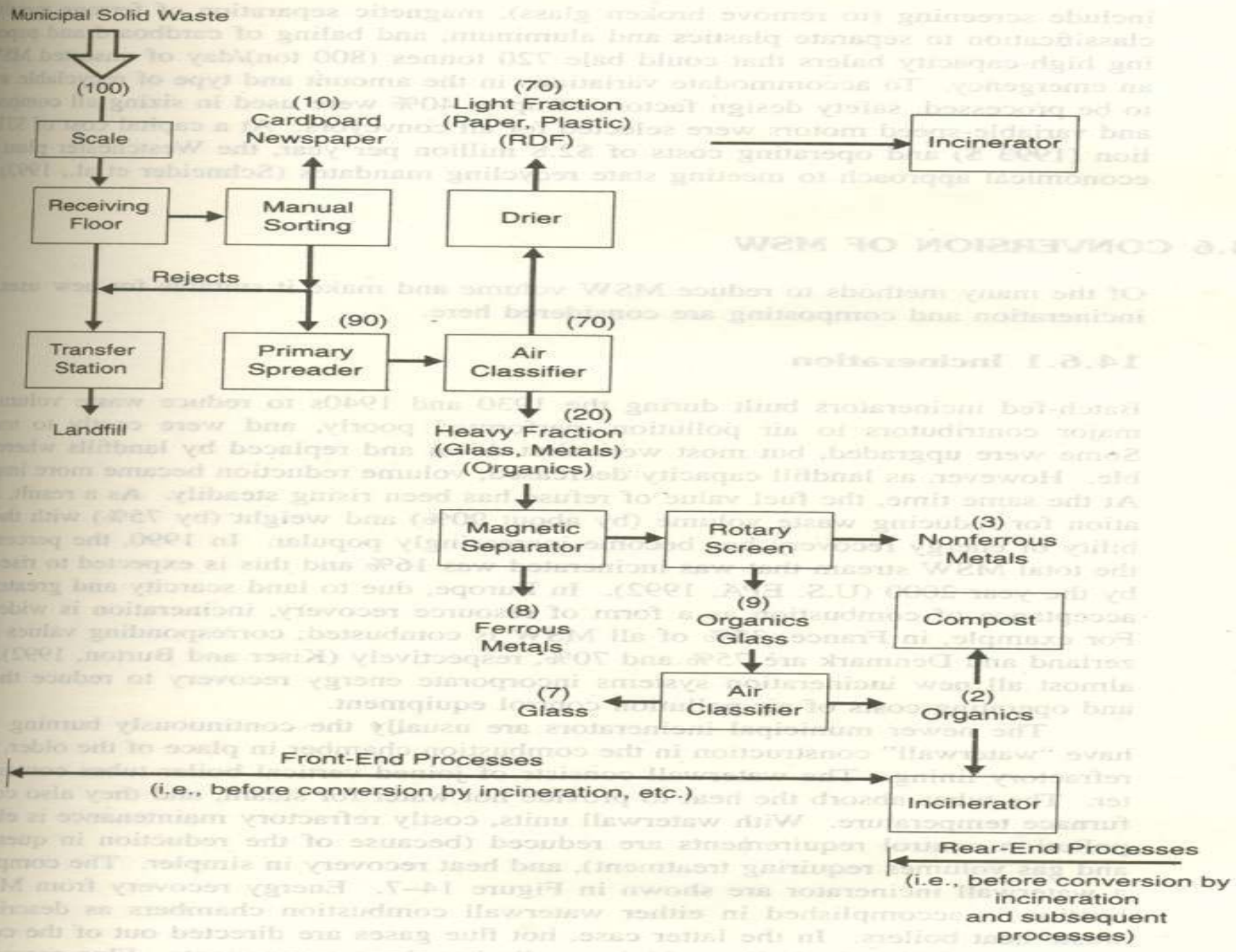


Figure 14–6 Flow diagram for a typical resource recovery plant.

Note: Figures shown in parentheses are approximate percentages handled (dry weight).

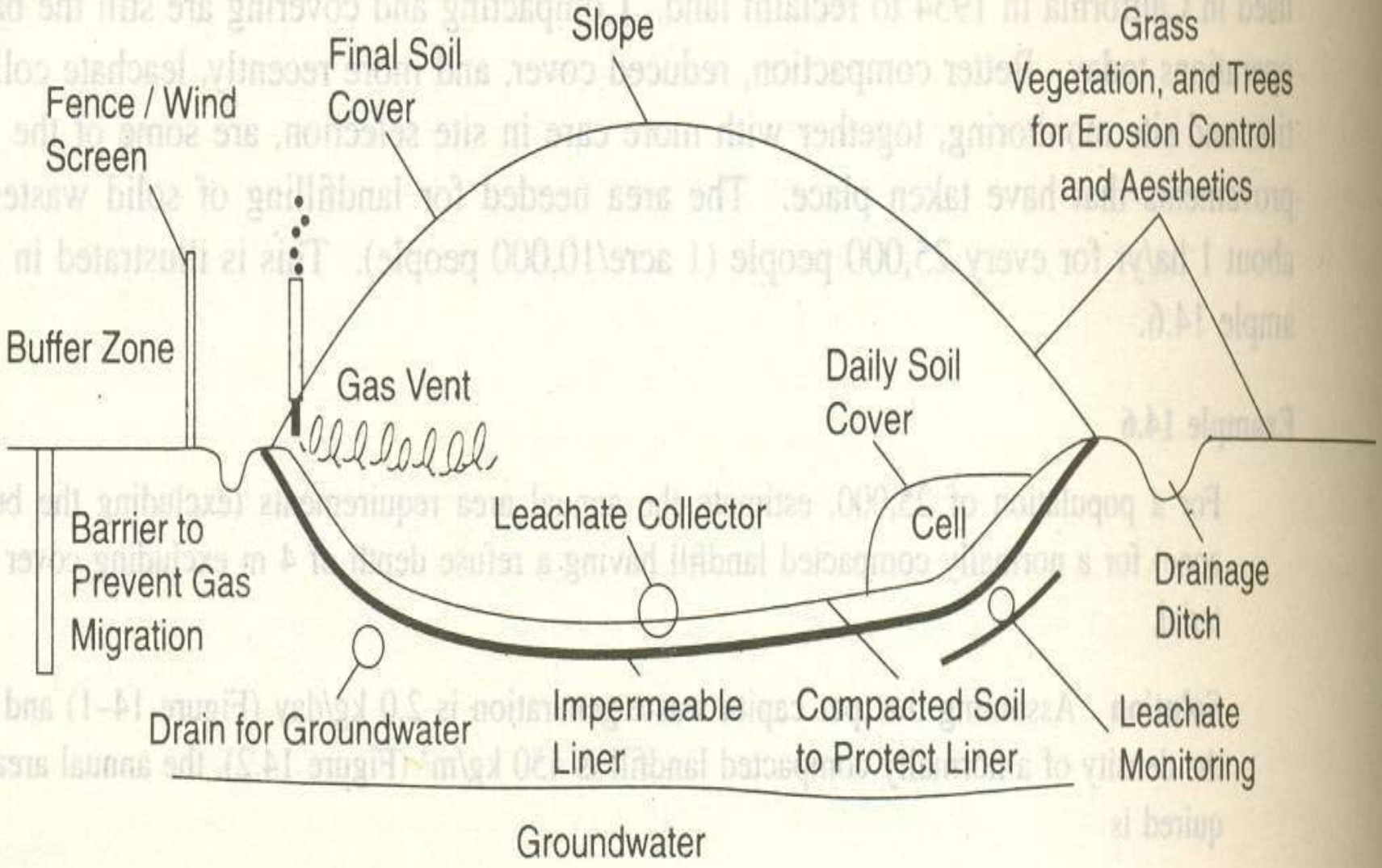


Figure 14–8 Cross section through a sanitary landfill.

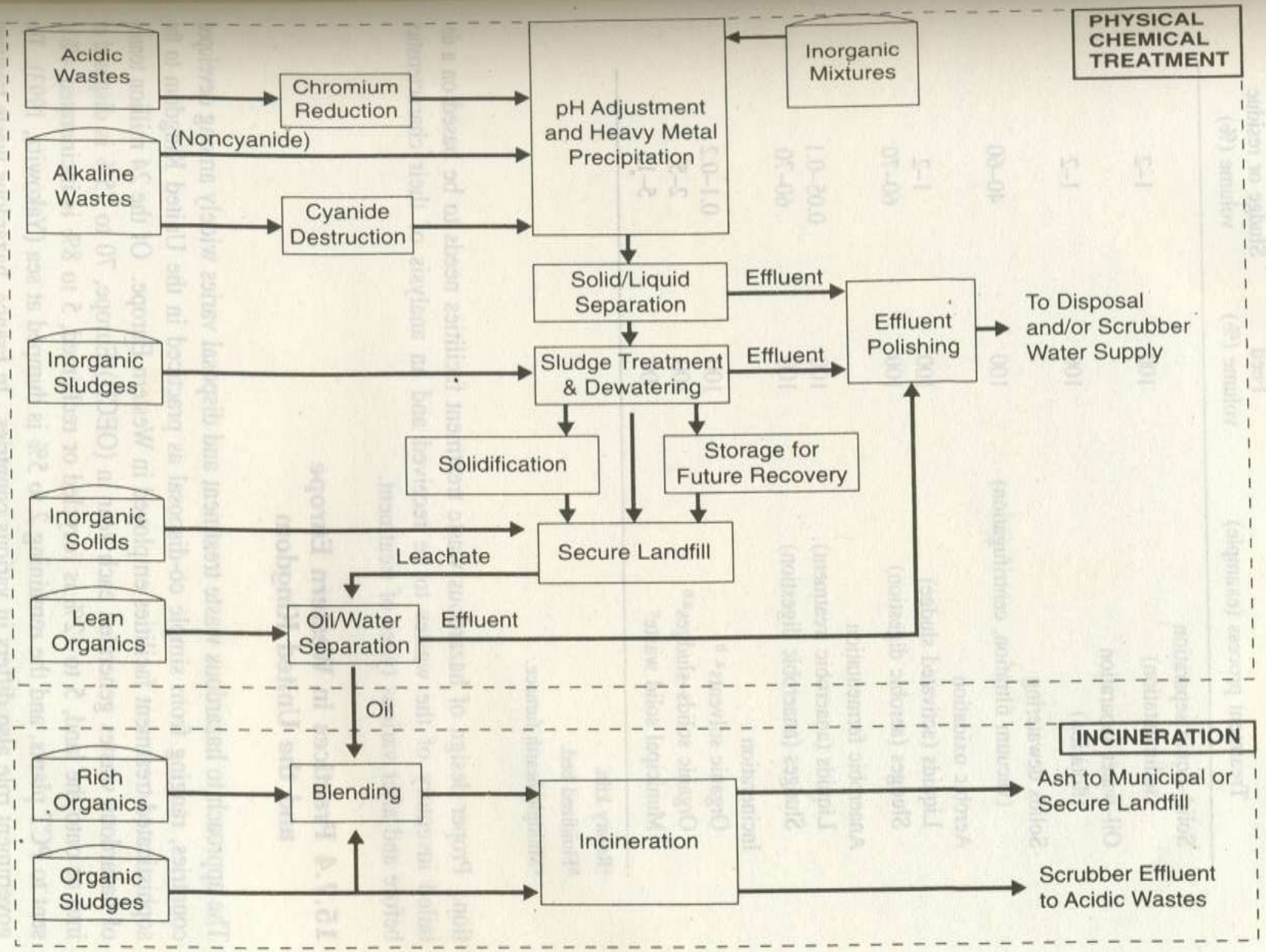


Figure 15–10 Typical components in a hazardous waste treatment facility.
Source: Henry and Martini (1982).

- Thank you