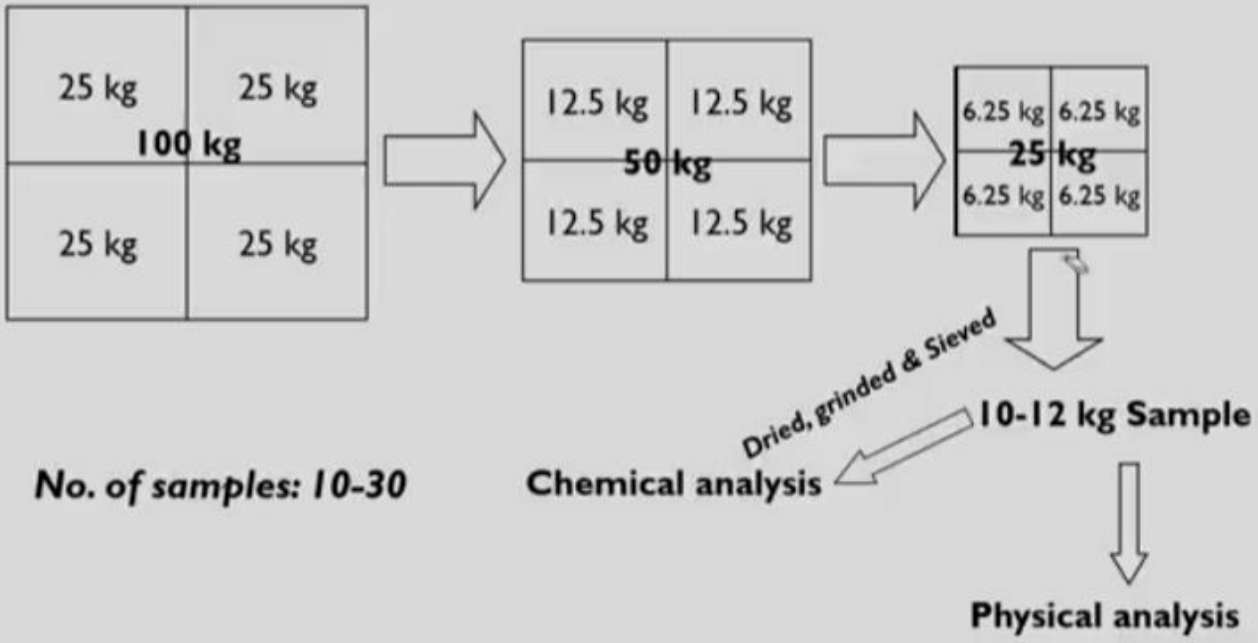
SAMPLING AND CHARACTERIZATION OF SOLID WASTE

Sampling: Quartering Method



- Sampling should be done for all 4 seasons, 7 days a week and at least twice in a season

Waste Characteristics: Physical

Compositional Analysis

- The wastes are separated on the basis physical properties such as dry, wet, paper, glass, metal, household hazardous, construction and mixed/ miscellaneous.
- They are weighed and are represented as a fraction of total waste.

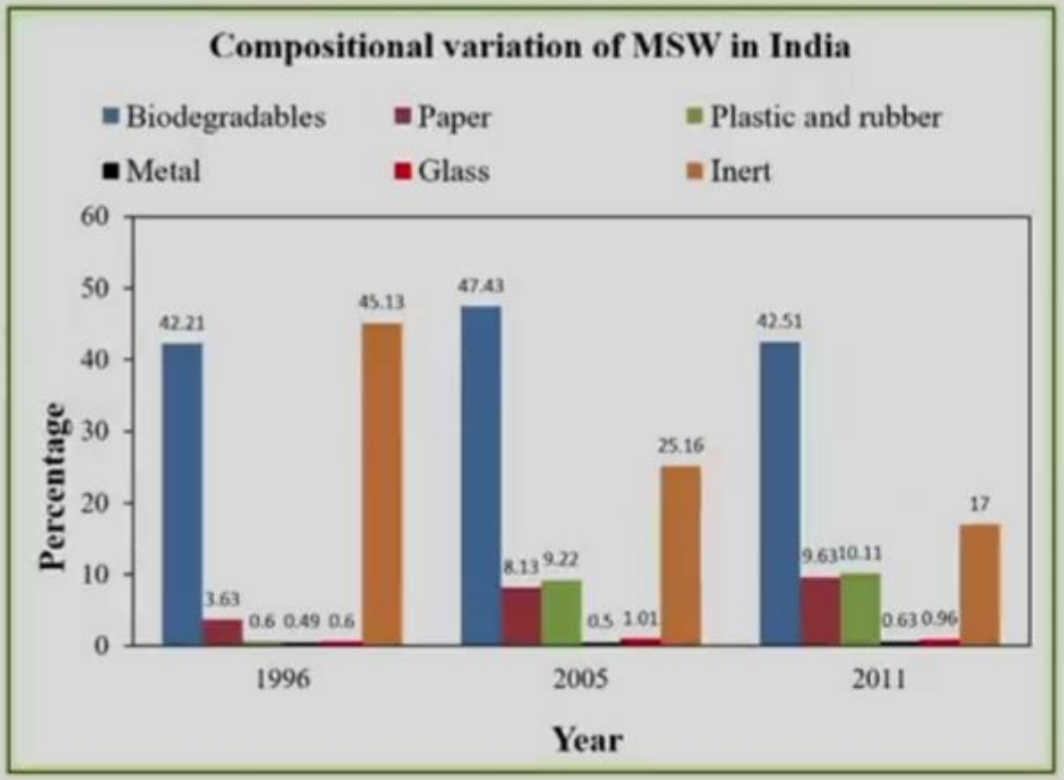
Importance of compositional analysis

- Selection and operation of equipment and facilities.
- Design of disposal facility.

Compositional variation

Variation in composition depends on:

1. **Location**: The commercial activity present, the food type, hilly or plane, and warm or cold.
2. **Season**: One of the key factors affecting the generation and composition of residual waste.
3. **Economy**: Fraction of dry waste generated from HIG households is high compared to that of LIG households.



Source: Planning Commission Report, 2014

Specific Weight

- Specific weight is defined as the weight of a material per unit volume. $Specific\ weight = \frac{weight}{volume}$
- Generally, higher waste density (400-600 kg/m^3) is observed in India may be because of high amount of inert material.
- It is helpful to know the collection vehicle capacity and landfill capacity also.
- It is often reported as loose, as found in containers, uncompacted, or compacted.
- It varies with season of the year, geographic location and length of time in storage.

Typical specific weight values of Asian countries

Components	Density (kg/m^3)	
	Range	Typical
Food wastes	130-480	290
Paper	40-130	89
Plastics	40-130	64
Yard Wastes	65-225	100
Glass	160-480	194
Tin cans	50-160	89
Aluminum	65-240	160

Particle Size

- The size and distribution of the waste material are an important consideration in the recovery of materials, especially with mechanical means such as trommel screen and magnetic separator.
- The size of the waste component maybe defined by one or more of the following equations:

$$S_c = l$$

$$S_c = \frac{l+w}{2}$$

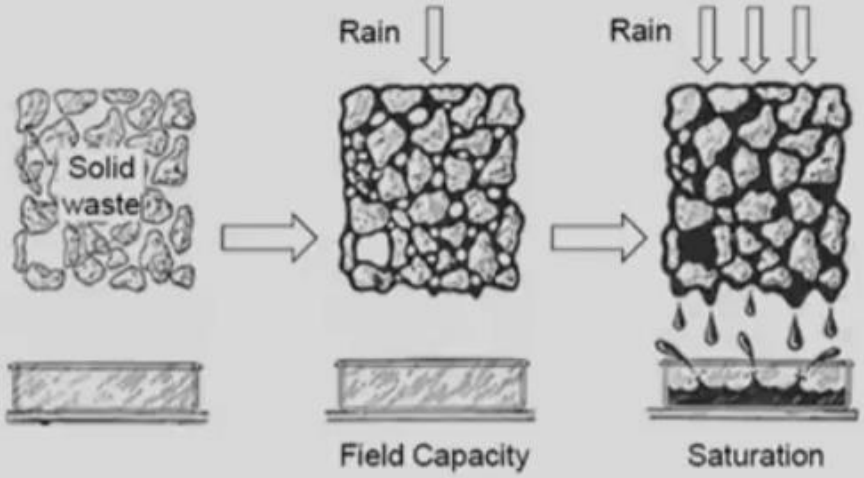
$$S_c = \frac{l+w+h}{3}$$

$$S_c = (l \times w)^{\frac{1}{2}}$$

S_c = size of the component (mm)
l = length (mm)
w – width (mm)
h = height (mm)

Field Capacity

- The field capacity of solid waste is the total amount of moisture that can be retained in the waste sample subject to the downward pull of gravity.
- It is very important in determining the formation of leachate in landfill.
  - ✓ Water in excess of the field capacity will be released as leachate.
- The field capacity varies with the degree of applied pressure and the state of the decomposition of the wastes.



Waste Characteristics: Chemical

Information on the chemical composition of the components that constitute MSW is important in evaluating alterative processing and recovery options.

Proximate analysis

The *proximate analysis* is important in evaluating the combustion properties of waste or waste derived fuel (refuse derived fuel). The fractions of greatest interest are:

Moisture content:

- ✓ Loss of moisture occur when heated to 104°C for 24 h.
- ✓ Moisture adds weight to the waste/fuel without increasing its heating value and the evaporation of water reduces the heat released from the fuel.

Ash:

- ✓ Weight of residue after combustion at 550°C (for 2 hours) in an open crucible.
- ✓ Ash also adds weight without releasing any heat during combustion.

Volatile matter:

- ✓ Additional loss of weight on ignition at 700-950°C in a covered crucible.
- ✓ Volatile matter is that portion of the waste that is converted to gas before and during combustion. The gases are passed through a combustion chamber where rapid combustion occurs.

Fixed carbon:

- ✓ Combustible residue left after volatile matter is removed.
- ✓ Fixed carbon represents the carbon remaining on the surface of grates as char. Waste or fuel with a high proportion of fixed carbon requires a longer retention time on the furnace grates to achieve complete combustion than does waste/fuel with a low proportion of fixed carbon.

Moisture (%) + Ash (%) + Volatile (%) + Fixed carbon (%) = 100%

Ultimate analysis

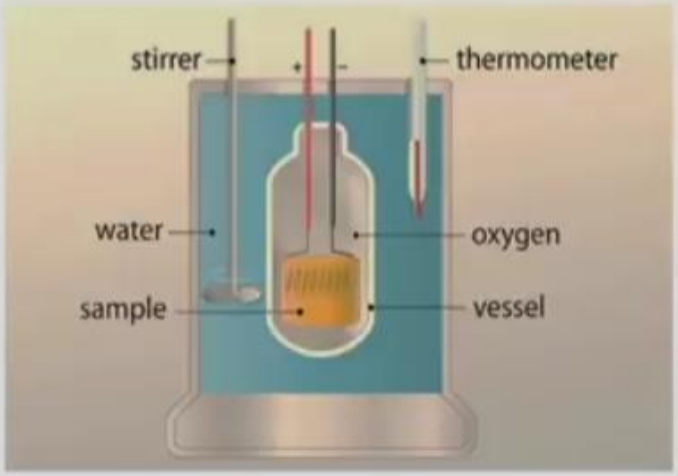
- ✓ Ultimate analysis of waste is carried out to determine the proportion of carbon, hydrogen, oxygen, nitrogen and sulphur (C, H, O, N and S).
- ✓ The *ultimate analysis* is useful during mass balance calculation for chemical and thermal process.
- ✓ The results are used to characterize the chemical composition of organic matter of MSW.
- ✓ Also used to define proper mix to achieve suitable C/N ratio for biological conversion processes.

Energy Content (Calorific Value)

The energy content of the organic components in MSW can be determined by:

- using a full scale boiler as a calorimeter,
- using laboratory bomb calorimeter, or
- Calculation, if elemental composition is known.

Because of difficulty in instrumenting a full-scale boiler, most of the data on the energy content of the organic components of MSW are based on the results of bomb calorimeter tests.



BOMB CALORIMETER

In India energy content measured in kcal/kg unit.

1 J = 0.24 g cal

Energy content (BTU/lb): 145 C + 610 (H_2-1/8 O_2) + 40 S + 10 N

1 BTU = 1055.06 J
2.326 BTU/lb = 1 kJ/kg

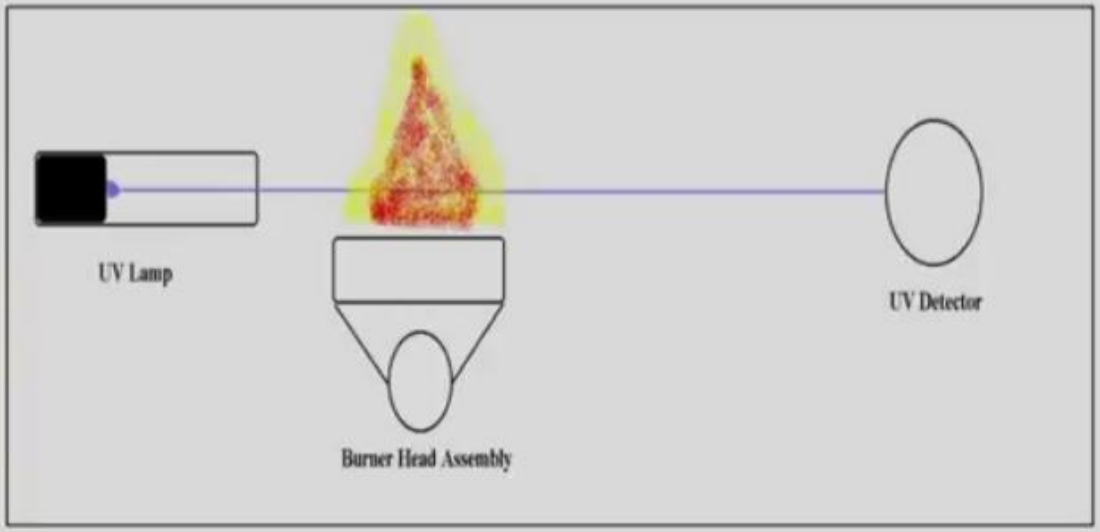
C, H, O, S, N – percentage by weight

Metal content (Trace elements)

The metal content (i.e. Cd, Cr, Hg, Ni, Zn, Mn, Pb, As etc.) should also be determined because of its potential harmful environmental effects.

Fig: Atomic absorption spectroscopy

Principle of AAS



Waste Characteristics: Biological

The most important biological characteristic of the organic fraction of solid waste is that all of the organic components can be converted biologically to gases and relatively inert organic and inorganic solids. The production of odor and generation of flies are also related to the putrescible nature of the organic materials.

Volatile Solids

- Volatile solids content is often used as a measure of the biodegradability of the organic fraction of solid waste.
- It is not an exact indicator of biodegradability.
- Some organic constituents are highly volatile but low in biodegradability. Eg: newsprint.

Biodegradable Fraction (BF)

Alternatively, the lignin content of a waste can be used to estimate the biodegradable fraction, using the formula:

$$BF = 0.83 - 0.028\,LC$$

BF = biological fraction expressed on a VS basis,

0.83 & 0.028 = empirical constant

LC = lignin Content of the VS expressed as a percent of dry weight

Biodegradable fraction of a typical MSW of a city in India

Component	Percent of MSW	Percent of each component that is biodegredable
Paper and paperboard	37.6	0.50
Glass	5.5	0
Ferrous metals	5.7	0
Aluminum	1.3	0
Other nonferrous metals	0.6	0
Plastics	9.9	0
Rubber and leather	3.0	0
Textiles	3.8	0.5
Wood	5.3	0.7
Other materials	1.8	0.5
Food waste	10.1	0.82
Yard trimmings	12.8	0.72
Miscellaneous inorganic	1.5	0.8
Total	100	

Breeding of Flies

- During warm climates, breeding of flies is an important factor to be considered for the on-sight storage of wastes.
- Flies can mature in less than two weeks after the eggs are laid.
- The larval (maggot), once developed, is very difficult to remove from the containers.

Odour

- Typically, the formation of odours indicates the anaerobic decomposition of the readily decomposable organic components found in solid waste are emptied.

THANK YOU