

**Solid Waste Management,  
Characterization and  
Its Evaluation for Potential  
Methane Generation: A Case Study**

# What is Solid Waste?

- Solid waste means any garbage, trash, waste tire, sludge from a waste treatment plant, water supply treatment plant and other discarded material, including solid, liquid, semisolid or contained gaseous material.
- Arises from human and animal activities.



- In other words, solid wastes may be defined as the organic and inorganic waste produced by various activities of the society and which have lost their value to the first user.

# Types of Solid Waste

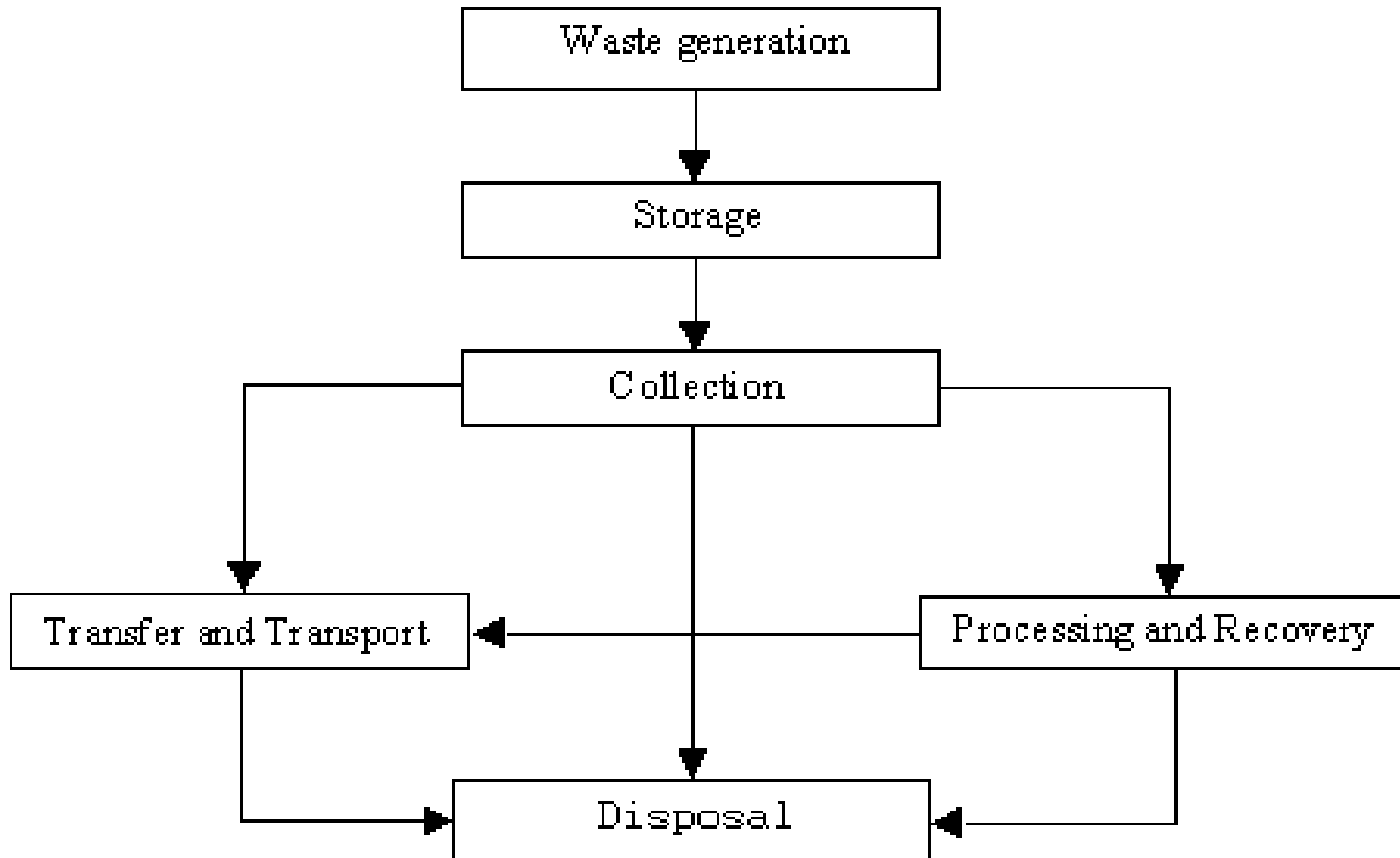
- Municipal solid waste: MSW consists of household waste, construction and demolition debris, sanitation residue.
- Hazardous waste: Industrial and hospital waste is considered as hazardous waste as they contain toxic substances.
- Infectious waste: Biomedical waste or hospital waste, generated during diagnosis treatment etc. Include sharps, chemical wastes, discarded medicines and human excreta etc.

# Why We Need SWM?

- With increasing urbanization and changing life styles, Indian cities now generate 8 times more solid waste than they used to in 1947.
- Generation of waste per capita increases from 1 to 1.33 % per year.
- Throughout the country, more than 1/3<sup>rd</sup> of all waste generated remains unclear on the streets and what is collected is dumped in insanitary dumpsites polluting ground water and degrading the environment.
- Poor waste management practices affect the health of the human.
- Solid wastes have been found to clog up drains leading to flooding.

- Impart multidimensional threats as serious health and environmental problem.
- Poorly maintained landfill sites are prone to groundwater contamination.
- Decomposition of organic materials produces different gases one of which is methane, it may cause explosions and also contributes to global warming.
- Some solid wastes would degrade or leach chemicals over time with long-term effects.
- Burning of waste results in air and soil pollution.
- There is an overall lack of in-country know-how to deal with the disposal of the waste.

# Flow chart of the functional elements in SWM



- **Storage**

- **At source:** stored at the source until they are picked up by the waste collectors.
- **At community level:** community bins are used in narrow and crowded market areas.
- **At transfer stations:** established for economic reason. Used as collection and sorting points for recycling materials.

- **Collection Method**

- **Door to door collection:** used in narrow streets where a collection truck cannot reach individual houses. The households place the filled containers outside their doors when the waste collectors arrive.
- **Curbside collection:** used in wider streets, where the collection trucks can pass through conveniently. The waste collectors collect the waste from the curbsides or empty the containers into the vehicles as it passes through the street at a set time and day. Practiced in Kanpur.
- **Block collection and community bins:** collection vehicles arrive at a particular place at a set day and time to collect waste from the households. Householders bring their containers and empty directly into the vehicles. Also known as Delhi bins.

	Collection Methods		
Sustainability Indicators	Door to Door Collection	Curbside Collection	Block Collection & Community Bins
Area improvement	✓	✓	✓
Convenience of the people	✓	X	X
Convenience of the staff	X	✓	✓
Handling the extra waste during festival	X	✓	✓
Frequency and Reliability	X	✓	X

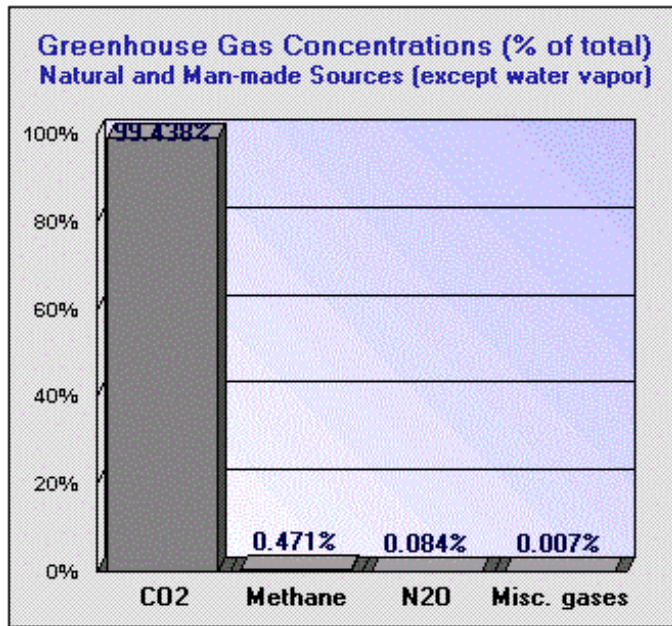


- **Treatment and treatment options**
  - **Reuse:** high quality materials and used products are cleaned or transformed for reuse. Eg. Old newspaper.
  - **Recycle:** recyclable materials are traded for recycling purposes.
  - **Organic waste** can be converted into compost. Used as manure.
- **Disposal and disposal method**
  - Non engineering disposal
  - Sanitary landfilling
  - Composting
  - Incineration
- **Sanitary landfilling**
  - A sanitary landfill is a method of solid waste disposal that functions without creating a nuisance or hazard to public health or safety.
  - Engineering principles are used to confine the waste to the smallest practical area, reduce it to the smallest practical volume, and cover it with a layer of compacted soil (clay) or specially designed traps at the end of each day of operation, or more frequently if necessary.
  - It is this covering of the waste that makes the sanitary landfill sanitary.
  - The cover effectively denies continued access to the waste by insect, rodents, and other animals, and it also isolates waste from the air.
  - The use of cover minimizes the amount of surface water entering into the waste and gas escaping from it.

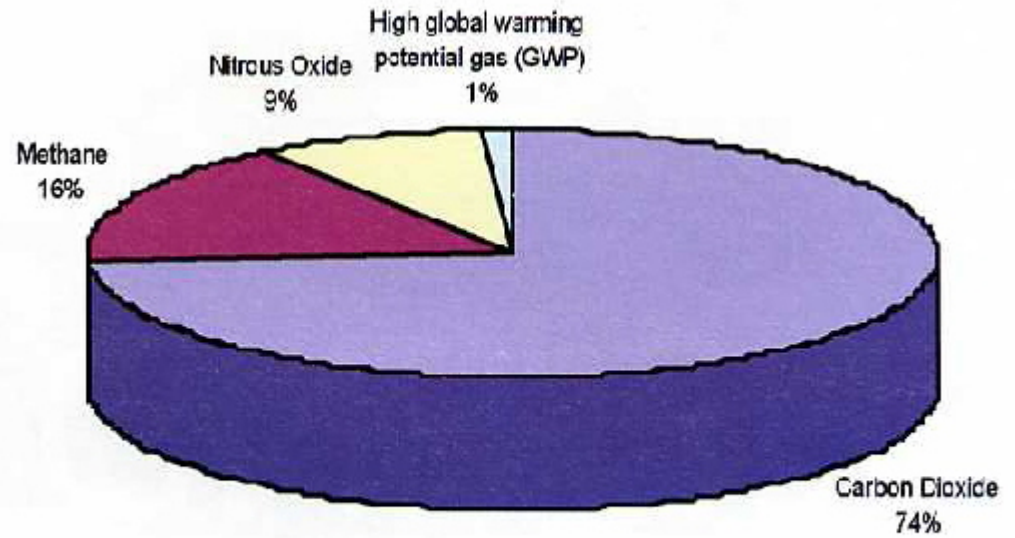
- Composting
  - Composting is a biological process of decomposition carried out under controlled conditions of ventilation, temperature, moisture and organisms in the waste themselves that convert waste into humus-like material by acting on the organic portion of the solid waste.
- Incineration:
  - Incineration is the process of destroying waste material by burning it.
- Problems with landfills disposal:
  - Groundwater or surface-water pollution:

If waste buried in a landfill comes in contact with water percolating down from the surface or with groundwater moving laterally –effect of leachates occur which created obnoxious, mineralized liquid capable of transporting bacterial pollutant.
  - Methane gas emission:

Another possible hazard from landfills is uncontrolled production and escape of methane gas, which is generated as organic waste decomposes. If methane gas is properly managed, (if not polluted with toxic materials) then it can be used as a resource.

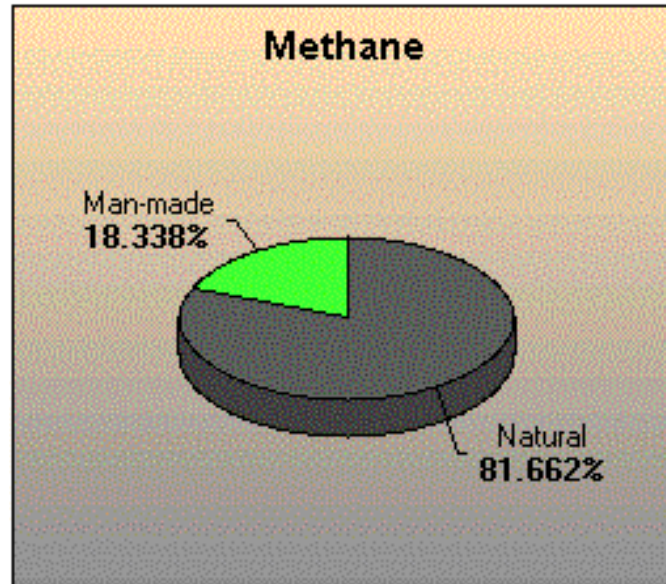


**Fig. 1 Important greenhouse Gases**



**Global greenhouse gas emissions in 2000**

**Fig. 2. Global greenhouse gas emission in 2000**



**Fig. 3. Methane contribution by natural and man made source.**

# Case Study

- Delhi, with a population approaching 14 million, is estimated to generate about 7000 metric tons of garbage daily.
- This waste is deposited in landfill sites. Landfill site emitted gas which consist of 50–60 vol. % of methane and 30–40 vol.% of carbon dioxide and other gases.
- The amount of methane produced from the Gazipur landfill site was estimated by applying first order decay model which can be expressed as,

$$\alpha_t = -1.87AdC/dt \dots\dots\dots(1)$$

where:  $\alpha_t$  = the landfill gas formation at a certain time (m<sup>3</sup>/year)

A = amount of waste deposited (ton)

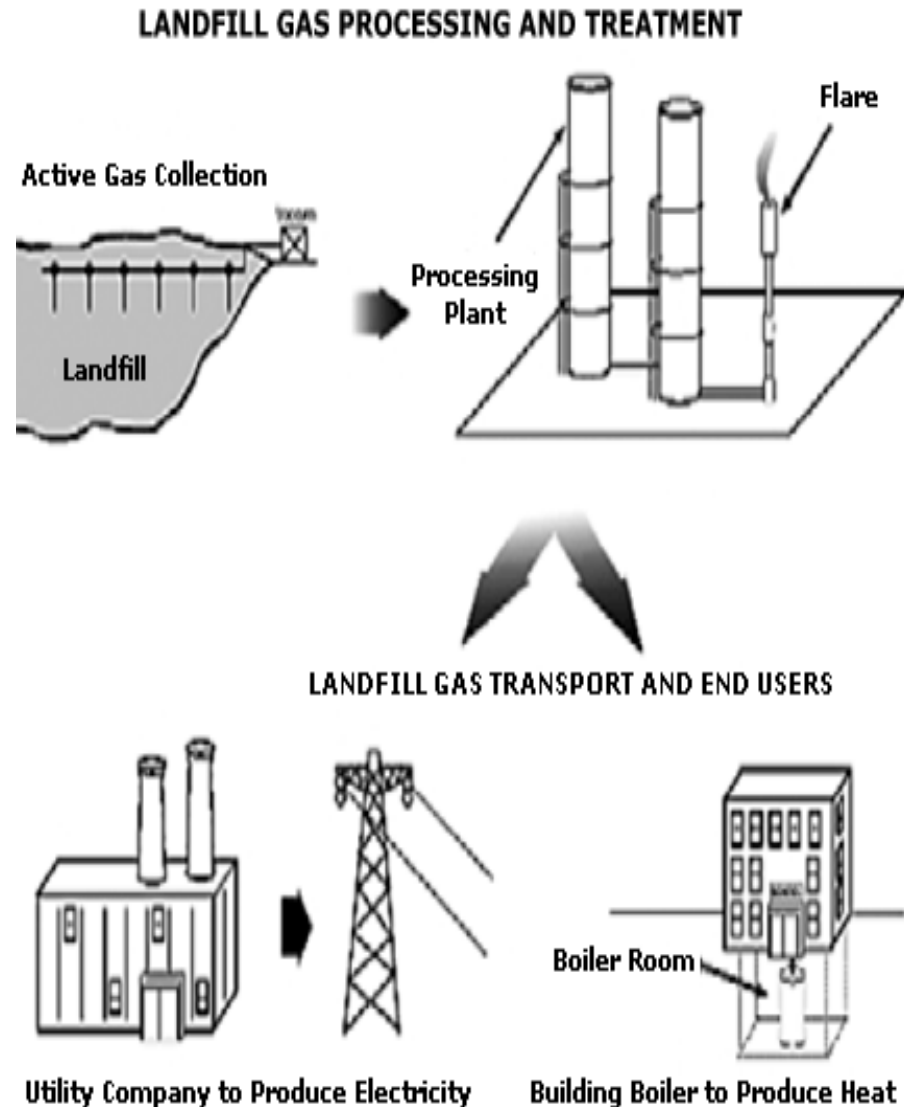
dC/dt = rate of carbon degradation, (where C (kg/ton) is the amount of organic carbon that can be converted into gas per ton of waste.

# Assumptions and Shortcoming

- Model assumes that the factor limiting the rate of methane production at a landfill is the amount of carbon remaining in the landfill.
- It assumes that other factors affecting the decomposition process are not limiting the rate of methane production.
- Due to the heterogeneity of the waste composition, anaerobic decomposition can be hindered in specific microenvironments due to unsuitable environmental conditions.
- The major problem is the data available for the study as they bore hole only in a limited area. Waste deposited in landfills are not uniformly distributed so we used a grid system to overcome this difficulty.

# Possible solution from landfill gas

- The gas can be recovered through an active system of wells, which are drilled into the waste or are placed in position at the time of landfilling. The wells are connected by a main collection header, which directs the collected gas to a point to be processed.
  - First to produce electricity with engines, turbines, and other technologies.
  - A second option is to process the LFG and make it available as an alternative fuel to local industrial customers or other organizations that need a constant fuel supply.
  - A third option is to create alternative vehicle fuel with LFG.





# Example

- GEETANJALI ENVIRONMENT IMPROVEMENT SOCIETY
  - Sub: Development of collection, segregation, and recycling of waste.
  - Started a model project of waste management at house to house level.
  - Reducing the burden of waste collection of Municipality.





# Conclusions

- Considering the impact of methane in global warming, it is necessary to control methane gas emissions from landfill sites.
- Landfill gas as an alternative potential source of energy.
- Everyone is part of the solid waste generation problem and everyone shall also be part of the solution of proper waste management- solution depends upon collective human action and efforts.
- So work towards a **ZERO WASTE AND ZERO POLLUTION FUTURE.**

**Thanks  
for your  
kind attention**