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Odour Nuisance In Municipal Landfill Site

Dr. Dinesh Kumar Swarnkar
Professor, Deptt. of Civil Engineering,Modern Institute of Technology & Research Centre, Alwar-Rajasthan, India
E-mail- dineshswarnkar2010@gmail.com

Abstract
Clean and natural air is treated as fundamental rights throughout the world, and also essential for sustainable living conditions. Presence of any type of air pollutant or odour affects the natural quality of air. The notification by the Ministry of Environment, Forest and Climate Change (MoEFCC), Solid waste Management Rules 2016, identified odour as a public nuisance. Out of all available management options for solid waste management, landfill disposal is the most commonly used waste management worldwide. Municipal solid waste landfill sites are the one of the odour generating activity, which having frequent complaints about unpleasant odour from nearby localities that are affected. Due to such reasons, pollution CPCB issue guidelines to manage the odour from these landfill sites and address it through a scientific process. Though regulations for odour control are at initial stage in India.
Keywords: *Odour, Landfill, Nuisance.*

1- INTRODUCTION

Land filling is, today, the most common and popular method used for municipal solid waste disposal. Whenever land is available, land fill sites for municipal solid waste management is most economical and complete disposal method. In spite of this, odour generation in one of the common problem associated with. Odour is basically a perception of smell, it may range on Hedonic tone scale from -4 (very unpleasant like rotten smell of garbage) to +4(very pleasant, like fragrance). Though the effect of odour differs from person to person but at sufficiently high concentrations, odorous substance may have a direct effect on human health. It generally leads to various medical problems such as vomiting, headaches, stress, anxiety, frustration etc.

2- ODOURANT

Odourous gaseous emission from MSW landfill contains odourants of various types. As per Practice Worldwide, they are categorized into five groups:

i. Reduced Sulphur Odourants (RSO) i.e. (Methyl Mercaptan, Ethyl Mercaptan, Dimethyl Sulphide, Hydrogen Sulphide)
ii. Volatile fatty acids
iii. Carbonyls
iv. Nitrogenous odourants (inorganic)
v. Volatile organics (non-methanogenic organics (NMOC) & Contaminants of Potential Concern (COPCS)

Various odourants and their smells are given in table bellow

Table: Odourants and offensive odour

S. No.	Odourant (compound name)	Description of offensive odour
1	Ammonia	Pungent, Irritating
2	Hydrogen sulphide	Rotten eggs
3	Methyl Mercaptan	Rotten Cabbage
4	Ethyl Mercaptan	Decayed Cabbage
5	Dimethyl sulphide	Decayed Cabbage
6	Butyric acid	Rancid butter
7	Methane	Odourless
8	VOCs (total)	Odour influenced by the dominating compound

3- LANDFILL SITE OPERATIONS EMITTING ODOUR

Processes which emit odours in landfill sites may be classified as in three categories they are

Physical processes – few of the daily physical activities emit odours in varying degree are

a. Arriving and queuing of hauling trucks carrying MSW
b. On-site vehicles and heavy equipment deployed to handle MSW
c. Working face
d. Temporary cover
e. Access road construction
f. Leachate collection systems
g.Leachate treatment systems

chemical processes - ex. generation of landfill gas .

biochemical processes - decomposition of organic waste in sanitary landfill is a complex process achieved through sequential chemical and biochemical reactions. Organic fractions of MSW easily decompose leading to generation of landfill gases and liquids. Initially, the biochemical reactions in a sanitary landfill take place under aerobic condition (in presence of oxygen), producing carbon dioxide (CO2) as the principal constituent. As most of the available oxygen (O2) is exhausted, later decomposition reactions continue under partial aerobic to anaerobic conditions, where the landfill gases generated are CO_2, methane (CH_4), trace amounts of ammonia (NH_3), and hydrogen sulphide (H_2S). Based on the generated landfill gases and physico-chemcial conditions, biochemical reactions for life time of sanitary landfill five sequential phases can be identified. Duration of each phase, and nature and quantity of various landfill gases generated are primarily dependent on the amount of biodegradable organic matter present in the waste.

Phase I – Initial Adjustment: This is the first phase in the life cycle of a sanitary landfill during which the organic constituents easily in the MSW undergo microbial decomposition under aerobic conditions, typical duration of this phase is few hours to about a week from the time of waste emplacement (Tchobanoglous et al., 1993).

Microorganisms – the agents in biodegradation – mainly come from the daily cover soil. Sometimes wastewater treatment plant sludge and re-circulated leachate also act as sources of microbial necessary for bio-decomposition of the waste. Primary gases generated in Phase I are N_2 and O_2 that occur in the same proportion as in the atmosphere.

Phase II – Transition Phase: In this phase partly aerobic and partly anaerobic condition occurs within the landfill.

Oxygen, already consumed and depleted during Phase I, leads to mostly anaerobic condition. Nitrate and sulphate act for generating nitrogen and hydrogen sulphide respectively.

Any leachate formed during this transition phase is generally acidic in nature having pH range 6 to 7(Pohland and Kim, 1999), due to the generation of organic acids and high concentrations of CO2 within the landfill. Duration of this phase is approximately 1 to 6 months.

Phase III – Acid Phase: In this phase, due to increase in microbial activities, generation of of organic acids in considerable amounts and minor quantities of hydrogen (H_2) gas. Acid phase is a three-step process in which the first step involves ***hydrolysis*** where energy source compound for micro-organism formed by enzyme-mediated transformation of lipids, proteins, nucleic acid.

The second step called acidogenesis, involves biochemical conversion of higher mass compounds(from first step reaction), into lower molecular-mass intermediate compounds, mainly acetic acid (CH_3COOH) with small concentrations of fulvic and other complex organic acid(Tchobanoglous el al. 1993).

The third step results in conversion of the intermediate compounds through microbial activities, into simpler products, mainly CO_2 and CH_4 that attain its peak in phase IV. The micro-organisms, referred to as acidogens or acid formers, are dominated by facultative and obligate anarobic bacteria.

Leachate form in Phase III is acidic, with pH of 5 or less. The lower pH facilitate many inorganic constituents, including heavy metals to dissolve in the leachate that makes it highly toxic. Time period of this phase is approximately 3 months to 3 years.

Phase IV – Methane Fermentation Phase: This phase is unique for its methane generation. A specific group of anaerobes, called methanogens**,** convert third phase compound CH_3COOH and H_2, to CH4 and CO2. the rate of acid formation is substantially reduced that causes the pH of the leachate to increase toward neutral values (between 6.8 and 8) during Phase IV (Tchobanoglous et al., 1993). Rise of pH ultimately causes precipitation of some inorganic constituents from leachate. Time duration of this phase is approximately 8 to 40 years, and the principle gases are CH_4 and CO_2.

Phase V – Maturation Phase: Maturation phase is the last phase in the life cycle of a sanitary landfill in which, microorganisms start decomposing other difficult to biodegrade materials. However, the rate and extent of biodegradation depend on availability of moisture. CH_4 and CO_2 are the principal product generated during this phase; and small amounts of O_2 and N_2 may also be found depending on the landfill closure measures (Tchobanoglous et al., 1993). Typical duration of this phase is approximately 1 to 40 years.

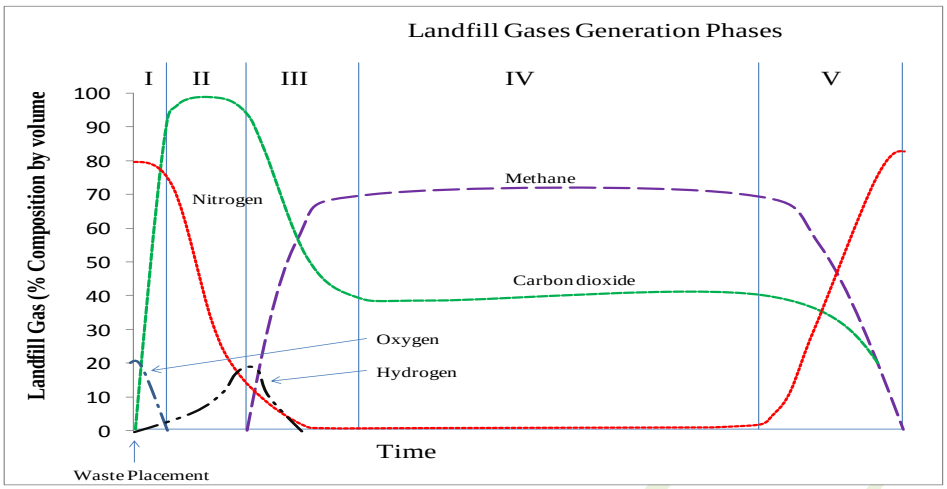

Figure – Schematic representation of landfill generation phases. (U.S. EPA, 2004)

4- IMPACT OF ODOUR NUISANCE

Odour sensing cells are linked to areas of the brain that control emotions and memory processes. So offensive odours can impacts on the health and well-being of humans, degree and effects depending upon duration of exposure as well as concentration of odourant Also, an individual's health may suffer indirectly due to stress associated with odour impact. Some social problems as well as financial problems also occurs due to odour nuisance.

Medical problems

• Vomiting, Headaches, Nausea

• Stress, anxiety, frustration

Social problem

• Restriction in outdoor activities

• Children unable to sleep due to odour in bedrooms,

• Discomfort for infirm elderly people.

Financial problem

• Rental value of houses and shops reduces

• resale value of property reduces considerably.

Various studies on the toxicity of odorous substances established that following odourants generated from Municipal solid waste may impart health hazard. The impact of different odourants tabulated below

Table-Impact of different odourants on human health

S. No.	Odourant (compound name)	Concentration	Exposure of time	Impact
1	Ammonia	low concentrations	Long exposure	irritation of the bronchi and lungs, chronic bronchitis or emphysema
2	Hydrogen sulphide	10 and 20 ppm	low exposure	irritation of the eyes
			Long exposure	respiratory tract
		1000–2000 ppm	low exposure	loss of consciousness and death
3	Mercaptan	low concentration	low exposure	provokes intolerable gastric effects
			longer	interfere with blood haemoglobin

			exposure time	and consequently with the oxygen transport process, causing temporary cyanosis.
4	Amines	low concentrations	Low exposure	Irritant effects on the mucus of the primary respiratory tract,
		High concentrations	High exposure times	possible irritation of the eyes with subsequent corneal damage
5	Organic acids	low concentrations	Low exposure	not lead to any pathogenic effects
			High exposure	irritation of the respiratory tract

5- ODOUR PREVENTION

To Prevent/minimize odour release from landfill site various techniques are available, as odour control is not a once-off activity. It requires a constant re-evaluation of control techniques as part of the odour management plan. Few of steps for odour control that may be adopted are

1. Waste Acceptance

Materials which promote the generation of gases should be excluded. For example,bio- degradable wastes should be separated from landfill waste for composting.

2. Covering of wastes

Tipping areas should be kept as small as possible to minimise the effects of wind.Waste must be covered earlest possible.

3. Landfill Gas management

An effective landfill gas management plan in combination with good operational practice (i.e. not leaving odorous waste uncovered) may reduces releases. preventing the expansion of the waste, including temporary and/or phased capping of the site, is an essential gas control measures.

4. Leachate management

Odour from a leachate treatment plant should be manage to prevent odours beyond the boundary of the site. Leachate sumps/wells should be properly sealed.

5. Monitoring

Standard procedure includes - gathering of weather conditions data, such as atmospheric pressure, rainfall, wind speed and direction and temperature of air. periodic inspection
of pipe-work and other relevant infrastructures,filters, adequacy of capping by trained persons.

Reactive procedure includes- Olfactory "sniff testing" at the boundary of landfill site or at some other location .Collection and analysis of air samples to identify odour sources.

6- FURTHER WORK

Recent odour related studies carried out focussed on examining odour creation, odour sampling and measurement. Future need is to identifying odour constituents and developing cost effective means of monitoring odorous constituent . A urgent need of producing guidance on odour control for site managers, identifying the key parameters associated with odour and rationalising the effectiveness of existing odour control techniques and practices.

It is also required to gain the knowledge of the specific odorant and selection of odour suppressant or masking sprays in cost effective manner.

7- REFERENCE

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