Municipal Solid Waste Management and Disposal

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Abstract: **Due to fast urbanization and industrialization, India is facing many problems such as environmental degradation, growing water demand, depletion of water resources due to overexploitation, decrease in per capita water availability in terms of quality and quantity. Most of the untreated waste water reaches the rivers everyday and pollutes them. Apart from these issues solid waste management is also an alarming problem. Solid waste is the unwanted solid materials generated mostly from residential, industrial and commercial activities. Municipal solid waste is generally a domestic waste such as kitchen, food, paper, plastic waste etc. It contains mostly biodegradable (kitchen waste etc.) and recyclable (newspaper and plastic waste etc.) waste.**

Solid waste also includes hazardous waste generated by chemical and pharmaceutical industries. Everyday huge solid waste is generated from domestic and other activities which require proper collection and disposal. At present, disposal is done mainly by land filling at dumping sites. Modern disposal facilities are less harmful to the environment and human health. But due to a lack of suitable treatment facilities, limited financial resources and non availability of disposal sites proper management of solid waste is a challenge to the environmentalist and scientists. Solid waste is hazardous for the environment and responsible for air as well as surface and ground water pollution. When Leachate produced by open dumping sites (traditional system of waste dumping) meets the ground water, leachate pollutes it. Aquatic system is also disturbed by the surface water pollution. Proper management of solid waste eliminates or reduces the harmful impacts on the environment and human health up to a certain limit and supports green Gross Development Product (sustainable development) and improves quality of life. This paper deals with only municipal solid waste for the sustainable development and management.

Key words: Solid waste, management, Disposal

I. INTRODUCTION

"Solid wastes are the discarded leftovers of our advanced consumer society. This growing mountain of garbage and trash represents not only an attitude of indifference toward valuable natural resources, but also a serious economic and public health problem-**Jimmy Carter**". Waste can be considered as substance or objects which are disposed of or intended to be disposed of or are required to be disposed of (K.Sasikumar, 2009). Solid Waste is defined as a material that is cheaper to throw away than to store or use. Solid Waste is a serious problem that must be managed properly and timely. In many cities waste is either burned in pits, dumped in random locations, or disposed of in uncontrolled dumps without any treatment causing harmful impacts on environment and human health. Proper waste management not only helps protect human health and the environment but also preserve natural resources.

During manufacturing, distribution and life cycle of products, emission of green house gases takes place that affects the climate change. Decomposition of organic waste in landfills produces methane contributing climate change. Solid Waste Management is a collection, transportation, and disposal of garbage, sewage and other waste products. Waste management is the process of treating solid wastes and offers variety of solutions for recycling items that don't belong to trash. It is about how garbage can be used as a valuable resource. Waste management is something that each and every household and business owner in the world needs. Waste management disposes of the products and substances that you have used in a safe and efficient manner. Figure -1 below shows the waste management.

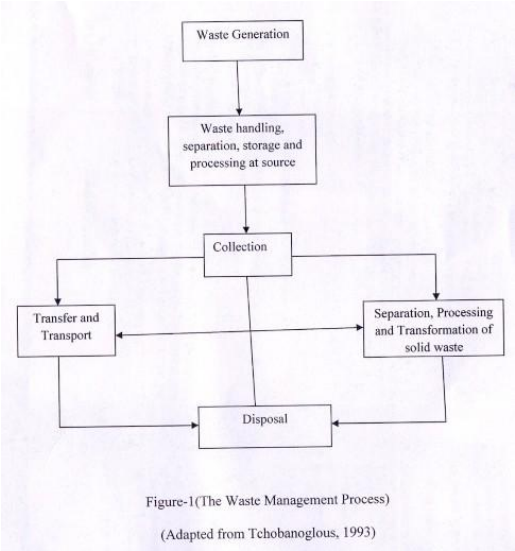

Figure-1(The Waste Management Process)
(Adapted from Tchobanoglous, 1993)

IV. TYPES OF WASTE (Khan and Ahsan, 2012)

- Residential and Commercial Waste
- Institutional Waste
- Industrial Waste
- Construction and Demolition Waste
- Municipal Services Waste
- Agricultural Waste
- Treatment Plant Waste
- Special Category Waste

V. MUNICIPAL SOLID WASTE

Municipal Solid Wastes include waste from residential, commercial and institutional areas, construction and

demolition wastes, and waste from municipal services.MSW is normally assumed to include all the waste generated by a community except the industrial waste. It may be Hazardous and Non hazardous. Hazardous waste possesses at least one of the four characteristics: ignitability, corrosivity, reactability and toxicity. Household hazardous wastes (HHW) such as paints, batteries, medicines etc. are hazardous waste. HHWs require special care during disposed of.

MSW which is biodegradable and non biodegradable but is not corrosive, toxic, ignitic, or reactive is considered non hazardous solid waste.

II. COMPOSITION OF MSW

Distribution of each component of wastes by its percent weight of the total weight is known as composition of MSW. Treatment and Disposal methods depends on the this composition. High percentage of food and yard waste is suitable for composting. MSW contains mostly food, yard waste, paper, plastics, card board etc. (ISEM, 2000)

III. PROCESSING OF MSW

Processing of MSW is essential before its disposal to protect the environment and human health. MSW should be collected and transported to a suitable site regularly as per MSW (management and handling rules). Segregation of MSW at the source plays a vital role in proper management. Disposal and Treatment facilities highly related to segregation.

VI. WASTE MANAGEMENT HIERARCHY

According to Wikipedia, "*Waste management is the "generation, prevention, characterization, monitoring, treatment, handling, reuse and residual disposition of solid wastes". There are various types of solid waste including municipal (residential, institutional, commercial), agricultural, and special (health care, household hazardous wastes, sewage sludge).*"Waste Management Hierarchy is an arrangement or ranking of solid waste management actions. It is shown in the figure-2 below

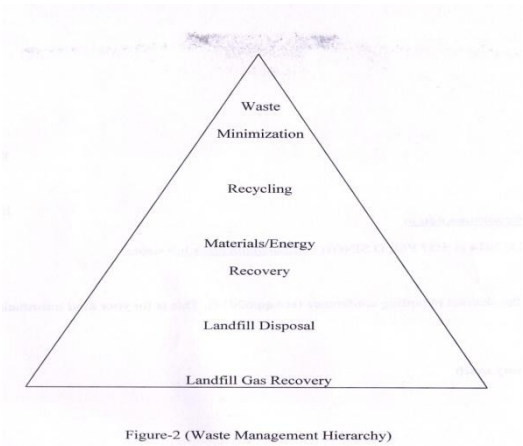

Figure-2 (Waste Management Hierarchy)

There are other similar strategies. For example the EPA in USA has a hierarchy of options: (Encyclopedia of Environment and Ecology)

- Source reduction
- Recycling (reuse and recycling waste)
- Treatment-destroying, detoxifying or neutralizing wastes
- Disposal-discharging waste

Another possible hierarchy is the 6 R's

Rethink Refuse, Reuse, Replace, Recycle, Remove.

Other schemes utilize the 3R's-Reduce, Reuse, Recycle.

VII. WASTE DISPOSAL

The most effective way to solve the problem of solid waste is by reducing the waste in the first place i.e. stopping waste before it happens. First priority should be the source reduction. The second option, Recycling and composting. Disposal in the landfills should be the last option. Generally waste management methods include source reduction and reuse, recycling, composting, vermiculture, engineered landfills, incineration and land application.

IX. METHODS OF WASTE DISPOSAL

a) WASTE MINIMIZATION (SOURCE REDUCTION)

The easier method of waste management is to reduce creation of waste materials thereby reducing the amount of waste. Waste reduction, prevention or minimization means reducing waste by not producing it. Source reduction, often called "waste prevention" is defined as "***activities to reduce the amount of material in products and packaging before that material enters the municipal solid waste management system*** "It can be done through recycling the items instead of buying new one, avoiding use of disposable products like plastic bags, reusing second hand items, and buying eco friendly items. Waste prevention actually avoids waste generation. In brief, waste minimization protects the environment and conserves natural resources. It prevents the formation of GHGs that are very harmful for the environment.

b) RECYCLING

In this method, discarded solid waste items are processed for further use or converted into energy. Recycling is the process of converting waste products into new usable products to prevent energy usage and consumption of fresh raw materials. The idea behind recycling is to reduce energy consumption, manufacturing cost, volume of landfills, air and water pollution, greenhouse gas emissions and preserve natural resources for future use and sustainable development. Paper, plastic, aluminum, glass etc. are commonly recyclable

materials. Other items are batteries, tires, computers, electronic items and mobile phones.
"The case for recycling is strong. The bottom line is clear. Recycling requires a trivial amount of our time. Recycling saves money and reduces pollution. Recycling creates more jobs than land filling or incineration. And a largely ignored but very important consideration, recycling reduces our need to dump our garbage in someone else's backyard – **David Morris".** Many of these items contain toxic substances. These items should be disposed of properly. In some countries, waste is recycled before reaching the landfill sites.

c) COMPOSTING

Composting is also a recycling process. It is an easy and natural bio-degradation process. In this process, organic waste turns into nutrient rich food i.e. humus which acts as an organic fertilizer for the plants and soil, thus reducing the needs of fertilizers and pesticides. The conversion of waste material into humus is known as composting. Composting is mostly used for organic farming. Composting is one of the best methods of waste disposal as it can turn unsafe organic products into safe compost. It is a slow process and takes a lot of space. This process is affected by following parameter.

- Particle size
- Moisture Content
- C/N ratio
- pH
- Temperature
- Blending and Seeding
- Air requirement
- Mixing and Turning
- Pathogen
- Odor

Note-- Recycling and composting is a couple of the best methods of waste management. Recycling is widely used around the world. Most recycled items are reused for its original purpose. These processes are eco-friendly and create jobs and income, hence improving their quality of life, health, and safety also. It significantly reduces waste, and decrease GHGs emissions.

d) VERMICULTURE

Organic waste is decomposed with the help of Earthworms (burrowing type). They produce the material known as vermicasting which contains earthworm excreta. It is simple, cheap and appropriate biotechnology to biodegrade the organic waste. This excreta is very useful as a organic mannure.

e) WASTE TO ENERGY (RECOVER ENERGY)

Waste to energy process involves converting of non-recyclable waste items into useable heat, electricity, or fuel through a variety of processes. This type of source of energy is a renewable energy source as non-recyclable waste can be used over and over again to create energy. It can also help to reduce carbon emissions by offsetting the need for energy from fossil sources. Waste-to-Energy, also widely recognized by its acronym WtE is the generation of energy in the form of heat or electricity from waste.

f) LANDFILL

Usual practice of open dumping of solid waste can contaminate groundwater and degrade the soil, attracts disease carrying rats and insects, causing fire also. Properly designed, constructed and managed engineered landfill is the best alternate to the open dumping. Engineered landfill (shown in Fig. 3) has an earthen or synthetic layer to protect the groundwater contamination from leachate.Landfill should have a way to vent, burn, or collect methane. The Landfill is the most popularly used method of waste disposal. This process of waste disposal focuses attention on burying the waste in the land. Landfills are found in all areas. There is a process used that eliminates the odors and dangers of waste before it is placed into the ground. Although this is the most popular form of waste disposal but it is becoming less these days due to the lack of space availability, suitable site, local opposition (**not in my backyard**) and the strong presence of GHG like methane and other landfill gases, both of which can cause numerous contamination problems. Methane can be recovered to generate electricity.

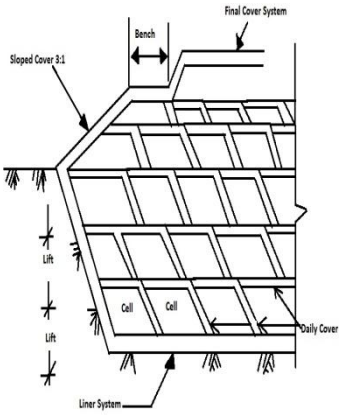

Fig-3 Engineered landfill (Khan Iqbal H, Ahsan Naved)

g) ADVANTAGE OF ENGINEERED LANDFILL

As the waste decomposes in open dump sites, it creates leachate (a mixture of toxic and nontoxic liquids and rain water) which may get local water supplies and contaminate the drinking water. These sites release gases that are explosive and flammable. Sometimes waste is burned at these sites, which poses a direct safety threat because of the danger of explosion. Since improper waste disposal produces GHGs, which contribute to climate change. While, properly designed, constructed and managed landfills aim to prevent or minimize

environment and health impacts. Engineered landfills have leachate collection system and liners that prevent groundwater contamination and gas collection system to store or burn methane generated by landfill safely.

h) THERMAL TREATMENT

- Incineration
- Pyrolysis
- Gasification

INCINERATION/COMBUSTION

When waste cannot be recycled, waste is managed by this process. Combustion (shown in Fig.4) is an exothermic, oxidative process that generates heat, carbon dioxide, and water. In this method; Municipal solid wastes are burned at high temperature under controlled condition and converted into ash and other gaseous products. The biggest advantage of incineration is that it can reduce the volume of solid waste up to 20 to 30 percent of the original volume and reduce the stress on landfills. This process is also known as thermal treatment of solid waste management. Incineration is very popular in Japan and Switzerland where space for the landfills is not easily available. Different types of incinerators are Mass Fired, RDF Fired, Fluidized Bed incinerators. Approximately 60% of MSW is incinerated in these countries. In combustion process, steam and water are produced as a byproduct that can be used to generate energy.

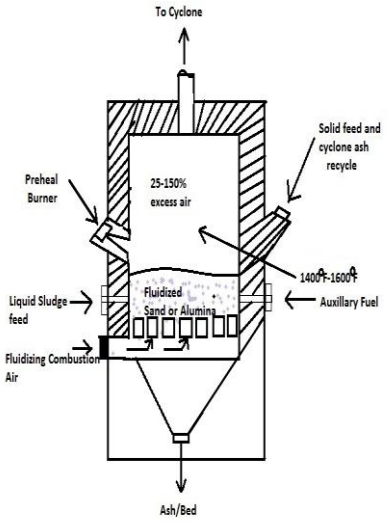

Fig-4 COMBUSTION (Khan Iqbal H, Ahsan Naved)

In this process, toxic chemicals are released in the atmosphere. Toxic substances are more concentrated in the ash. It is very expensive as compared to landfills and destroys useful recyclable and compostable materials by turning them into toxic ash.

PYROLYSIS

Pyrolysis is a thermal process where oxidation of the organic fraction is not allowed to occur. Instead, the organic is evolved from the refuse with heat, leaving an ash consisting mostly of free carbon and any inorganic matter (metal and glass not removed before pyrolysis). This process takes place in the absence of oxygen. This is an endothermic process which requires heat from an external source. In this process, we get gas (methane, CO_2 etc.), liquid (Tar containing acetic acid, acetone and methanol), solid (Char containing carbon and inert materials.)

Proportions of these items depend upon the temperature used. More the temperature more the gaseous items and lesser quantity of liquid and solid items are released)

GASIFICATION

This process takes place in the presence of lesser amount of oxygen than that is required stoichiometrically for complete combustion. Hydrogen and CO_2 gases obtained are used as fuel.

X. IMPACT OF SOLID WASTE ON CLIMATE

Any product goes through many processes before it becomes solid waste. Processing of raw material, manufacturing and transportation of the product are very common. Operation of any product also requires energy. All of these processes generate green house gases through following means:

Greenhouse Gas emissions—During the decomposition of organic waste in landfills, Methane gas is generated that is very harmful to the environment.

Energy consumption---Extraction and processing of raw materials, manufacturing and transportation of the product etc. generate greenhouse gas emissions by consuming energy from fossil fuels.

XI. INTEGRATED SOLID WASTE MANAGEMENT

Integrated Solid Waste Management (ISWM) (shown in Fig. 5) takes an overall approach to creating sustainable systems that are economically affordable, socially acceptable and environmentally effective. An integrated solid waste management system involves the use of a range of different treatment methods, and key to the functioning of such a system is the collection and sorting of the waste. It is important to note that no one single treatment method can manage all the waste materials in an environmentally effective way. Thus all of the available treatment and disposal options must be evaluated equally and the best combination of the available options suited to the particular community chosen. Effective management schemes therefore need to operate in ways which bestmeet current social, economic, and environmental conditions of the municipality

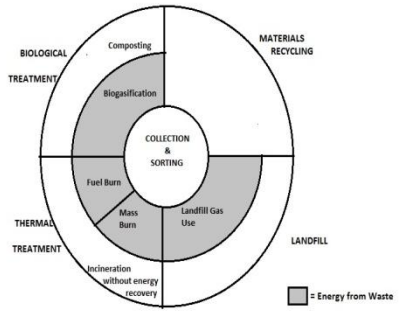

Fig-5 Elements of Integrated Solid Waste Management (Source- http://visi.ei.jrc.it.iwmlca/)

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