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Role of Waste Management at Landfills in Sustainable Waste Management

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ABSTRACT: Landfills become the compulsion for the disposal of large amount of Municipal Solid Wastes (MSW). Landfills have historically been seen as the ultimate solution for storing wastes at minimum cost. The disposal of tons of garbage daily without any treatment and segregation create heaps at landfill sites. In developing countries like India, landfills are generally unscientific and create problems such as air pollution from burning of wastes at landfill sites and pollution of groundwater as well as deterioration of the quality of soil (from leachate-the liquid residue that forms as water or moisture content seeps through contaminated areas and mixes with surfaces and groundwater). The purpose of this paper is to suggest various approaches for waste management at landfills, and to facilitate some approaches as policy instruments. The waste hierarchy (recycling/reduction, materials recovery, incineration, landfilling and composting) can be developed as a thumb rule from an environmental aspect. This study shows that reduced landfilling in privilege of increased recycling of materials and energy lead to lower environmental impact, lower health hazard, and lesser consumption of energy resources, lower economic costs and finally sustainable waste management.

Keywords: Municipal Solid Waste, Waste Incineration, Landfilling, Composting, Leachate.

I. INTRODUCTION

In developing countries like India, open dumping is the most common disposal alternative for MSW. Economic considerations also led to maintain unscientific landfilling as the most attractive disposal route for MSW. With the increase in the population, the quantity of MSW is also increasing (Sharholy *et al.,* 2008).

But country is following the same old method of disposal of wastes. So, Waste management emerges out as a critical issue in India. Lack of availability of space is also need to be considered. In India, all metro cities have more than two landfill sites which are in operation since more than 15 years and some sites have completed their shelf life also. Heights of these landfills are increasing day by day and these landfills continue as a cause of concern from environment as well as human aspect. Generally there is no segregation of MSW while disposing off at landfill sites so it contains high amount of recyclable as well as recoverable materials in it.

Methods which are in practises for waste management at landfill sites are: incineration, landfilling and composting. However, these methods are also inappropriate and harm to the environment is not reducing. Solution of the waste management is a need not to be merely technical, but also organizational. Now, there is a demand to change the approach from the disposal-based towards the reduction/recovery-based of waste management. This change in approach requires some level of society participation also with proper regulation and monitoring of waste generation and disposal (Narayana, 2009).

The thumb rule "Waste Management Hierarchy" (recycling/reduction, materials recovery, incineration, landfilling and composting) with some policy instruments such as landfill tax, producer responsibility etc. must be adopted by countries like India as the approach for developing MSW management strategies. The extent to which any one approach is used within a given region varies depending on various factors, including topographical features, population density, transportation facilities, infrastructure, social, economic and environmental regulations (Sakai *et al.,* 1996; Finnveden *et al.,* 2007).

II. INCINERATION

Incineration refers to the combustion of solid waste materials that lead to ash and slag residues and gas emissions. Waste incinerators do not eliminate waste instead they generate it. Since physical matter could not be destroyed, associate burning really transforms the first waste materials into many new forms, including: gas emissions, ash, slag and liquid discharge. These new forms are more difficult to take care of than the first raw waste materials (Narayana, 2009).

A. Objective Of Waste Incineration

The main objective of MSW combustion area unit is to reduce the contaminants of the waste and scale back the quantity of waste requiring final disposal. Recent combustion facilities must be designed for energy recovery, either within the sort of electricity or industrial uses or district heating purposes. Over the past decades, the trouble of over air emissions from these facilities have resulted in most countries adopting terribly tight air emission management laws that has enhanced the value of constructing and operative incinerators. However, some countries area unit currently implementing new measures to cut back the volumes of post-recycled waste destined for disposal by limiting the organic content of the waste to not up to 5%, therefore promoting the implementation of combustion systems among associate degree of integrated waste management strategy (Hjelmar, 1996).

B. Outcome Of Waste Incineration

Waste Incineration produces emissions of hazardous gases and pollutants to atmosphere via stack gases and to water systems via discharges of water from wet stack gases treatment. Combustion destroys most organic pollutants and hazardous substances, at the same point of time dioxins, sulphur oxides, nitrogen oxides and different other pollutants are also generated throughout the process. Huge amount of waste combustion leads to lot of ash and slag production which ultimately must be landfilled. Ash and slag from stack gases treatment contains enormous amounts of dioxins, metals and salts. This can be as a result of stack gas treatment instrumentality filters out these pollutants from the waste that is incinerated. The ash and slag must be treated as dangerous waste and should be disposed of in accordance with specific rules. Therefore, there is a need to develop some strict guidelines for the waste incineration.

C. Need For Waste Incineration

Incinerators need advance technology with oversized capital investment and very little economic come back. For incineration process, MSW must contain high materials such as rubber, leather, cardboard, papers and plastics etc. There are also some materials present in waste mixture which have high calorific values as that of some power generating fuels (Davis, 1994). During incineration, these materials produce contaminants and hazardous gases which are harmful for all. In India and varied different developing countries, waste incineration does not take place properly, also due to lack of technological advancement and economical condition.

III. LAND FILLING

A landfill is a region of land onto or into that waste is deposited. The aim is to avoid any contact between the waste and also the encompassing atmosphere, significantly the groundwater. Landfills are classified into 3 classes, which are:

i. Open dumps or unsanitary landfill, that may be low lying area or natural area where there is no measure has been taken for collection of leachates as well as gas emissions. Such landfills are present in maximum number in developing countries.

ii. Semi-controlled or monitored landfills, in these sites disposed wastes are compacted and waste dumps are covered by topsoil layer so as to reduce nuisance. Generally, all kind of wastes are dumped without segregation such as municipal, medical and industrial etc. Collection systems for leachates and gas emissions are also not present.

iii. Sanitary landfills, such types of landfills are generally present in developed nations. These landfills are provided with all facilities such as collection system for leachate and gas emissions. There is also provision for leachate treatment and use of this treated leachate. Such landfills also have controlled the gas emissions that may be generated from waste incineration and biological treatment of waste (Tchobanoglous et al., 1993).

A. Leachate And Leachate Treatment

Leachate is produced as a result of moisture available in the waste, precipitation and of surface water or groundwater entry into the lowland disposal site. Once this generated contaminated water percolates through waste, it aids and fosters the method of decomposition by available micro-organisms in the waste such as bacteria, fungi etc. These biological processes are in turn helpful in the release of by-products which are in eager to use any available oxygen, building an anoxic atmosphere. Leachates are also responsible for changing the chemical composition of materials which never go for biological reactions by themselves such as fly Ash, slag, construction and demolition wastes etc.

The generated leachate may be characterized as a composition of water-related solution of four groups of ingredient contaminants: dissolved organic matter (acids, aldehydes, alcohols sugars etc.), inorganic macro components, heavy metals, and xenobiotic organic compounds such as halogenated organics (Wiszniowski *et al.,* 2006).

The generated leachate is collected and should be befittingly treated before being discharged into the atmosphere. The choices for treatment embodied are recirculation of the leachate back to the landfill, treating for sewerage discharge, or treating for native surface water discharge. The treatment of landfill leachate in conjunction with municipal waste material is not suggested beneficial due to the build-up of hazardous compounds from the leachates within the activated sludge throughout the treatment method. It makes the utilization of this sludge as plant food in agriculture not possible (Marttinen et al., 2003). Technologies meant for leachate treatment will be classified as follows (i) biological strategies (ii) chemical and (iii) physical strategies. However, so as to fulfilled strict quality standards for direct discharge of leachate into the surface water, a development of integrated strategies of treatment, i.e. a mix of biological, physical and chemical steps, are needed (Wiszniowski *et al.,* 2006).

B. Gas Emission

In India, the MSW has approximately 50-60% of biodegradable waste which generates various harmful gases under anaerobic condition. One such gas is methane which is responsible for undesirable fires at landfills and has nearly 21 times higher global warming potential (GHP) than carbon dioxide equivalent (Ranjan *et al.,* 2014). Biological treatment such as nitrification and de-nitrification helps in the production of nitrogen dioxide, which has GHP 310 times greater than carbon dioxide equivalent. Organic components in the municipal refuse of landfills result in 3% Green House Gas emission under aerobic as well as anaerobic condition. The approximate composition of landfill gases is 45-55% methane, 40- 50% carbon dioxide, 3-6% nitrogen gas, 0.1-1% oxygen as well as ammonia, 0.01-0.6% non-methane organic compounds (NMOCs), 0-1% sulphides, 0-0.2% hydrogen and 0-0.2% carbon monoxide (Rawat *et al.,*2011).

C. Health Impact

Due to waste incineration and set out of undesirable fires from landfill site leads to the development of thick black smoke around landfill site and finally air pollution, which ultimately leads to heat-related illness and respiratory disorders. The presence of enormous quantities of mixtures of probably risky chemicals in landfill areas due to the generation of contaminants such as leachate from landfill sites which migrates into the adjacent environment. On the brink of landfills, residential populations have progressively been caused concern. Many varieties of cancer have also rumoured in individuals living close to landfill site wherever landfill gas and leachate migrates through the soil and water system (Montague, 1998). Diseases like respiratory disorders, asthma- like symptoms, skin allergy, eye irritation, neurologic symptoms, anxiety, and liver related issues in those who are living close to the landfill surroundings. However, these diseases are not merely due to impact of landfills and need further investigation related to health related illness.

D. Patterns To Be Followed In Developing Countries

Landfilling, or dumping of waste on an open and uncontrolled dump, is the easiest as well as worst method (from environment perspective) for disposal of waste, various materials are often recovered or which may be incinerated for energy. However, for the predictable future open dumping or landfilling will remain as a necessary methodology for taking away waste, which for numerous reasons, is unsuitable for any kind of utilisation. Numerous measures have been taken to use resources additional expeditiously in waste management, thereby reducing the quantity of waste planning to be landfilled. There is also need of a tax to be imposed on landfilled waste in developing countries like India. The aim of this tax is to discourage landfilling as a waste disposal methodology and increase the economic incentives for treating and utilising waste in a very additional environmentally friendly and resource-efficient method (Swedish, E.P.A., 2005).

Some wastes have properties rendering them unsuitable for materials recovery from associate environmental viewpoint, or as a result of the environmental advantages would not justify the trouble or prices entailed. Combined with recovery of materials, waste burning for energy recovery is thus of satisfactory importance as a resource-efficient method of utilising waste that ought to not head to landfill. Since recovery of materials is usually cost consuming, or yields lower revenues than burning, there has been reason to require action specifically designed to encourage recovery of materials, together with biological treatment. Producer responsibility will also increase recovery of materials if producers are bind up in strict guidelines and also answerable for salvage value as well as disposal of the product they sell. Producer responsibility expressly needs an explicit proportion of waste to endure materials recovery. Final aim of all policy instruments is to encourage sustainable waste management.

IV. COMPOSTING

Generally composting is a natural process but it has adverse effects on the environment, so there must be controlled decomposition of organic matter present in the waste through biological processes, leading to nutrient-rich products i.e. Humus. For composting, it involves the mixing of a combination of vegetable residuals, animal wastes, soil matters and water to create humus. The quantity of compostable material within the waste of developing countries is 75–85%. The typical waste composition of developing countries makes it clear that composting is the most appropriate choice to handle MSW.

A. Problem In Composting

Various studies have shown that composting is troublesome as a result of the waste arrives in a very mixed kind and contains a great deal of non-organic material. Once mixed waste is composted, the final product is of dumb quality. The presence of polythene, plastic products etc., within the waste stream are particularly problematic, since these materials do not get recycled or have a secondary market. Within the absence of segregation, even the simplest waste management system or plants are rendered useless. The impact on environment due to composting would result in emission of methane, ammonia, nitrous oxides and sulphur oxides to atmosphere, and of eutrophication causing substances to water systems. If processes do not seem to be controlled and monitored carefully, or if they occur within the open, there could also be emissions of two dangerous greenhouse gases. Odour problem might also be a nuisance to native residents.

B. Guidelines For Composting

Guidelines are offered for sustainable collection/storage, biological digestion and composting of varied forms of waste supported the preventative principle embodied within the Environmental Code. As an instance, storage ought to be restricted in time and garbage ought to be composted in closed systems with treatment of air and leachate. Biological digestion ought to conjointly ensue in closed systems, in order that emissions of methane, ammonia and other odorous substances should be reduced.

There is a need to adopt policy instruments such as polluter pays policy, then whoever generates the waste must take the bulk of the responsibility for clean it up. Within the context of mixed waste, the households, markets, industries and commercial institutions that generate the waste need to take the primary responsibility for segregating the waste. Once quarantined, the perishable things may be composted and therefore the remainder of the waste may be recycled. Thus, participation is critical to the resource recovery approach to waste management.

C. Use Of Solid Wastes On Land

Use of varied recycled and compost waste varieties on land area or in soil surfaces might lead to eutrophication i.e., fulfilling the various nutrient demands such as nitrogen and phosphorous saturation same as that fulfilled by fertilizers. Samples of applications are use as chemical for soil cultivation, likewise as construction of roads, parks, golf courses, noise screens and material for covering landfill sites. Proper exercise of waste for construction functions has not been outlined and practiced, very widely throughout the country. It is so necessary to provide tips or propose laws governing this kind of exercise. There should be well-established environmental standards governing the employment of biodegradable pollution sludge as a chemical on tillable land. Voluntary quality assurance schemes for mistreatment sludge, compost and digestion residues have conjointly existed for long ago. The efficaciousness of those voluntary schemes ought to be examined.

D. Decentralization Of Waste

Society participation would naturally cause a suburbanised approach. A number of the benefits of this sort of approach are:

i. Primary waste segregation is helpful in the recycling and reduction of the waste. There is also a need to make the residents subsided enthusiastic about the gathering and segregating of municipal waste.

ii. It is often enforced with reduced investment and low in operation prices but with proper involvement of society and governmental bodies (e.g., Municipal Corporations).

iii. Composting of waste at small level i.e., manually is definitely developed into the present Indian social and environmental conditions, because it requires number of labourers so creates employment opportunities also.

iv. Produced compost is often sold-out for the agricultural activities. With prime quality of compost, there would be a prepared market (Narayana, 2009).

V. CONCLUSIONS

There is a need to follow a trend and it must be consistent – lesser the waste to be landfilled and higher the waste must be recycled. This trend can be made possible by adopting policy instruments. Producers can be made responsible for dealing with plastic waste, packaging, rubbers, electronic waste etc. There is also requirement of prohibitions on landfills which are overflowing and taxes can also be imposed on landfilling. More demand of recovery of waste and recycling targets must be set out.

Proper segregation of waste at source and which can be ensured by public participation with the help of Governmental bodies. There is also great need for collection of leachate and its proper treatment. Proper collection of gas emissions and their uses is helpful environmentally as well as economically.

Maximum possible use must be made of the resources that waste represents, while at the same time minimising the impact and risk to health as well as environment. Environmental impacts define the limits for use of most natural resources, rather than a shortage of the resource itself. The greatest benefit derived from better management of waste resources is in reducing greenhouse gas emissions. The greatest risk posed by waste management is the risk of dispersal of hazardous substances found in the waste or formed during its treatment.

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