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A Review on Municipal Solid Waste Disposal by Sanitary Landfilling Method

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ABSTRACT

Over the years, the generation of municipal waste in India has increased significantly. Solid waste management has become an important issue due to poor waste management practices affect public health and urban services. Municipal waste generation increases with increasing population, urbanization and industrialization. Municipal solid wastes disposal is a stinging and widespread problem in many developed and developing countries, in both urban and rural areas. Municipal waste management solutions must be economically sustainable, technically feasible, social, legally acceptable and environmentally friendly. Sanitary landfilling is popular in most countries because of the due to its relatively low cost and low technical requirements This paper mainly review on need to dispose of municipal waste, sanitary land filling method of disposal of MSW, Evaluation of the impact of landfills on the environment such leachate, land fill gases (LFG), land fill fires (LFF), strategies for effective management of sanitary landfills and sustainable measures (reduce, reuse and recycle) to minimize the amount of waste that ends up in landfills.

***Keywords**:* Municipal solid waste, Sanitary landfill, leachate, land fill gases (LFG) and land fill fires (LFF).

INTRODUCTION

Due to the rapid industrialization and urbanization of India, many people migrate from rural areas to cities, which generate thousands of tons of MSW each day. This amount of municipal waste is expected to increase in the near future as the country seeks to become an industrialized nation [1]. Economic development, urbanization and increasing living standards in cities have led to an increase in the quantity and complexity of the waste generated. Inefficient management and improper disposal of solid waste are the main causes of environmental degradation in most cities in developing countries. Municipal corporations in developing countries cannot handle increasing amounts of waste, leaving uncollected waste on streets and other public spaces. Unscientific disposal of MSW causes adverse impact on human health and environment. Employees working in landfills suffer from respiratory symptoms, diarrhea, fungal infections and skin ulceration, burning sensation in the extremities, tingling or numbness, temporary memory loss and depression [2-3].

Proper disposal of municipal waste (MSW) remains one of the world's toughest environmental problems. Landfills and open dumps are waste management practices widely used in developing countries [4]. Generally, MSW is disposed of in low-lying areas by without following any precautionary measure. This leads to MSWM is becomes one of the major environmental problems of Indian megacities. Municipal waste activities related to the generation, storage, collection, transfer and transportation, processing and disposal of solid waste. However, in most cities it only includes four activities i.e., Generation, collection, transport and disposal of waste. This is becoming increasingly expensive and complex due to the continuous and unplanned growth of urban centers [5-7].

Proper disposal of solid waste will reduce or eliminate negative effects on the environment and human health and support economic development and improved quality of life. Various processes are involved in effective community waste management are monitoring, collection, transportation, processing, recycling and disposal. Municipal waste management solutions must be economically sustainable, technically feasible, social, legally justifiable and environmentally friendly. Solid waste disposal is the biggest challenge for the authorities of small and large cities. Disposal of solid wastes is a stinging and widespread problem in both urban and rural areas in many developed and developing countries [8].

In general the following methods are used for disposal of municipal solid waste.

1. Solid waste open burning
2. Solid waste sanitary landfilling
3. Incarnation process
4. Composting
5. Disposal by ploughing into fields
6. Disposal by hog feeding
7. Salving procedure
8. Fermentation or biological digestion

Of all the solid waste management options available, landfill is the most widely used waste management method in the world. These landfills have served as the last receivers for municipal waste, industrial or agricultural waste, sewage sludge, incineration ash, recycled waste and / or treated hazardous waste, thus stimulating greater interest in innovation and advancement of waste management systems.

SANITARY LANDFILLING

The sanitary landfill method for the final disposal of municipal waste continues to be a generally accepted and used method due to its economic advantages. The sanitary landfill is defined as the disposal, compaction and dumping of waste in suitable places. Landfilling is currently simple, more cost-effective than other disposal methods, and is the only method of disposing of all waste. Although municipal waste disposal in landfills has decreased, landfills are likely to remain an important part of integrated waste management systems around the world. Comparative studies of various waste management methods (landfill, incineration, composting, etc.) show that among the technological options for municipal waste treatment and disposal in most countries, sanitary landfill is popular due to its relatively low costs and low technical requirements [9-11].

Sanitary Landfill is a healthy system of landfill where waste is dumped in low laying areas or trenches are dug to collect garbage, then garbage is piled up with soil carried out layer by layer in such a way that waste is not in the open[12]. Landfill disposal is considered an effective waste management method[13]. However, there are many reasons why landfilling appears to be the least efficient method of waste management. Waste can only be landfilled for a limited time and the duration of the landfill can last up to hundreds of years [14]. Biogas and leachate produced in landfills can seriously affect the environment [14-17].

BY-PRODUCT OF A SANITARY LANDFILL

Landfill leachate

Leachate is a liquid that seeps through solid waste and has extracted, dissolved, and suspended substances that may contain potentially harmful substances [18]. Leachate can cause serious problems as it can carry pollutants that can contaminate soil, groundwater, and surface water. Numerous studies have shown that landfill leachates are an important source of pollutants as a result of the leaching of hazardous substances [19-21].Landfill will produce leachate throughout its life and even for several hundred years after decommissioning [22]. Leachate contains four main components: nutrients, volatile organic compounds, heavy metals, and toxic organic compound [23-24]. The quality of the leachate is influenced by many factors, such as age of the landfill, seasonal climatic fluctuations, and total amount of precipitation, type and composition of the waste. The composition of the seepage water changes significantly, particularly depending on the age of the landfill [25].

Leachate production is also strongly influenced by climatic conditions, since they influence the entry of precipitation to the landfill and losses due to evaporation. In addition, the production of leachate depends on the nature of the waste removed, that is, on the water content and the degree of compaction of the upper layers of the landfill [19].NH_3 is one of the main contributors to the toxicity of leachate from municipal waste landfills. Furthermore, NH_3 is released from the leachate through volatilization and increased NH_3 concentrations in the atmosphere can have negative effects on vegetation [26].

Land fires:

During the waste degradation process, huge amounts of heat and landfill gases (LFG) such as carbon dioxide (CO_2) and methane (CH_4) are generated. Biological and chemical reactions that take place on the surface and within the landfill contribute to the development of heat. The ignition of waste is one of the main causes of spontaneous fires in landfills. The risk of landfill fires in India is high as most landfills are non engineered [27-28]. Landfill fires can seriously damage the environment through polluting emissions to the atmosphere, soil, and water. The risk factors depend on the type of waste burned, the geographic location of the sanitary landfill and the type of fire [29].

A common cause of these landfill fires is spontaneous combustion. This results from an increase in the oxygen content in the landfill, which increases bacterial activity and increases temperature (aerobic decomposition). These so-called "hot spots" can come into contact with pockets of methane gas and cause fires. It can be identified when white or brown smoke emanates from a portion of the landfill surface [30]. The heat from a fire can cause the chemicals to evaporate or decompose and enter the environment through smoke. Heat from fire can cause chemicals to evaporate or decompose and enter the environment through smoke. Smoke from landfill fires can contain dangerous toxic gases such as CO, H_2S, CH_4 etc. and carcinogenic substances such as dioxins. Bad smells and smoke emitted is a nuisance for the neighborhood and can even endanger human health, especially in vulnerable populations such as the elderly, children, pregnant women and people with pre-existing chronic respiratory diseases [30-34].

DESIGN AND CONSTRUCTION OF SANITARY LANDFILL

Landfill design involves designing the physical elements of the landfill as well as the operating systems. The most important structural components of a landfill are the substructure, liner, leachate management system, gas management system, final cover or cap, and rainwater management [35].

Landfill Sub-Base Preparation

It is important to have a properly prepared base as the landfill liner will be built directly over the base. If the soil is not properly compacted, compacting the waste becomes a challenge during the first few lifts. In sandy soils, it is recommended to compact the subsoil to 85-90% of the relative density. During construction, density is generally verified at 30 m grid points [36].

Liner Design

The primary purpose of a liner system is to prevent contamination of the soil and groundwater. It also facilitates the collection and disposal of the leachate created by the waste. Generally, a liner system is made up of multiple layers of clay or geosynthetics to prevent movement of any liquid between the landfill and the surrounding site. The choice of lining material should be based on the type of waste and the landfill's method of operation. Leachate should not affect liner material. The siding is generally made with some type of durable and puncture resistant HDPE synthetic plastic in combination with compacted clay flooring. The thickness of a coating always depends on the type of material selected. Generally, a 1.5 to 2.0 mm thick geomembranes is used to line the [37].

Leachate Management

Leachate Management Leachate can be removed by gravity flow or by pumping. Leachate management includes the plumbing system and a sump. The plumbing system is located at the bottom of the landfill, which consists of a series of perforated pipes, packs of gravel and a layer of sand, while the sump is a trench where the seepage water that flows through the Plumbing system is collected. The leachate collected at the landfill can be stored on-site for further treatment or transported off-site for treatment and disposal. Surface impoundments and tanks are typical leachate reservoirs. The most economical option is to transport the leachate to an offsite facility for treatment and disposal [38]. This allows the owner / operator to focus on their main objective, landfill management, while the leachate is treated by a wastewater treatment expert. Leachate treatment is challenging primarily due to irregular production rates and variable composition. They used polymeric coagulation, flocculation, sedimentation, anaerobic biological treatment, aerobic biological treatment [39].

Rain water or Stormwater Management

This is a developed system designed to control and collect runoff water when it rains. Rainwater that falls into landfills must be channeled through natural drainage routes. Rainwater is collected through rainwater ditches and then channeled into rainwater basins before being released into the natural environment. Multiple trenches can traverse a landfill, depending on the estimated amount of runoff through each section of the landfill. The Manning equation is typically used to design trenches. Triangular or trapezoidal profiles are often used. If higher speeds are expected, additional erosion protection measures such as masonry or erosion mats can be used [36]. A new generation of landfill covers called Phytocap is being developed that could also solve rainwater problems. Phytocap is a natural ground plant alternative to the traditional built landfill cover design. It requires less technical effort and is less expensive than traditional waterproof covers because only local resources are used. It also has the benefit of oxidizing methane to reduce greenhouse gas emissions from landfills. These types of covers have the potential to significantly change the way that developing countries are capping their waste sites.

Landfill Gas Management

Gas collection systems can be implemented actively or passively. Passive systems use vents to release landfill gas into the atmosphere. They are generally used in small landfills of less than 40,000 m^3 in size. The passive gas ventilation system consists of a series of isolated gas outlets. The depth of a passive vent can be up to 75% of the depth of the landfill or just a few meters below the limit. The spacing used is typically one vent per 7500 m^3 [37].

An active ventilation system consists of a series of deep exhaust shafts connected by a manifold. Active systems use vacuum pressure to collect landfill gas through extraction wells. Passive landfill gas collection systems use both vertical and horizontal wells. The gas is extracted with central blowers, which are sized according to the amount of gas to be transported [37]. Using large pipes and minimizing the number of bends and valves used in them can help minimize pressure drops.

Condensation often occurs due to the drop in temperature of the saturated landfill gas as it moves through the collector. The condensate collected in the pipes can be returned to the landfill or treated similarly to seep water. In colder climates, care must be taken to prevent condensate from freezing and clogging the pipes.

Daily, intermediate and final Cover or cap design

Daily cover is the name of the compacted soil layer or soil that is applied to a daily deposit in an operating landfill. The cover helps prevent interactions between waste and air, reduce odours, and provide firm support for vehicle operation [38]. Intermediate covers are placed on previously active landfill work surfaces that are not covered with waste for an extended period of time, typically 7 to 60 days or more. Intermediate covers traditionally consisted of a layer of soil and may involve the use of an additional layer of geotextile material. A final cover (or plug) is placed on the MSW when it reaches its construction height to minimize rainwater ingress, trash dispersal, and odour [37].

POST CONSTRUCTION MONITORING

Monitoring is an important task during construction / operation of the landfill, as well as after closure. Air quality, leachate monitoring and leakage control, groundwater quality monitoring, landfill odour management, landfill fire prevention or suppression, landfill gas monitoring, Disease vector control, stability coverage and the Contingency plan are among the most frequently monitored aspects.

Air Quality

Ambient air quality must be regularly tested at the landfill, and average concentrations of gaseous emissions must comply with the United States Environmental Protection Agency (USEPA) 2004 Ambient Air Quality Standard.

Leachate Control monitoring and leakage control

Control of leachate includes control of the leachate head in the liner, as well as the quality and quantity of leachate produced. Monitoring the seepage water level in the liner is necessary to control possible leaks due to the high delivery heads. Leaks are generally detected with a lysimeter installed below the apex of the liner, which is considered the point of maximum potential for leakage. The location and number of lysimeters may vary, but at least several must be installed [39]. Leak detection is carried out by monitoring the unsaturated zone between sub base and seasonal high water levels. Two approaches are used: direct monitoring and indirect monitoring [36]. The direct monitoring approach involves instrumentation that collects samples. Lysimeter for collecting liquid samples. The indirect method uses instruments to detect water seepage. Leachate from landfills should not enter waterways, rivers, aquifers, etc. by installing a good floor covering and piping system to direct the leachate to the treatment plant. The selection of the liner material must take into account the stabilization.

Landfill Gas Monitoring:

In order to manage landfill gases and minimize greenhouse gas emissions, it is necessary to develop, implement and monitor suitable landfill gas containment (for example, landfill cap and side liners) and landfill gas collection systems must be developed, implemented and monitored. The landfill gas management system should be designed before the landfill is constructed and installed gradually over the life of the landfill. The quality and composition of the landfill gas in the landfill and adjacent land should be monitored. Gas monitoring probes are installed to monitor the concentration of methane and other dangerous air pollutants.

Landfill Odour management:

Landfill odour is an important aspect of landfill settlement. Landfill odours have two main sources; Odour of aerobic decomposition of freshly deposited waste and odours of landfill gas resulting from anaerobic decomposition of waste. Leachate ponds can also be a source of unpleasant odours. Proper operation and proper buffers are essential for odour management. These buffers are configured to accommodate disruptive conditions and are not a substitute for best landfill management practices or normal operating conditions. The odour from aerobic waste disposal is controlled by minimizing the exposure of this waste to the atmosphere.

Landfill fire prevention or control

Landfill fires are difficult to extinguish, so the main objective should be to prevent them from starting. To do this, remove potential sources of ignition, such as embers, from the tipping area. Other measures include burning waste and lighting fires in or near areas where waste has been or is being deposited. Waste must be covered with non-combustible material. The carbon monoxide content in landfill gas gives an indication of whether an underground landfill fire is or has been. Carbon monoxide levels above 1000 ppm clearly indicate a landfill fire. Values above 100 ppm are not as conclusive, but should be investigated as part of the fire investigation plan with further gas and temperature measurements to determine if and where a fire [40].

Stability of the Final Cover

Excessive deformation due to differential settlement can cause the cover to fail, especially when using synthetic covers. The stability of clay covers should also be controlled if the tendency to slopes is higher than usual. Cover work must often be monitored with a 100-foot grid. Monitoring should be done quarterly or every six months [36].

Disease vector control

The main mechanisms used to combat disease vectors are the use of cover material to cover waste daily and eliminating any water bodies that are not required for fire, sediment and leachate control. Other measures, such as scare devices and traps, can also be used to reduce or control infestations. Professional exterminators should be used to reduce pest infestations.

Contingency plan

Contingency planning should be part of the site's environmental management system. All landfill employees must be trained in the implementation of the contingency plan. The contingency plan must include all effects, such as: detection of contamination of surface or ground water, detection of landfill gas, clogging of leachate and landfill gas collection pipes, landfill fire, disposal of unauthorized waste, nuisance from odours or dust outside operating limits, debris outside operating limits, equipment failure, and power outage.

SUSTAINABLE WASTE MANAGEMENT

In various phases of a product's life cycle, material efficiency can be increased through more efficient design, material substitution, product recycling, and quality cascade [41]. The new demand for sustainable waste management requires a new paradigm [42]. Set to "3Rs" or "RRR", where the first "R" means Reduce, the next "R" means Reuse and the other "R" means Recycle [43-44]. The reduction, reuse and recycling of biodegradable and non-biodegradable waste are very important in waste management as they reduce the amount of solid waste that is ultimately disposed of in the landfill. This approach is known as the 3R approach

Reduction of solid waste

Waste reduction could be achieved through legislation, product design, and local programs to remove compostable and recyclable materials from waste. Waste reduction emphasizes the careful use of resources in production. Legislation requires the manufacturer to adhere to certain standards when developing products or limiting production activities, as is the case in Europe and the United States [45]. Separating waste at the source also achieves the same goal of reducing waste; reinforced by public awareness and education. India, for example, uses student rallies and public gatherings as campaign strategies to promote waste separation and reduction [48].

Reducing the quantity purchased is the most important of all waste management options. The key is to buy only the products we need in the right quantities. Packaging waste accounts for around a third of municipal waste and has doubled in recent years. Banning certain types of packaging that are not biodegradable could help reduce solid waste. Reducing the use of plastics in packaging would be a good start, as it takes hundreds, if not thousands of years for them to break down; could be replaced with paper bags because they decompose faster.

Reuse of solid waste:

The second R (reuse) covers the secondary and subsequent use of waste materials, either in whole or in part. An example of waste recycling is the trade in used goods: clothing, electronics, automobiles, furniture, and other goods [45-46]. "Reuse" is achieved by sorting at the source rather than at the point of disposal and through detailed processes of verification, cleaning, reconditioning, repair of whole objects or spare parts [46-47].

The idea of splurging makes many people uncomfortable. Most people waste because they can't think of anything better with old or worn products / materials. Reuse means that a product can be reused with little or no processing. The reuse process begins with the assumption that the used materials that flow through our lives can be a resource, not a waste. When we actually look at the things we throw away, we can learn to see them as materials that can be reused to solve everyday problems and fulfil daily needs. .For example: containers can be reused at home or for school projects, reused wrapping paper, plastic bags, boxes and wood, gifting adult clothing to friends or charities, buying drinks in reusable containers, donating broken equipment to organizations local charities or professionals. school for art class or for students to use to practice repairs, to offer furniture and household items that are no longer needed to those in need, friends, or charities amongst so many others [49].

Recycling of solid waste:

The third R (recycling) depends on waste materials that cannot be directly reused, but that can be converted into new products or raw materials through conversion processes. For example, used paper is recycled into folders, envelopes, and cards. Energy is recovered through recycling through: pyrolysis (burning waste in the absence of oxygen to form gases, liquids and solid compounds), incineration (burning in the presence of oxygen to produce oxidized compounds), anaerobic digestion, gasification and pelletization [50].

Recycling is the reuse of materials to create new products by reducing the need to harvest, extract, and process new materials. Recycling saves wood, minerals, energy, and water. Recycled aluminium, for example, requires around 95% less energy to process than the production of new aluminium cans, as the production of aluminium is a very electrically intensive process. Recycling also reduces greenhouse gas emissions, especially CO_2, as reprocessing consumes less energy than original processing. Recycling reduces pollution in the community and saves waste that is eventually sent to landfill [51].

CONCLUSIONS

Ideal disposal methods should be environmentally friendly with optimal recycling, less economically demanding and socially acceptable. Therefore, it is important to go back to the root causes of solid waste problems and address them from there. Reduces the amount and toxicity of waste before it enters the municipal waste stream. The success of source reduction largely depends on the attitudes of producers and consumers, which include legislation, social perception, education, etc. Along with rising living standards and consumer behaviour, consumption patterns need to be reversed to prevent waste from entering the waste stream.

Sanitary landfill remains the cheapest and most suitable method of waste disposal in India. As most landfills have poor landfill practices, it is important that authorities improve the current state of landfill practice. If properly planned and maintained, the landfill will have a less negative environmental impact compared to other methods. of course, it is impossible to make overnight changes to convert all untreated open landfills to landfills. The importance of the landfill cannot be emphasized enough; not only does it reduce pollution; it also reduces the potential risk to human health. The 3R approach also needs to be considered efficiently.

The improvement of the sanitary landfill should be gradual, depending on the state of the land and its financial and technical capacity. The following improvements can be made to minimize the negative environmental and socioeconomic impact in the short term: 1. Insure Daily cover. 2. Improvement of access road. 3. Construction the basic infrastructure, fencing and weighbridge. 4. Stop open burning inside landfills. 5. Establishment of a surface drainage system. 6. Sensitize employees. 7. Construction of leachate collection and gas venting facilities. 8. Ensure no disposal of hazardous and medical waste. Minimizing waste from sources will help minimize solid waste management and treatment costs while minimizing the impact on landfills; therefore, the government should start to encourage residents to sort their waste, from source to supply of the necessary equipment for household awareness.

Another important step that can be taken is to enforce landfill regulations that would ensure that the construction of the landfill is well planned and properly managed. Law enforcement can significantly reduce the impact of a landfill on soil, air and water quality. Well-planned and properly operated landfills ensure compliance with environmental regulations and ultimately ensure that the environment is free of contaminants. Proper construction and maintenance also ensures that landfills are not located in environmentally sensitive areas and are integrated with on-site environmental monitoring systems that track signs of gas and groundwater release. Landfill management should focus on the design and operation of sustainable landfills. Similarly, communities must be part of this sustainable future by focusing on reducing waste generation and thus effectively limiting the negative effects of landfills.

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