FINAL DISPOSAL OF SOLID WASTE AND ALTERNATIVE OPTIONS FOR CHITTAGONG, BANGLADESH

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ABSTRACT

The research highlighted on final disposal and solid waste management (SWM) system in Chittagong for improving its inhabitant's environmental health and how peoples perceived on solid waste management activities in their areas. Sanitary land filling was cost very low and it did not require any technology. Chittagong City Corporation was practicing a sanitary land filling of waste disposal at 'Rowfabad' under Bayezid Bostami (R) Thana, about 3.5 miles away from Chittagong City. The waste generation rate in Chittagong City was 0.30 kg/capita/day (CCC, 2000). Chittagong City Corporation requires an estimated space of 232272.73 cubic-metres (approximately 188 acre-ft) for disposal of solid waste per year. The population growth rate of Chittagong City Corporation was high about 6% (BBS, 1997) and waste production was increasing with the increase of population annually. More vacant space would be required for the improvement of collected solid waste disposal. Increase in collection coverage will aggravate the disposal problem, if the volume of waste is not reduced. As such, waste reduction methods deserve serious consideration in conjunction with sanitary landfill method. Solid waste comprises of organic matter in Chittagong and those wastes contain high moisture and low phosphorous which meant incineration of solid waste in Chittagong City would not be a viable option because 1) large amount of heat will be required to evaporate the moisture content; 2) plastic and papers which mainly add to the calorific value are in low percentage; 3) The waste of Chittagong has lower calorific value since organic part of Chittagong a self sustained combustion reaction cannot be obtained from these wastes. The high percentage of organic matter in the solid waste shows a good possibility of composting for Chittagong City garbage. Moisture content between 50 and 60 percent and carbon-nitrogen ratios between 35 and 50 are optimum for aerobic composting (Peavy et al, 1985, p. 661). The typical moisture content of solid waste of Chittagong was around 45% that was within the acceptable range. The carbon-nitrogen ration of Chittagong solid waste was 23.5% and 0.40% respectively. Soil fertility in many areas of Bangladesh has decreased due to excessive use of chemical fertilizer and lack of use and availability of organic manure (DoE, 1990, p. 68, and The Bangladesh Observer 1994 c, d). As such, the scope, need and importance of recycling of organic waste into organic manure, viewed from agricultural, environmental and sustainable development aspects, highlight the necessity of undertaking composting projects in Chittagong. Presence of high percentage of organic matter in the solid waste of Chittagong made it favorable for bio-gas production. The solid waste of residential and commercial area of Chittagong contained 70%-80% organic matter. Generally, 8 to 12 cubic foot's gas can be produced by decomposition of 1 found of organic solid waste of which 60% is methane (Pandey et al., 1992, p. 247). Therefore, bio-gas from organic solid waste has good prospect in future to meet the energy requirements of the Chittagong. However, at present bio-gas may be used in areas where natural gas is not available. So, anaerobic digestion for production of bio-gas would obviously help environmental improvement of Chittagong City.

Keyword: *Solid waste, Disposal, Compost, Landfill, Incineration etc.*

1. INTRODUCTION

Of all functional elements involved in solid waste management, disposal is the most important element as it includes planning, administrative set up, finance, technology support & their interdisciplinary relationships. The crucial aspect of this stage is the selection of proper disposal technology (Shukur et al, 1993).

Disposal referred to the 'different treatments which are given to the waste for avoiding environmental & health hazards'. Success of solid waste management system directly related to disposal efficiency. It is determined at the stage where the collected waste is unloaded on dumping site to its final stage- disposal. To dispose waste in efficient way technology knowledge, trained manpower, appropriate infrastructure & availability of land is required (UNCHS, 1988; Schertenleib, 1992b; Islam, 1992b).

For disposal of solid waste commonly used methods are open dumps, landfills, sanitary landfills, and incineration plants (Ogwa, 1989). One of the important methods of waste treatment is composting. Selection of proper disposal method is necessary & primarily it depends on the 'quantity of MSW generated & type of waste to be disposed'. There is, however, no single technique which is suitable in all situations.

Urbanization is now becoming a global phenomenon. Rapid urbanization and uncontrolled growth rate of population accelerate the generation of municipal solid waste. The increasing population directly influences the municipal solid waste generated around the surrounding areas (Ahmed, 1993; 1994). The socio-economic profile of the population, the consumption patterns govern the characteristics of the waste generated. The industrialization not only influences the quantity of waste but also affects level of urbanization & increases population levels which results in increase in the overall waste generated (Enayetullah, 1995).

The compositions of solid wastes are related primarily to the standard of living and dietary habits of the population (Devkota, 1993). The composition of waste is also time variant. In addition to the qualitative difference, the quantum of generated garbage shows wide variation too. Some decades ago the waste was mainly contributed by biodegradable contents. So the simple open dump disposal do not harm the situation but the present trend indicates that the plastics & other non-biodegradable content in solid waste is on rise, while the organic content (biodegradable) is comparatively low (Trivedi et al, 1992).

The municipal solid waste is a mixture of vegetables and non vegetable wastes in cooked and uncooked stages, leftovers, Packaging materials, papers, plastics, rags and other fabrics, dust, ash and a variety of combustible and non - combustible matter. The waste characteristics are change due to urbanization, increased commercialization and standard of living. People are consuming more than their “basic needs”, and the list of “wants in life” is endless. With the following data, one can imagine how huge task have to be accomplish. Metro cities like Chittagong is severely facing the problems related to disposal of waste (Goldstein, 1989; Glenn, 1990).

2. MATERIALS AND METHODS

2.1 Site selection

In Chittagong Metropolitan City, there were 41 wards; it was not possible to investigate the feasibility of alternative options for each and every ward. So the final disposal site as the main sampling site for this investigation. This study was done from January 2000 to August 2000 for a period of 08 months.

2.2 Methods of investigation

Questionnaire survey is conducted among the inhabitants near the dumping site to get their views regarding various issues related to final disposal and alternative options for Chittagong. Due to lack of time each and every ward in Chittagong Metropolitan City area was not possible to survey.

2.3 Discussions and consultations with organizations officials

Different offices are visited and officials are consulted to know their views, and suggestions for the proper solid waste management system of Chittagong city. Different offices which are visited and consulted are World Health Organization (WHO), World Bank (WB), Asian Development Bank (ADB), Department of Environment (DoE), Chittagong City Corporation (CCC), German Cultural Centre (GCC), Chittagong Water and Sewerage Authority (CWASA), Local Government Engineering Department (LGED) and Public Health Engineering Department (PHED).

2.4 Data analysis

Collected information and date were analyzed and literatures were explored related to final disposal practice and what would be the alternative options for Chittagong.

2.5 Limitations of the study

The study was based on primary information (interviews, observations, questionnaire survey, and informal talks), and secondary information collected from various agencies. Detailed discussions on alternative options for solid waste management were drawn with the current practices of waste disposal of households and had been provided along with identification of problems, efficiency and draw backs of the present system.

3. RESULT AND DISCUSSION

This research evaluates the waste disposal options for Chittagong City. Final disposal of solid waste is one of the major problems of SWM of the metropolis. The following sections deal with different options for final disposal of solid waste in Chittagong City.

3.1 Current waste disposal practices in Chittagong

Open dumping

The cheapest and the oldest easy method of Municipal Solid Waste (MSW) disposal is 'open dumping' where the waste was dumped in low - lying areas on the city outskirts. Open dumping is not a scientific way of waste disposal. Open dumps refer an uncovered site used for disposal of waste without environmental controls. The waste was untreated, uncovered, and not segregated. In spite of its simplicity in execution, the financial involvement for this traditional method of waste management has been quite high particularly for the big metropolis.

Uncontrolled, open dumps are not a sound practice. Open dumps are exposed to flies and rodents. It also generates foul smell and unsightly appearance. Loose waste is dispersed by the action of wind. Drainage from dumps contributes to pollution of surface and ground water and also the rainwater run-off from these dumps contaminates nearby land and water thereby spreading disease. A World Health Organization (WHO) expert severe pollution of the environment “Dumping should be outlawed and replaced by sound procedures”.

Land filling

Disposing of waste in a landfill involves burying the waste, and this remains a common practice in most countries like Chittagong. Landfills were generally located in urban areas where a large amount of waste was generated and had to be dumped in a common place. The equipment required to operate was relatively inexpensive. Landfills were often established in abandoned or unused quarries, mining voids or borrow pits (Ogwa, 1989).

Unlike an open dumping, it was a pit that was dug in the ground. The waste was dumped and the pit was covered at the dumping ground with debris/ soil and spread evenly in layers. At the end of each day, a layer of soil was scattered on top of it and some mechanism, usually earthmoving equipment was used to compress the garbage. Thus, every day, garbage was dumped and became a cell. The organic waste undergoes natural decomposition and generates a fluid, which is known a leachate, and is very harmful to the ecosystem. After the landfill was full, the area was covered with a thick layer of mud and the site can thereafter be developed as a parking lot or a park.

By and large, crude dumping of waste for land filling was done in the most of the cities without following the principles of sanitary land filling. As negligible segregation of waste at source takes place, all waste including hospital infectious waste generally finds its way to the disposal site. Quite often industrial hazardous waste was also deposited at dump sites meant for domestic waste. The waste deposited at the dump site was generally neither spread nor compacted on a regular basis. It was also not covered with inert material. Thus, very unhygienic conditions prevail on the dump sites. The workers handling waste do so in highly unhygienic and unhealthy conditions. Leachate if not treated properly it penetrates the soil and, if not prevented, pollutes the ground water.

Sanitary land filling

An alternative to landfills or modern landfill which solves the problem of leaching to some extent is a sanitary landfill which is more hygienic and built in a methodological manner. Designed "landfill" means a waste disposal site for the deposit of residual solid waste in a facility designed with protective measures against pollution of ground water, surface water and air fugitive dust, wind-blown litter, bad odor, fire hazard, bird menace, pests or rodents, greenhouse gas (CH_4) emissions, slope instability and erosion. These were lined with materials that are impermeable such as plastics and clay, and are also built over impermeable soil.

Deposited waste was normally compacted to increase its density and stability, and covered to prevent attracting vermin (such as mice or rats). Many landfills also have landfill gas extraction systems installed to extract the landfill gas. Gas was pumped out of the landfill using perforated pipes and flared off or burnt in a gas engine to generate electricity. Fully operated landfills may even enhance property values. Constructing cost of sanitary landfills was very high.

Composting

Decomposition and stabilization of solid organic waste material has been taking place in nature ever since life appeared on this planet. Composting was done by decomposition and stabilization of organic matter under controlled condition. Waste materials that were organic in nature, such as plant material, food scraps, and paper products, can be recycled using biological composting and digestion processes to decompose the organic matter. The resulting organic material was then recycled as mulch or compost for agricultural or landscaping purposes. In addition, waste gas from the process (such as methane) can be captured and used for generating electricity. There was a large variety of composting and digestion methods and technologies varying in complexity from simple home compost heaps, to industrial-scale enclosed vessel digestion of mixed domestic waste. Methods of biological decomposition are differentiated as being aerobic or anaerobic methods, though hybrids of the two methods were practiced in public level (Glenn, 1990).

Vermi-composting

Vermi-composting is very successful at community level but it is yet to develop at commercial scale. Manual composting was carried out in smaller urban centers. Although mechanical composting plants were set up in cities but presently, only few plants out of them continues to be in operation. The high cost of mechanical composting plants and the non - utilization of by-products were among the factors which make the process an uneconomic proposition. The most critical link in the process of composting was the segregation operation. Hand sorting of garbage at the compost plant was expensive and unsanitary (Haug, 1980).

Depending upon the availability of land and its topography, economic viability, types of waste, quantity of waste and social conditions; one can choose any one or more or combination of two of the said techniques for waste disposal.

Household waste disposal methods

Doing a spring or fall cleaning for the house will generally expose unwanted junk, potentially hazardous waste and other household materials that make you think twice before chucking it into the garbage can. Protect yourself and the environment by disposing hazardous materials at designated landfills or recycling plants. Toss regular garbage to the curb, but remember to double-check what household items need special care before throwing them away.

Recycle

Recycling of household items was done by many of the residents to make money and for a greener and better environment. Give a second life to paper, plastic, aluminum, glass, metals and even some oil and fluid containers. Many plants owner buy these materials and recycling to produce raw materials for his own and also to sell to another company. Auto shops in many places take in small quantities of old motor and engine oil.

Special disposal method

Pressurized cans, chemical liquids and old paint require a little extra care before tossing in the communal waste bin. There was a connection with local waste service for special collection to dispose of liquid items. Flush away small amounts of cooking oil down the drain with a large quantity of water. Other liquids like coolant, paint or cleaning chemicals should never be flushed or dumped out in the yard. These chemicals can leach toxic poisons into plants and wildlife, corrode and leak into creeks, lakes or other bodies of water.

Personal entrepreneur

Some inhabitants were practicing dumping of their household wastes by using polythene bag available from the shopping centre during their way to office. Just throwing the bag by their own hand or even from the window of the multistoried buildings. This open dumping or with polythene are polluting the surrounding environment.

3.2 Solid waste disposal options or final disposal options for Chittagong

Final disposal of solid waste may be done by different methods, such as Sanitary Land Filling, Incinerations, Composting and Anaerobic Digestions. Feasibility of different techniques of solid waste disposal for Chittagong City was being examined

3.3 Sanitary land filling

Sanitary land filling is the method of disposing of solid waste on land without creating nuisance or hazard to public health or safety. Advantages and disadvantages are:

Advantages

1) The method is cheap and easy to operate; 2) Public health problems are minimized because flies, rats, and other pests are unable to breed in covered refuse; 3) There is no air pollution from burning of wastes and none from dust

or odors; 4) Fire hazards are very small; 5) There is less chance of water pollution and 6) Sanitary land fill, if properly planned, can be used later for construction sites or recreational facilities such as parks and golf courses.

Disadvantages

There is a danger of ground water and surface water pollution, if the landfill site is improperly chosen or if it is dug too deep. But this danger can be avoided by proper site selection. Moreover, sanitary landfill requires large area of land.

Feasibility of sanitary land filling in Chittagong

Sanitary land filling is a low-cost method, which involves simple technology and possesses good grounds for adoption in preference to the existing method of crude dumping (Ellis, S. 1991). Recently, Chittagong City Corporation is practicing a sanitary land filling of waste disposal at 'Ropabad' under Bayezid Bostami (R) Thana, about 3.5 miles away from Chittagong City.

The present waste generation rate in Chittagong City is 0.30 kg/capita/day, Chittagong City Corporation requires an estimated space of 232272.73 cubic-metric (approximately 188 acre-ft) for disposal of solid waste per year. The present population growth rate of Chittagong City Corporation is high about 6% (BBS, 1997) and waste production is increasing with the increase of population annually.

More vacant space would be required for the improvement of collected solid waste disposal. Moreover, with the increase of population and urban areas of Chittagong City it would become very difficult to find suitable disposal site within easy access for solid waste disposal, necessitating long haulage and resulting in increase of transportation cost. Certainly, increase in collection coverage will aggravate the disposal problem, if the volume of waste is not reduced. As such, waste reduction methods deserve serious consideration in conjunction with sanitary landfill method, in order to prolong the life of landfill sites and also to reduce SWM cost.

3.4 Incinerations

Incineration is the process of reducing combustible waste to an insert residue by high temperature burning (Strom, P. F. (1985). Incineration involves the burning of solid waste at high temperature to leave ashes, glass, metal and unburned combustibles amounting to perhaps one-fourth the original weight, which must be then disposed of in a landfill. The important factors to be observed have been the maintenance of a minimum temperature of 850^0 c in the combustion chamber to burn up the smoke produced and the presence of grit extractors to remove finely divided dust before it gets discharged into atmosphere.

The process of burning waste in large furnaces at high temperature is known as incineration (Williams et al, 1992a). Incineration is a disposal method that involves combustion of waste material. Incineration and other high temperature waste treatment systems are sometimes described as "thermal treatment". Incineration is carried out both on a small scale by individuals and on a large scale by industry. It is used to dispose of solid, liquid and gaseous waste.

Incineration facilities generally do not require as much area as landfills. Waste-to-energy or energy-from-waste is broad terms for facilities that burn waste in a furnace or boiler to generate heat, steam and/or electricity. At the end of the process all that is left behind is ash. It is recognized as a practical method of disposing of certain hazardous waste materials (such as biological medical waste).

Combustion in an incinerator is not always perfect and there have been concerns about micro pollutants in gaseous emissions from incinerator stacks. Particular concern has focused on some very persistent organics such as dioxins which may be created within the incinerator. Both the fly ash and the ash that is left in the furnace after burning have high concentrations of dangerous toxins such as dioxins and heavy metals. Disposing of this ash is a problem. Cost of incinerator and additional investment on pollution control devices make the process capital - intensive. Under

Bangladesh conditions large scale incineration plants are economically non - viable in view of their capital - intensive character and the low calorific value of city garbage available.

Advantages

1) The main advantage of incineration compared to other conventional methods of waste treatment and disposal is that large reduction in the volume of material requiring final disposal and the less severe constraints on land disposal of incineration ash compared to those of untreated solid waste; 2) Under certain circumstances, the heat energy released from combustion of the waste may be beneficially used or converted to another form of energy and 3) Incineration is often an appropriate treatment and disposal process in areas of high population density, where land for disposal of untreated waste may be unavailable.

Disadvantages

Incineration can present several economic, ecological and technical disadvantages such as: 1) High construction cost; 2) High operation and maintenance cost; 3) The need for skilled personnel to operate and maintain the plant; 4) Difficulty in using generated heat; 5) Destruction of potential recyclable material in the waste; 6) The needs for expensive control measure to prevent air and water pollution and 7) Among different methods of solid waste disposal, incineration is the most expensive one.

Feasibility of incineration in Chittagong

The major portion of solid waste comprises of organic matter and the wastes contain high moisture and low phosphorous. So, incineration of solid waste of Chittagong would not be a viable option because: 1) A large amount of heat will be required to evaporate the moisture content; 2) Plastic and papers which mainly add to the calorific value are in low percentage as most of these items are recycled in Chittagong and 3) The waste of Chittagong has lower calorific value (since organic part of Chittagong and Dhaka City wastes are almost same; a self sustained combustion reaction cannot be obtained from these waste characteristics.

3.5 Composting

Composting can be defined as biological decomposition of organic constituents of wastes under controlled condition (Rynk. (1992). This process can take place in the presence or absence of oxygen.

Advantages

1) Reduction of volume and weight of waste to be disposed of; 2) Reduction of emissions, such as odors and leachate (Poincelot, 1997); 3) Recovery of resources, with possible reduced disposal; 4) The most important use of compost is its application to land, as a fertilizer, soil conditioner or it can be used as a means of land reclamations; 5) Application of compost to land improves the quality of soil making it more productive; 6) Compost increases soil aeration; 7) Compost makes heavier soils easier to till; 8) Reduces soil erosion; 9) When compost is used in conjunction with chemical fertilizer, it makes the phosphorus more readily available and also prolongs the nitrogen availability to plant; 10) Compost also improves the quality and longevity of soil, reduces health risk of having pathogenic material in the environment; while improved aesthetic quality of surroundings is difficult to quantify but it is quite important in ensuring adequate maintenance of environment (Richard, 1992a); 11) Compost may be used on land for purposes like agriculture, horticulture, home gardening landscaping, land fill, forestry or commercial farming and 12) It has a buffer effect as a protection against very large application of chemical fertilizer (Enayetullah, 1995).

Disadvantages

In a mechanical plant, the construction cost is high, maintenance and operational cost are also high in mechanical plant, there might be difficulty in marketing the product and sufficient space is required for storage of compost and installation of compost plant (Hossain, 2000).

Feasibility of composting in Chittagong

The high percentage of organic matter in the solid waste shows a good possibility of composting for Chittagong City garbage. Moisture content between 50 and 60 percent and carbon-nitrogen ratios between 35 and 50 are optimum for aerobic composting (Peavy et al, 1985). The typical moisture content of solid waste of Chittagong is around 45% that is within the acceptable range. The carbon-nitrogen ration of Chittagong solid waste is 23.5% and 0.40% respectively.

Soil fertility in many areas of Bangladesh has decreased due to excessive use of chemical fertilizer and lack of use and availability of organic manure (DoE, 1990, p. 68, and The Bangladesh Observer 1994 c, d). As such, the scope, need and importance of recycling of organic waste into organic manure, viewed from agricultural, environmental and sustainable development aspects, highlight the necessity of undertaking composting projects in Chittagong.

3.6 Anaerobic digestions

Anaerobic decomposition is the process of digesting organic waste in the absence of oxygen and light. Bio-gas is the by-product of anaerobic decomposition of organic matter.

Advantages

High percentage of bio-gas can be produced, can be used as alternative of natural gas and can be produced successfully.

Disadvantages

Operation cost is high and need experts and personnel's.

Feasibility of anaerobic digestion in Chittagong

Presence of high percentage of organic matter in the solid waste of Chittagong makes it favorable for bio-gas production. The solid waste of residential and commercial area of Chittagong contains 70%-80% organic matter.

Generally, 8 to 12 cubic foot's gas can be produced by decomposition of 1 found of organic solid waste of which 60% is methane (Pandey et al, 1992). Natural gas reserve in Bangladesh is estimated at 303.62×10^9 cubic meter (BBS, 1993). With the present rate of consumption, this reserve is expected to be exhausted in 20-22 year's time i.e. by 2013-2015 AD. Therefore, bio-gas from organic solid waste has good prospect in future to meet the energy requirements of the Chittagong. However, at present bio-gas may be used in areas where natural gas is not available. So, anaerobic digestion for production of bio-gas would obviously help environmental improvement of Chittagong.

3.7 Environmental Impact of Solid Waste

Improper solid waste management leads to substantial negative environmental impacts (for example, pollution of air, soil and water, and generation of greenhouse gases from landfills), and health and safety problems (such as diseases spread by insects and rodents attracted by garbage heaps, and diseases associated with different forms of pollution).

The important negative impacts due to inadequate solid-waste collection are: aesthetics, public health, traffic obstruction, contamination of ground and surface water, air pollution, disease transmission, on-site noise pollution, public relations, and potential on-site fire hazards. Due to high population density, the dominant agronomic activities in urban areas impact solid waste insignificantly.

Health impacts due to solid waste collection

Scavengers suffer from serious occupational health risks. Because of manual handling and lack of protective clothing and equipment, they are undoubtedly exposed to various health risks (Wilson et al, 2006). Getting direct contact with toxic and infectious components, odor, polluted air and water are most common factors responsible for health risks.

Table-1: Risk causing factors associated with handling solid wastes manually

Origin of risk factor	Example of source of possible risk
Composition of waste	Toxic, allergenic and infectious components including gases, dust, leachate, sharps, broken glass
Nature of organic decomposing waste	Gaseous emissions, bioaerosols, dust, leachate and fine particle sizes, and their change in ability to cause a toxic, allergenic or infectious health response
Handling of waste	Working in traffic, shoveling, lifting, equipment vibrations, accidents
Processing of waste	Odor, noise, vibration, accidents, air and water emissions, residuals, explosions, fires
Disposal of wastes	Odor, noise, vibration, stability of waste piles, air and water emissions, explosions, fires

Source: Cointreau, undated cited in Wilson et al, 2006.

Forty nine percent (49%) of the respondents were affected by diarrhoea. They reported that respiratory problems and skin diseases are common among the scavengers. Poor living condition also contributes in health problems and in many cases, it is difficult to distinguish between health implications of work and living conditions (Eerd, 1996).

Fig-1: Negative impacts of unmanaged solid waste (Waste Concern, 1999, 2000).

Environmental impacts for poor management of solid waste disposal

Waste disposal refers to the management of the huge amount of waste from modern societies. Various methods to collect and decompose waste in an organized manner have been used, but emissions from the collected waste remain

a threat. However, the environmental impact of waste disposal is not limited to the effects on the atmosphere; waste disposal also affects the world's flora and fauna.

Methane (CH_4) Emission

Methane **(CH_4)** is a strong greenhouse gas and one of the primary factors contributing to global warming. It is emitted in considerable quantities by waste that fills landfill sites around the world. Landfills are one of the most widely used waste disposal methods. In simple words, household and industrial waste is accumulated in one large area, along with mining and quarrying waste, and is left to decompose.

Carbon Dioxide (CO_2) gas emission

Carbon dioxide and a number of potentially hazardous air pollutants in smaller concentrations are released during the process of incineration. Waste incineration is the burning of waste, which releases a large amount of energy, along with the aforementioned pollutants. Modern incinerators use mechanical, biological, heat and thermal treatment technology to contain the energy produced. This energy can be used for the production of electricity as well as heat.

Soil contamination for solid waste generation

In landfill sites, leachate fluids from the decomposing waste penetrate the underlying and surrounding soil and contaminate the groundwater. This water is either used by plants, which perish as a result of the soil pollution, or it can even be used as a drinking water source. For this purpose, elaborate -- but also more expensive -- containment landfills are used to prevent the leak.

Contribution to Acid Rain

Sulfur **(SO_x)** and nitrous **(NO_x)** oxides are two of the main substances that contribute to acid rain. They are released into the air during waste incineration, and when airborne they are brought back to earth through rain, creating a pollution cycle. Along with carbon dioxide, these pollutants are the main focus of modern technology incinerators, since their emission can have multiple effects on the environment, from air pollution, to water and soil contamination.

4. CONCLUSIONS

From this research it is clear that sanitary land filling is the simplest and inoffensive solid waste disposal method. Since the population of Chittagong City is growing day by day, so waste generation is also increasing. Consequently, land area is not available for disposal of solid waste. That is why, waste minimization is a crying need for Chittagong City. There is a good prospect of recycling the organic portion of wastes into compost that is important both for environmental and sustainable development aspects. So, Chittagong City Corporation should follow the composting method.

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