Proposed Waste Management Strategies for Small Pockets of Greater Hyderabad City: a Technical Review

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Abstract

Municipal solid waste management is one of the major environmental problems of world. Improper management of municipal solid waste causes hazards to pubic and environment. Various studies reveal that about 90% of MSW is due to improper management of open dumps and landfills, creating problems to public health and the environment. In Hyderabad more amount of solid waste is generating mostly due to the rapid population and industrialization and mainly due to unawareness of solid waste among the public and masses. In the present day, an attempt has been made to provide a comprehensive review of the characteristics, generation, collection and transportation, disposal and treatment technologies of MSW practiced in Hyderabad. An alternative and economically viable technique in the form of bio-mining attributed with refuse derived fuel (RDF) separation and compost recovery has been proposed. The day pertaining to has been carried out to evaluate the current status and identify the major problems. Various adopted treatment technologies for MSW are critically reviewed, along with their advantages and limitations.

Keywords: Bio-mining, Compost, Landfill, Municipal solid waste, Refuse Derived Fuel.

1. Introduction

Solid waste is a broad term, which encompasses all kinds of waste such as Municipal Solid Waste, Industrial Waste, Hazardous Waste, Bio-Medical Waste and Electronic waste depending on their source and composition. Solid wastes are those organic and inorganic waste materials produced by various activities of the society (Wolsink 2010). Solid waste management is becoming a major public health and environmental concern in urban areas of many developing countries (Phelps et al. 1995). Municipal solid waste comprises of domestic wastes and commercial wastes collected within an area (Annepu et al 2012). Municipal solid waste includes biodegradable waste, recyclable material inert waste and hazardous and non hazardous wastes. Depending on the physical state of waste, wastes are categorized into solid, liquid and gaseous (Ghose 2006). Due to rapid industrialization and population waste generation is more and people do not any awareness about MSW generation (Goel 2008). This is also one of the reasons for the rapid increase of solid waste. SWM involves activities associated with generation, storage and collection, transfer and transport, treatment and disposal of solid wastes (Frank et al. 2002). But, in Hyderabad, the Municipal solid waste management system comprises only four activities like waste generation, collection, transportation, and disposal (Gupta et al. 1998).

1.1. Status of Municipal Solid Waste in Hyderabad

Hyderabad is the capital and largest city of Telangana state. It occupies 650 kilometers on banks of Musi River. As of 2011, the population of the city was 6.8 millian while the metropolitan area had a population of 7.75

million, making it India's fourth most populous city. Generation of municipal solid waste is also more in high income areas. The waste generated in Hyderabad is 0.6kg/capita/day. The total waste produced in Hyderabad city per day is 3000 ton and per year 10950000 tons. As per recent estimates, the municipal waste generation in metro cities varies between 0.2-0.6 kg/capita/day (Agarwal *et al* 2005) and urban MSW generation is estimated to be approximately 0.49kg per capita per day (Fig. 1). This is estimated to be two are three times. However vary from city to city and the per capita waste generated in Hyderabad 0.62kg/day (Jampala et al 2016).

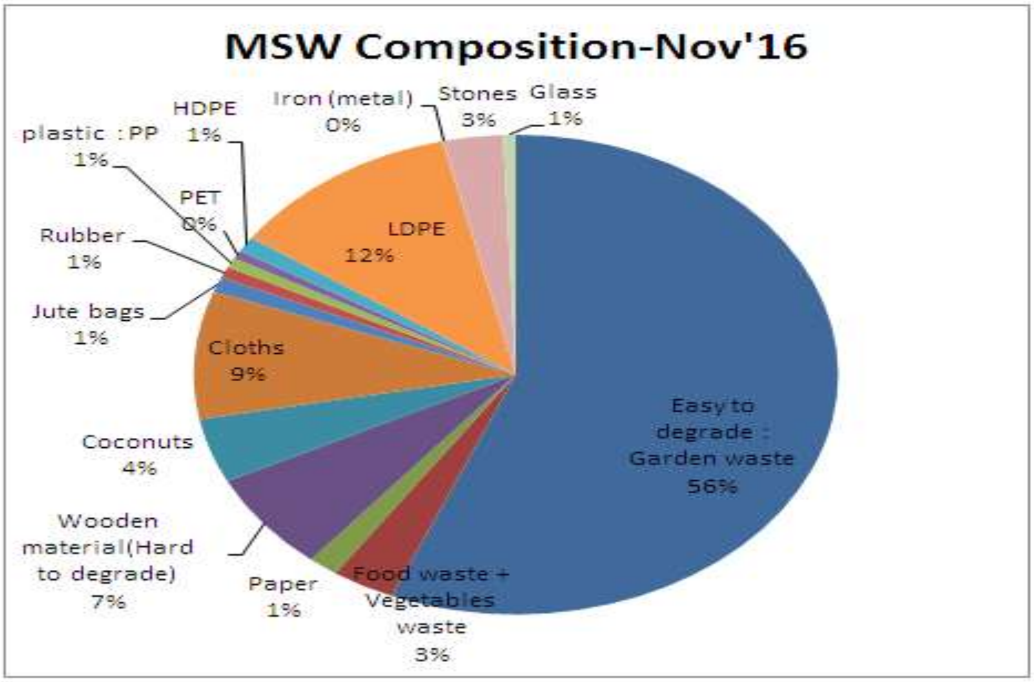

Figure 1: Percentage wise MSW Composition

2. Bio-mining

Bio-mining, a promising technology is extraction of metals from low grade ores and can also be employed to metal wastes. The technique would in turn revolutionize the mining of metals in an eco-friendly way and help create better future and better tomorrow (Fig. 2). This review article is a comprehensive article about bio-mining, the principle behind bio-mining, bio-film development and the techniques which are used for bio-mining. It also focuses on various mining areas around the world which make use of microorganisms for extraction of the metal to some extent. The paper also throws light onto the various microorganisms used with their efficiency to extract a particular metal. The paper highlights the beneficial uses of bio-mining and benefits of using microorganisms for extraction of metals. The paper concludes with the application of microorganisms in bio-mining and extraction of precious metals from electronic waste, contaminated sediments, fly ashes and other sources (Thosar et al. 2014). The cost effectiveness and economic feasibility of the process has been tabulated in table 1.

2.1. General Mechanism of Bio-Mining and Bio-Film Development

Breaking down of minerals into constituent minerals is the basis of bio-mining. This provides energy to the microorganisms involved (Das et al, 1999). The cascade of oxidation reaction consists of different intermediates. There are two mechanisms proposed for oxidation viz. Thiosulphate mechanism and polysulfide mechanism. Thiosulfate mechanism includes acid-insoluble metal sulphides like pyrite (FeS_2) and molybdenite

(MoS_2) whereas polysulfide mechanism includes acid-soluble metal sulphides like chalcopyrite ($CuFeS_2$) or galena (PbS) (Das et al, 1999; Sand W et al., 1993). In thiosulfate mechanism, the attack of ferric ion on acidinsoluble metal sulfides brings about solubilization via thiosulfate as an intermediate and sulfates as end-product.

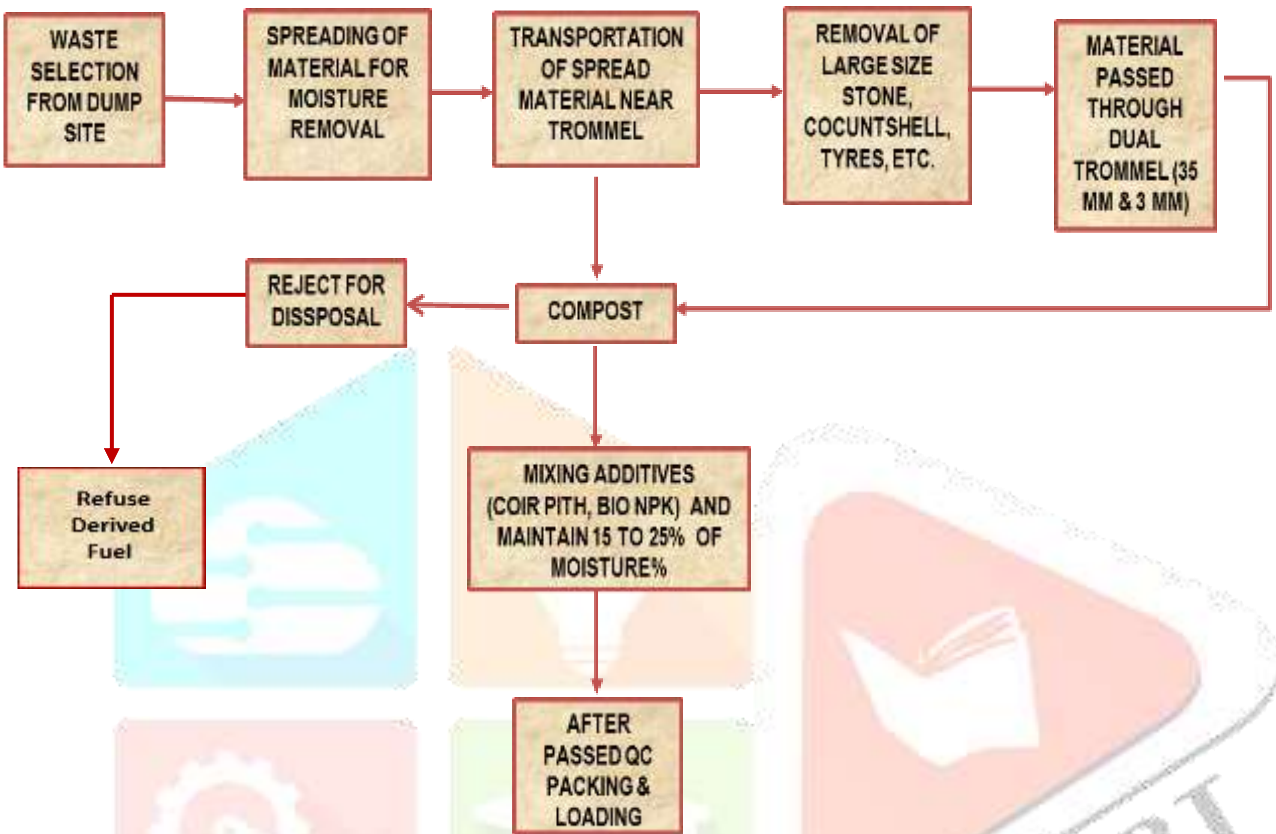

Figure 2: Process flow of Bio-mining

2.2. Factors affecting the biomining

Temperature and pH of the environment are the major factors affecting biomining. Either the growth of the organism is interrupted or the activity (biooxidation) is interrupted. It is the inherent property of microbes to respond the temperature and pH.

2.2.1. Effect of pH

The ranges of temperature and pH vary among microorganisms. Although the mostly used bacteria are *T. ferrooxidans* and *leptosporillium ferrooxidans*. The major reason for their usage in industries is due to their oxidation potential; certainly Fe3+/Fe2+ ratio. The pH value ranges from 1.8-2.5 is considered the optimum pH for the growth and activity of *T. ferrooxidans* while *L. feroxidans* have more acidic resistant ability than *T. ferooxidans* and grow at the pH of 1-2.

2.2.2. Effect of temperature

With the temperature changes the most preferred one is *Leptosporillium ferooxidans, T. ferooxidans* cannot tolerate the high temperature. The optimal temperature considered for the *T. ferooxidans* is 30-35^{0}C but strains can be activate at 100C.While *leptosporillium ferrooxidans* show their activity at maximum of 45^{0}C and minimum of 20^{0}C. Most of the biooxidation of gold recovery methods and concentrates operations are carried out at 40^{0}C and 1-6 pH value (Brierley 2008).

Table 1: Cost anticipated for Bio-mining

REQUIRE MACHINERY/EQUIPMENT	UNIT COST	QTY	TOTAL COST		
25 TPD Capacity of Trammel	500000	1	500000		
SHED	1500	1250	1875000		
EXCAVATOR	1300	20	26000	26000	
TIPPER	100	20	2000	2000	
JCB	550	20	11000	11000	
OPERATOR	15000	1	15000	500	
POWER	10	400	4000	150	
				39650	
			1YR	DAY	
		TRAMMEL	100000	273.9726	
		SHED	187500	513.6986	
		COMPOST	500	40437.67	
			50	808.7534	PER TON

2.3. Limitation of Bioremediation

Some common environmental limitations to biodegradation are related to hazardous chemical wastes which posses' high waste concentrations and its toxicity. Because some time this toxicity either inhibits the growth of microorganism or some time kill them. For proper growth of microorganism it requires of favorable pH condition and sufficient amount of mineral nutrients and also requires temperature on which maximum microbes can survive i.e. 20°C to 30°C. Once the limitations by environmental conditions are corrected, the ubiquitous distribution of microorganisms, in most cases, allows for a spontaneous enrichment of the appropriate microorganisms. In the great majority of cases, an inoculation with specific microorganisms is neither necessary nor useful. Besides all these some other factors are also effect the bioremediation such as solubility of waste, nature and chemical composition of waste, oxidation – reduction potential of waste and microbial interaction with this. Hence the researchers should search genetically different type of microbes which can also work on slightly adverse condition. Therefore, bioremediation is still considered as a developing technology to regulate the day to day environmental problems faced by man residing in an area (Tiwari and Singh, 2014).

3. Refuse Derived Fuel (RDF)

Densified Refuse derived fuel (d-RDF) generally refers to the product of CHEMICAL plus MECHANICAL processing of Municipal Solid Waste (MSW) produce as per specific output. The current research work is the assessment of the energy available from the MSW and from the rural Village for the Self-Sustainable development of new (RDF), as a green fuel and development of the new site for MSW management. The study also entailed the Collection and Segregation of all the energy available in the villages as well as Municipal Corporations. From the study it is found that the green village as well as Municipal Corporation has considerable energy potential. The magnitude of the energy density will help in building a self, power generation villages. The energy & green fuel density will also help for the development of the green fuel at one particular village as well as at MC locations. A suitable sustainable renewable energy generation from the green fuel, system of (SITES) which was studied for the villages and for MC is also being recommended with STATE of the ART designs for sites as SMART-CITITIES projects of INDIA (Fig. 3) (Kothari and Thorat, 2014).

3.1. RDF Characteristics

Calorific Value is 2500 – 3000 Kcal /Kg. High Volatile Matter (60%). Emission Characteristics d- RDF is Superior Compared to COAL with less NOX, SOX, CO & CO2. Bio fertilizer and the FLY ash are the useful by products. Analysis of City Waste was carried out recently, reveals 37.8% easily compostable (short-term biodegradable) materials, in which 19.5% hard lignite and long-term biodegradables, and 16.20% textiles. The plastics and rubber components having 35.70% content in the MSW which become a major cause of concern. These materials are a negative contributor to the processing plant efficiency and rapidly exhaust available land for land filling. Refuse derived fuel (d-RDF) is a kind of alternative solid fuel which is derived from domestic or insulated solid wastes, recyclable materials such as plastic, glass, metal, etc or after decomposition burnable hard to recycle materials (Table 2).

Table 2: Characteristics of different conventional and alternative fuel sources

RDF Types	Heating value of received (J/g)	Moisture Content (%)	Ash Content (%)
RDF	12,000 to 16,000	15 to 25	11 to 22
Coal	21000 to 32000	3 to 10	5 to 10
MSW	11000 to 12000	30 to 40	25 to 35

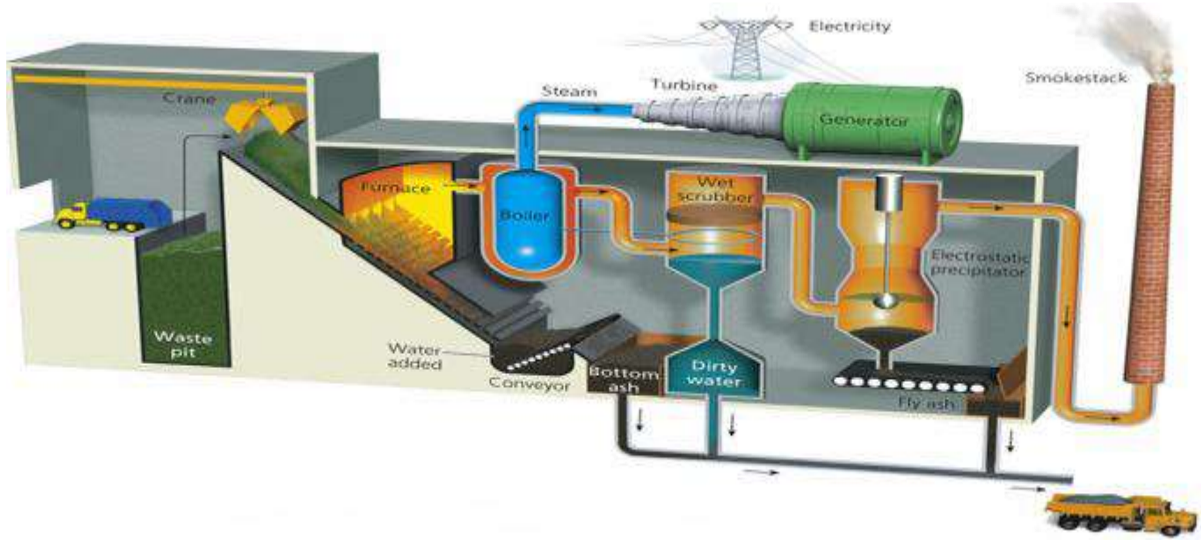

Figure 3: Waste to Energy cycle by incinerator

4. Compost recovery

The quality of compost and its suitability for agricultural application depend upon physical and chemical parameters such as water-holding capacity, porosity, pH, electrical conductivity, C/N ratio, available nutrients and the absence of toxic substances. Organic waste composting is a controlled bioprocess that has been proposed as an alternative to landfilling and the incineration of municipal solid waste (Fig. 4) (Rosen *et al.* 1993, Ribeiro *et al.* 2000, Soumare *et al.* 2003, Manios 2004, Adani *et al.* 2004). Composting is usually carried out by aerobic processes, although more recently an anaerobic pre-treatment of MSW has also being utilized, followed by an aerobic curing step (Vogt *et al.* 2002, Silva *et al*. 2004). During composting, several groups of bacteria, yeasts and fungi metabolize the waste to produce a stable organic-rich, soil-like material, while producing CO_2, energy and microbial biomass (de Bertoldi *et al*. 1983). Aerobic MSW composting facilities include a pre-processing step, consisting of an initial screening to remove contaminants and recyclable materials, even if the organic waste has already been separated at its origin. The organic solid waste then remains in windrows, static piles, aerated piles or in com posting tunnels for several weeks. During this period in which active decomposition of organic waste takes place, the composting material is aerated periodically, either by mechanical turning or by means of forced aeration through open floor systems. After the active composting period the partially decomposed biowaste requires additional curing for at least 2 or 3 months in order to produce mature and stable compost, which can be used in agriculture, soil reclamation, landscaping and gardening, and as a component of growing media for containerized plants (Silva et al., 2007).

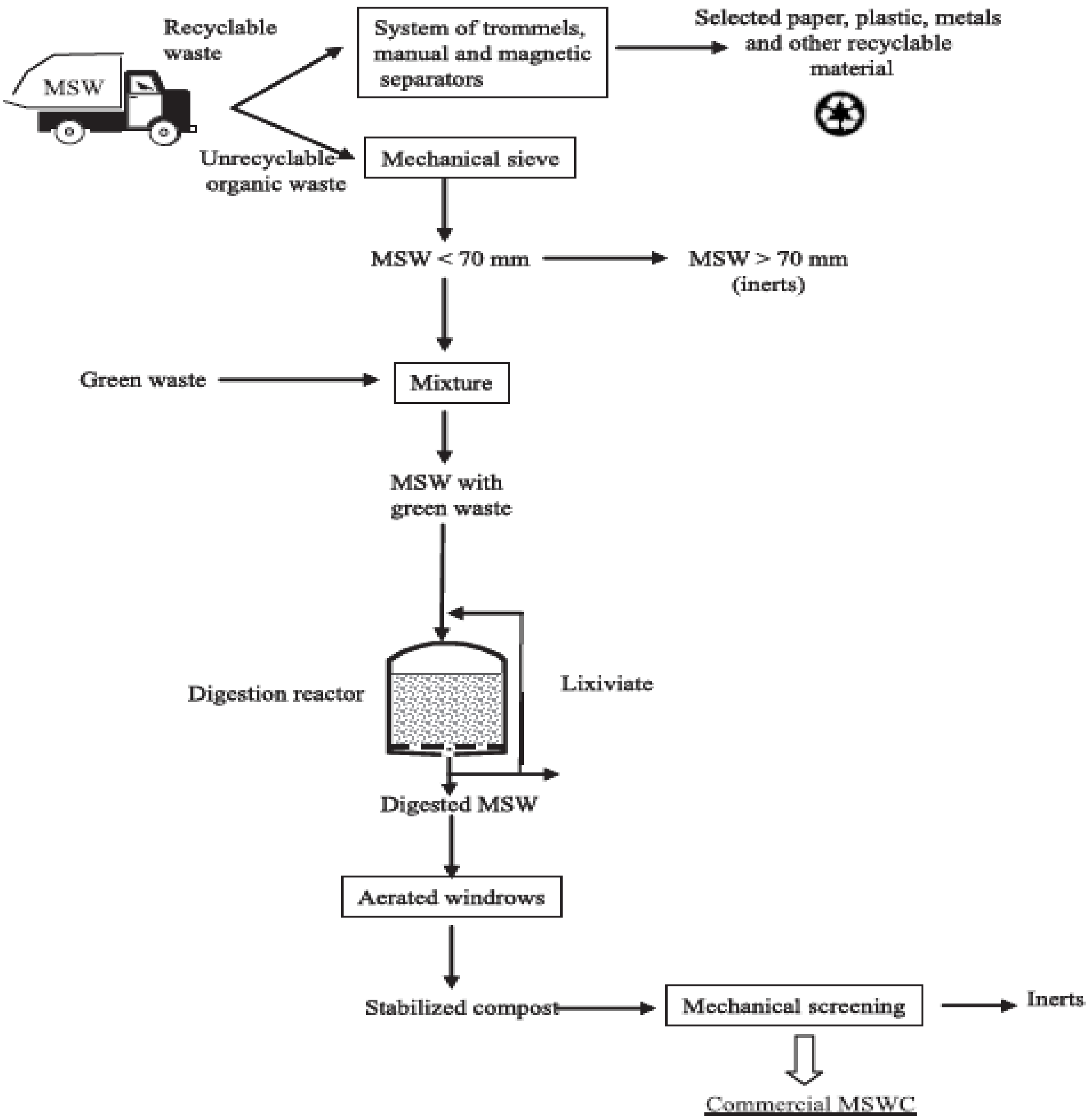

Figure 4: Scheme of the process followed to obtain the municipal solid waste compost

5. Smart Solution

Waste conversion systems, including both the mass burn and d-RDF technologies, have the potential to provide as much as 3% of the nations annual energy demand. Furthermore, the recycling of inorganic such as ferrous metals, glass and aluminum would further reduce our total energy use by an additional 1%. Beneficiation of d-RDF is given as; (1) Cement Production using d-RDF as a supplemental fuel is an economically viable option to reduce fuel costs and reduce landfill disposal. (2) Produces beneficial effects on air emission and ash residue when used as a fuel. (3) Produces a more homogeneous fuel which burns more evenly at a higher temperature thereby making combustion control easier. (4) Has a higher calorific value content, lower ash and moisture content. (5) Allows recovery of saleable materials. (6) Can be processed at one site and transported to other location for combustion. (7) Can be burned in a wide range of existing boilers, fluidized bed combustors, gasifies and cement kilns with no, or only minimal modifications required. (8) Can be co-fired in existing boilers with other fuels such as coal, wood or sewage sludge. (9) Achievers 50% greater power generation efficiencies than mass burn power plant, when blends of d-RDF and Coal are co-fired (Fig. 5) (Kothari and Thorat, 2014).

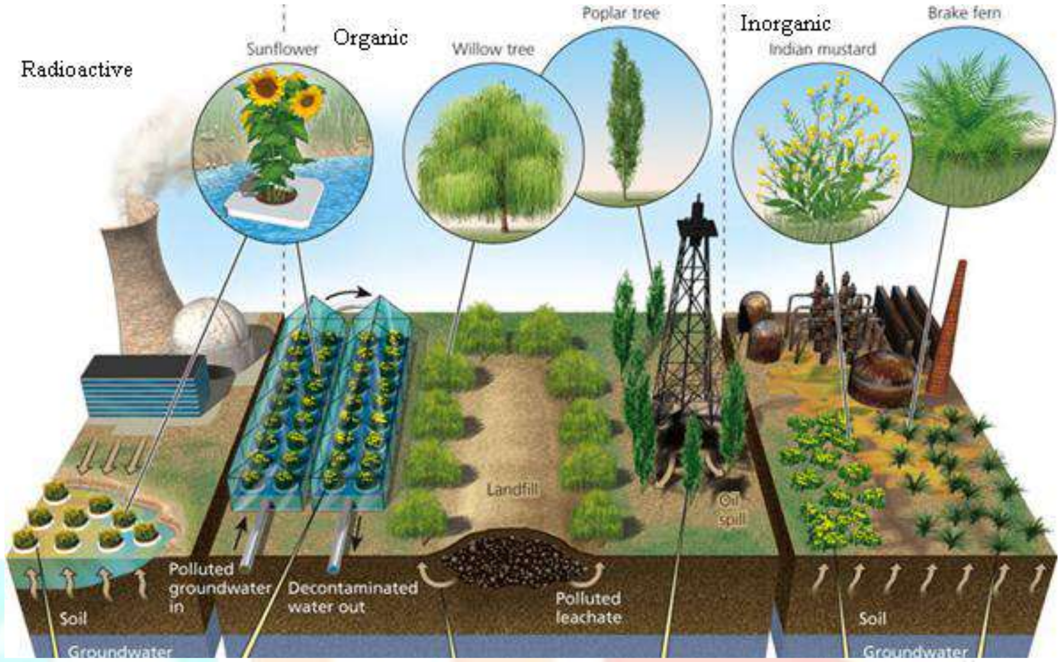

Figure 5: Smart management of landfill

6. Conclusion

Municipal solid waste at Jawahar nagar is being maintained well by greater Hyderabad Municipal Corporation. Proper segregation of solid waste at the point source of generation is very important for easy & safe disposal. For proper management of municipal solid waste the municipal authorities should maintain the storage facilities in such a manner that they do not create unhygienic & unsatisfactory conditions. Transportation of vehicles should be regularized to reduce the quantities of waste disposed on road sides. Open dumping of waste without proper maintenance leads to soil & ground water pollution (due to leakage of leachate), bad odour, harmful gases released into atmosphere causing several health hazards. Sanitary land filling should be encouraged under the guidance of pollution control authorities. Anyway, rural areas in absence of ample manpower and finance biomining can be a pertinent alternative to cumbersome and cost consuming landfilling process. Furthermore, if biomining get attributed with separation of heavy fraction of MSW such as jute bag, cardboard, clothes, coconut coir etc. then Waste to Energy (WTE) concept can be implemented in practical scenario. Moreover, the organic fraction can be effectively converted into nutrient rich compost which will open an economic niche for small scale entrepreneurship. The policies of Reduce, Reuse & Recycle (3R) play an important role in the reduction of solid waste. Some areas of Hyderabad are generating more amount of solid waste due to lack of awareness on municipal solid waste management among the public. The municipal authorities should aware the public about the health hazards due to improper management of the waste.

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