<u>Proposal of Lifecycle reduction of MSW using Bioreactor model</u>

Background:

As compared to many developed countries, the concept of bioreactor landfill operation is still relatively very new to India. As a solution to mismanaged open dumps in the country, a systematic rehabilitation strategy must be planned and executed. The simplest thing that can be achieved in the short term without much additional investments to significantly improve the open dumps and reduce its adverse impacts and associated nuisances is to move to controlled tipping. As a well-known fact that landfill are an unavoidable component in MSW management and its planning, design, construction, operation and maintenance involves technical skills and safety measures in terms of protection of health and environment (CPCB, 2008). The landfilling of biodegradable waste can lead to many environmental problems including fires and explosions, odour nuisance, vegetation effects, pollution of water bodies and soil, local air quality impacts and GHG emissions (Donovan et al., 2011), which need to be strategized properly. Moreover, according to Poulsen (2014), the future landfill is becoming more recycling and temporary storage station type and that the requirements for new landfill space will be reduced in the long term. Beside this, it is widely recognized that MSW management is not only a technical problem, but is strongly influenced by political, legal, socio-cultural, environment and economic parameters, as well as being constrained by the available resources (Kum et al, 2005).

India produces around 70 million tons of MSW annually, of which at present less than 5% is processed scientifically (Planning Commission of India, 2011). Given the scarcity of urban land for scientific waste disposal there is a common practice of open dumping with most of the dumpsites overflowing in urban cities. Due to this practice waste continues to be one of the biggest public health, environmental, and land-use challenges for urban cities in India (Planning Commission, 2011). Almost all cities have adopted open dumping for MSW disposal (TERI, 2010). Rapid urbanization and population growth are largely responsible for the very rapidly increasing rate of MSW in urban areas, its proper management and recycling is a major problem for urban local bodies (Gautam et al., 2009). There are more than 5100 municipalities in India. The average collection efficiency of MSW ranges from 22 to 60%. The waste characterization data showed that MSW typically contains 51% organics, 17% recyclables, 11% hazardous and 21% inert. Municipalities have been mandated to implement the MSW (Management & Handling) Rules, 2000 in all towns/cities of India to cover 100% collection, segregation, transportation, treatment and disposal of waste (MoEF, 2010b). India's per capita waste generation varies from 0.2 to 0.6 kg in cities with population varying from 0.1 to 5.0 million and it is increasing by 1.3% per annum. Moreover, with the growing urban population, the MSW is expected to increase by 5% (Ahmad and Choi, 2010). Moreover, study shows that landfills are the second-fastest growing source for methane emissions in India after coal mining (IEA, 2008). The total GHG released from the waste sector in 2007 was 57.73 million tons of CO_2e, of which, 2.52 million tons was emitted as methane that is, 22% of the emissions were from MSW disposal (MoEF, 2010a). Studies carried out in 59 selected cities by CPCB in India have revealed that not a single landfill site has LFG to energy facility (Kumar et al., 2009). Pre-feasibility studies have been completed for evaluating LFG to energy potential at landfills in Pune, Ahmedabad, Mumbai, Hyderabad, and Delhi.

It has been found that about 4000–5000 TPD of MSW reached to the Delhi's landfills in the year 2011–2012 (Annepu, 2008). On an average, the compostable matter in Delhi's MSW range within 55 ± 20% with rest of the fraction as non-compostable material. Out of the non-compostable materials, recyclable materials (mainly polythene, plastic materials, foam, paper, packing and packaging materials, metals, cloths etc.) amounts to 20-30% while rest are inert material like construction and demolition waste, excavated soil, silt etc.

The waste degradation in landfills can be accelerated by operating it in the bioreactor mode and in the end; the "stabilized" waste mass with limited methane and odor production and less harmful leachate that can be recovered creates valuable landfill airspace. In this matter the research was been carried out since more than past ten years, the experimental testing and field, pilot studies have been conducted to develop for improve landfill techniques. The bioreactor technology accelerates the biological decomposition of food, green waste, paper and other organic wastes in a landfill by promoting conditions necessary for the microorganisms that degrade the waste. The single most important factor in promoting waste decomposition is the moisture content of the waste. The Bioreactor landfill has advantage in recovering of 15 to 35 percent of landfill space as waste decomposes and is converted to gas extends the useful life of landfills, reducing the need to site new facilities, and reduce the GHG emission.

We in our study will designs the latest bioreactor landfill model to enhance solid waste degradation with aim to reduce the time period of landfill, reduce the land use for landfill, treatment and recirculation of leachate, increasing methane production and collection, accelerating the subsidence of waste and thus permitting GHG recovery and reduction of contamination life span. The techniques used to enhance the degradation process will involve the separation and shredding of waste, leachate recirculation and use of microbial consortium, for increasing the rate of degradation.

Objective: To develop a latest working model of a landfill with life cycle reduction concept using microbial consortia and collection of methane for energy generation and reduction of the GHG emission.

PRIORITY:

- Building a demonstration model for the landfill using latest bio-cleaning techniques and waste management
- To develop a Life cycle reduction landfill model
- Biotechnological exploration for methane extraction using microbes
- Impact assessment of the new landfill model on ecosystem

PROPOSED WORK STRATEGY:

- **Selection of the suitable place for set up of demonstration plant** (Impact assessment strategies)

  The selection of demonstration plant will carried out keeping in mind the infrastructure requirement for the landfill model and will be made out of city to avoid NIMBY (not-in-my-backyard) effect, but well-connected for easy transportation of the waste and garbage for the landfill. We will try to sign an agreement with NDMC for the waste transportation so that we can work on the actual waste generated form the city.

Beside this we will try to work on landfill stability impact analysis which will include (i) Environmental Criteria, (ii) availability of Area, (iii) Design considerations, (iv) Development prospects insurance and (v) Social criteria

- **Construction of a bioreactor model**

The bioreactor accelerates the decomposition and stabilization of waste. At a minimum, leachate is injected into the bioreactor to stimulate the natural biodegradation process. Bioreactors often need other liquids such as storm water, wastewater, and wastewater treatment plant sludge to supplement leachate to enhance the microbiological process by purposeful control of the moisture content and differs from a landfill that simple recirculates leachate for liquids management. Thus, heterogenous and anisotropic nature of MSW greatly influences the distribution of leachate, moreover varying unit weight and saturated hydraulic conductivities with depth must be considered for design and leachate operation (Giri and Reddy, 2014). Landfills that simply recirculate leachate may not necessarily operate as optimized bioreactors. As moisture content is the single most important factor that promotes the accelerated decomposition. The bioreactor technology relies on maintaining optimal moisture content near field capacity (approximately 35 to 65%) and adds liquids when it is necessary to maintain that percentage. The moisture content, combined with the biological action of naturally occurring microbes decomposes the waste. The microbes used for this model will be either aerobic or anaerobic. A side effect of the bioreactor is that it produces landfill gas (LFG) such as methane in an anaerobic unit at an earlier stage in the landfill's life and at an overall much higher rate of generation than traditional landfills. Thus we will design the recovery of methane and use it for power generation.

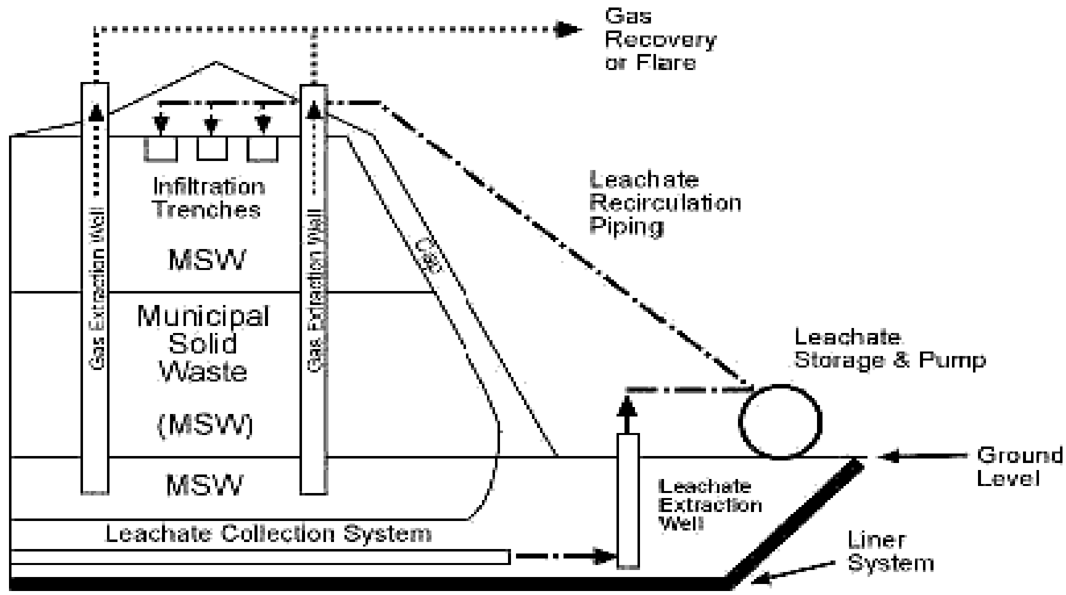

Fig: Schematic layout of a landfill demonstration plant

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