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Estimation of land-fill gas generation from municipal solid waste in Indian Cities

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Abstract

Estimation of methane emission from the landfills is very much required for fast urbanizing countries. Rapid growth in population and industrialization causes a direct impact on the environment. As methane emission is a key contributor to the greenhouse effects it is necessary to quantify the methane emission from municipal solid waste (MSW), so as to take measures to ease the greenhouse gas emission. In this present study four models have been used to quantify the LFG emission estimation characteristics from MSW in six metropolitan cities covering different parts in India for a period of 30 years (1982 - 2012).

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Keywords: GHG emission; Municipal solid waste; Landfill gases; Indian cities; LFG estimation

1. Introduction

In recent times with rapid urbanization, management of municipal solid waste (MSW) is one of the biggest problems faced by India and other developing countries. According to Census 2011, India with a population of 1.21 billion generates about 100000 tons of municipal solid waste (MSW) per day. Daily per capita waste generation rate vary from 200 to 600 gm in major cities of the country depending on the lifestyle adopted by the people and the nature of the places [1]. Few years back community bins collection was practiced, however after commencement of MSW (Management and Handling) rules 2000, collection, segregation and containerized system adopted in many

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cities. But unfortunately almost 70-90% of MSW is openly dumped, which is the most ordinary and cheapest disposal method for every municipalities of India [2].

The unscientific way of dumping MSW in landfills may lead to hazards like soil pollution, ground water contamination and air pollution due to emission of greenhouse gases. Lack of attention by the government causes huge amount of methane gas exposed into the atmosphere. Methane is one of the major ingredients of greenhouse gases (GHG) which is responsible for global warming. Today methane is the second most greenhouse gas after carbon dioxide. About 30% of methane emitted to the atmosphere is from landfill sources as per Intergovernmental Panel on Climate Change (IPCC) [6]. Today policies have been adopted all over the world to reduce emission of landfill gases (LFG) from MSW.

Quantitative assessment of landfill gases with appropriate methodology is required to reduce the greenhouse gas emission by possible means waste to energy conversion. It is not feasible for a new project to be successful if we do not asses potential of the source. For the application of new technologies it is also necessary to determine the energy generation potential from MSW. Government is adopting new concept to recovery energy from the MSW but in most of the cases, lack of insufficient potential of raw material leads to a failure. Although MSW treatment is a great challenge but it can prove to be a golden opportunity if we can extract energy using certain technologies. The energy recovery from the MSW may repay for energy demand and thus to minimize the use of conventional energy sources. Various inventories are practiced throughout the world for estimation of landfill gases. India is also adopting different methodologies for assessing GHG emissions like stoichiometric method, IPCC 1996 default method, IPCC 2006 first order decay (FOD) method, triangular method (TM), modified triangular method (MTM), in-situ closed flux chamber method [2]. Protocol like First Order model (TNO), Multi-phase model, LandGEM model (US-EPA), EPER Model Germany (UmweltBundesamt), GasSIM, EPER Model France (ADEME) are used by European Union and other developed nation also for estimation LFG emission from landfills [3]. In many countries estimation of LFG using these inventory is a great challenge because of inadequate data availability on MSW management. During the landfill process the municipal waste has to gone through a certain stages like collection, transportation and or segregation leading to variation in quantity and quality of waste during final disposal of waste. In the present paper an attempt has been made to estimate LFG emissions from landfills of some selected tier I cities in India considering various factors in Indian condition.

2. Methodology

Four different models (1) First Order model (TNO), (2) Multi-phase model (Afvalzorg), (3) LandGEM model (US-EPA) and (4) EPER Model Germany (UmweltBundesamt) have been used to carry out the present work. All the data implemented here were secondary data collected from different sources. Tier one cities of India were selected for quantification of LFG emission for a period of 30 years from 1982 to 2012. Populations of the respective cities have been obtained from Census 2011. Here it is considered that total MSW generated in the city are directly proportional to the population of the city and with no collection recovery efficiency. In the existing work, we have considered per capita MSW generation in Indian cities increased with a rate of 1.2 % every year [4]. Total volatile solid (VS) and organic carbon content of the typical MSW in urban India have been considered as 13.27% and 12.06% respectively in wet weight basis throughout the investigation. All the generated waste in throughout the city is landfilled in the respective dumping sites.

2.1. Overview of selected cities

To carry out the present work tier I cities of India are taken for estimation of LFG emission. Six cities (tier I) namely Bangalore, Chennai, Delhi, Hyderabad, Kolkata and Mumbai have been selected for this study. As per government of India tier I refer to the city having population of one lakh and above. Tier I cities are selected here because these cities are highly affected with the overwhelming increase in MSW with the increase in population and industrialization. Cities with area, population, and waste generation rates are shown in Table 1. The generated wastes of the city are usually landfilled within the city. Table 2 shows the landfill sites of the respective cities. Also the physical characteristics of MSW of these cities are shown in Table 3.