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Opportunities & Challenges in Capturing Landfill Gas from an Active and Un-scientifically Managed Land Fill Site - A Case Study

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Abstract

Currently, nearly 210 Million Metric Tonnes/Annum of Municipal Solid Waste (MSW) is generated in India and most of it gets disposed in Open and un-scientifically managed Landfills. The typical Indian MSW contains approximately 50% of bio-degradable organic components that starts degrading under anaerobic conditions and generates LandFill Gas (LFG). The LFG mainly contains Methane (40-50%) and CO_2 (50-60%). Methane is a Green House Gas (GHG), and is 25 times more potent than CO_2 in causing Global Warming and is the 2nd largest anthropogenic source of Methane emissions after coal mining. Thus capturing and destructions of LFG shall lead to mitigation of GHG emissions.In addition, open Landfill sites also pose safety risks like fire hazard, explosion, and asphyxiation etc. apart from health risks.

At the current MSW generation rate of 0.575MMT/day in India, the LFG generation potential is around 86.25 MMSCMD of LFG. Presently, LFG from the landfill sites is not being captured leading to fugitive GHG emissions. Further, due to rapid population growth and accompanying urbanisation and lack of new landfill sites, the existing waste handling infrastructure is getting stressed and leading to overflowing and vertical growth of the existing landfills. Thus Indian landfills provide good opportunities for the extraction & utilisation of Methane from LFG. However, there are lot of Issues that need to be overcome for exploitation of LFG in a sustainable manner.

GAIL (India) Ltd, a Maharatna company, as a part of its R&D activities has taken up an initiative in this direction and implemented a Pilot project to ascertain the recovery of LFG from an un-scientifically managed open active MSW dumping site at Ghazipur Delhi. The utilization of LFG for energy recovery is being explored. This Paper shares the Challenges faced and Key insights gained during the LFG Project Implementation and its Operation.

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1. Introduction

Millions of Tons of Municipal Solid Waste (MSW) is generated daily across the world. The MSW is disposed off in landfill sites. The MSW starts degrading under anaerobic conditions and generates Land Fill Gas (LFG). The LFG principally contains Methane (40-50%) and CO_2 (50-60%)and other minor constituents like H_2S in ppm level apart from few micro constituents. The Developing countries are disposing their MSW in open dump yards (which are not scientifically managed) leading to uncontrolled emissions of LFG to atmosphere. The Methane in the LFG is a potential Green House Gas (GHG), considered 25 times more potent than CO_2 in causing Global Warming. Methane emissions from waste handling are the 2nd largest anthropogenic source of Methane emissions after coal mining and nearly 1.5 percent of global warming is related to emissions from landfills (IEA, 2009). Apart from the global emission effect, these emissions have a local environmental impact on air quality at landfills and in the surrounding areas.Thus capturing of LFG for energy recovery or destructing it by combustion shall lead to mitigation of GHG emissions. In addition, open Landfill sites havesafety risks like fire hazard, explosion, and asphyxiation etc. apart from health risks. GAIL had taken up a Project to capture LFG (in Phase-1) at Ghazipur Landfill site in Delhi and purify it for use as CNG (in Phase-2). This Paper shares the key insights gained during the LFG Project execution.

2. LFG Generation Process:

LFG generation process consists of complex series of biological and chemical reactions as the refuse decomposes. The earlier studies indicate that at least four types of decomposition happens :(i) An Initial aerobic phase; (ii) An aerobic acidic phase;(iii) An initial methogenic phase and (iv) A final stable methogenic phase(Farquar and Rovers,1973). As the waste is initially dumped at the site it undergoes aerobic digestion leading to depletion of Oxygen and production of CO_2. This phase extends only for a brief period as the waste is being dumped continuously and compacted. The bottom lying waste starts getting subjected to anaerobic condition and supports fermentation reaction. The biodegradable organic constituents of waste are subjected to three types of bacterial actions: (i) Hydrolytic and fermentative bacteria hydrolyze polymers and ferment the resulting monosaccharidestocarboxylic acids and alcohols;(ii)Acetogenic bacteria convert these carboxylic acidsand alcohols to acetate, hydrogen and carbon dioxide; and (iii) Lastly, the methanogenicbacteriaconvert the end products of the acetogenic reactions to methane and carbon dioxide. The above reactions of LFG generation are greatly influenced by the field conditions like the actual composition of organic waste, moisture in the landfill, compaction level, ambient temperature etc. (González et al, 2011). Various theoretical & experimental studies report generation of around 100-200 M^3 of LFG per tonne of waste with 60% of bio-mass content. Considering a Methane content of 50% in LFG, the methane generation potential works out to 50-100 M^3/Tonne of MSW (Siddiqui, F. Z., et al, 2013).

3. MSW management In India:

Currently, nearly 210 million metric tonnes annum of MSW is generated in India & most of it is disposed in open landfills. The typical Indian MSW contains 50% of organic biodegradable components, 20% of recyclable portions, 22% inerts and others 8%. The biodegradable waste is contributed by food &yard waste. It is estimated that the level of per capita waste generation in India is 0.1kg, 0.3kg & 0.5 kg for small, medium and big cities respectively and is expected to grow at a rate of 1.3% per annum. Most of this collected waste (>90%) is not processed and gets disposed off in landfills that are not scientifically managed & lack safe disposal practices like landfill compaction, soil covering etc.(Siddiqui, F. Z., et al, 2013).Rapid population growth and accompanying urbanisation is putting huge pressure on the existing waste handling infrastructure. New landfill sites could not be developed due to acute scarcity of land. Consequently, Urban Municipal Bodies are not able to improve their waste management system which is leading to overflowing and vertical growth of the existing landfills. The LFG generated in these landfills is not being captured and utilised for energy recovery or destroyed for GHG mitigation.