

Literature review methane

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Methane Recovery from Landfills Utilization as a Potential Energy Source and Impact on Reduction of Green House Gasses According to The Conference Board of Canada, current Canadian municipal solid waste (MSW) generation levels are approximately 30 million tonnes per year, with a rate of 894 kg per capita, 67 percent of which is landfilled. (Jones L. et al. 2002) Sanitary landfills bury MSW under soil, sanctioning a complex series of reactions to occur, where anaerobic microorganisms decompose a portion of the organic fraction of the waste producing methane and carbon dioxide.

Methane generation and emission from landfills are topics of major interest due to methane's role in the greenhouse effect, migration of hazard potential, health and safety issues and energy applications. The objective of this literature review is to provide a concise relationship between MSW and landfill gasses (LFG), details of potential methods used for capturing methane as oppose to emitting the gas as well as the benefits of doing. Referring to information written by D. R. Reinhart and T. G. Townsend (1998), MSW contains approximately 50 - 70 % of biodegradable material, such as food, paper, wood, and garden trimmings.

Once MSW is deposited into a landfill, it undergoes a number of biological, physical and chemical changes. These changes are greatly dependent on site conditions, waste characteristics, temperature, quantity of oxygen, moisture content and other factors. (Nozhevinikova et al. 1993) The most important reactions occurring within the landfill are those involving the microbes which begin to consume the carbon in the organic material, in turn causing the decomposition and eventually leading to the evaluate of LFG.

In sanitary landfills, the process of burying waste and regularly covering deposits with a low permeability material creates an internal anaerobic environment that favors methane producing bacteria since the presence of oxygen is lacking. Pathways leading to the production of methane and carbon dioxide from anaerobic digestion of organic fraction of solid waste are briefly described below: 1) Decomposition of organic matter- In this preliminary process, compounds of higher molecular mass (Lipids, proteins, nucleic acids etc. are transformed into intermediate mass compounds making them much more suitable for the microorganisms as a source of energy and cell carbon 2) Conversion of decomposed matter to Organic Acid- In this phase, the existing microorganisms convert the intermediate molecular mass compounds into lower molecular mass compounds such as complex organic acids. 3) Conversion of Acetic Acid to Methane Gas- During this stage, the microorganisms transform the acetic acid into methane (CH₄) and carbon dioxide (CO₂) gases. Cassia de Brito Galvao, T. and Pos, W. H. 2002) As the solid waste decomposes in landfills, the gas which is emitted is composed of approximately 50 percent CH₄ and 50 percent CO₂, both of which are green house gases (GHG) (Bingemer, H G. , ; Crutzen, P. J. 1987) With Landfilling being the primary source of disposal of MSW around the world, (Encyclopedia Britanica 2012) methane emissions from landfill represent the largest source of GHG emissions from the waste sector, contributing around 700 Mt CO₂-e. United Nations Environmental Programme 2012) As recorded by Environment Canada (2010), similar trends exist nationally with emissions from Canadian landfills accounting for 20% of the total national methane emissions. Information gathered in a thesis prepared by Palanathakumar, B. (1991) outlines the <https://assignbuster.com/literature-review-methane/>

proportion of methane produced world wide from landfills, and can be seen illustrated graphically below in Figure 1.0. Figure 1.0: % of Methane Production Contributions Worldwide from Landfill Existing research leads to the confident statement that methane is a potent greenhouse gas.

As summarized in a 2009 article from the Municipal Solid Waste, the Journal for Municipal Solid Waste Professionals, In its Fourth Assessment Report (2007), The Intergovernmental Panel on Climate Change (IPCC) concluded that, on a 100-year time frame, each molecule of methane has a global warming potential 25 times higher than that associated with a molecule of carbon dioxide. (Duffy, D. P. et al 2009) Table 1.0 summarizes the enumerated global warming potential for the primary greenhouse gasses discussed. Table 1.0: Global Warming Potential (GWP) for a Given Time Horizon

Greenhouse Gas	GWP 20-yr (kg CO ₂ -e)	GWP (IPCC 2007) 100-yr (kg CO ₂ -e)	GWP 500-yr (kg CO ₂ -e)
Carbon Dioxide (CO ₂)	1	1	1
Methane (CH ₄)	72	25	7.6

(Forster, P. et al 2007) In the last decade, attention to methane emissions from landfills has grown significantly with increased and ongoing awareness of global warming. The efforts of individual landfills as well as the nations as a whole are closely monitored for the control of methane emissions.

A trend has been observed that the magnitude of methane emission has been slightly decreasing, which is potentially due to the development of LFG to energy projects. Contrary to the negative perception associated with all greenhouse gasses, capturing this LFG can lead to beneficial outcomes. Generally, recovered methane either flares or is used as source of energy. The use of the gas as a source of energy is economical and environmentally

friendly method to reduce LFG emissions. There are three primary approaches for the utilization of LFG.

They include; 1) Direct use of gas locally 2) Generation of electricity and distribution through power grid 3) Processing and injection into a gas pipeline. (Palanathakumar, B. 1991) The captured LFG has the potential to provide a continuous source of energy and improve local air quality. In addition, using LFG can significantly reduce GHG emission, making the option of exploiting this alternative energy source a very viable option to MSW management. The United States Environmental Protection Agency has utilized this MSW management option and continues to encourage it.

They have created a program that aims to help reduce methane emissions from landfills by assisting and encouraging the recovery and use of LFG as an energy resource. Since the programs inception, Landfill Methane Outreach Program (LMOP) has assisted 520 LFG energy projects in the United States reduce landfill CH₄ emissions and avoid CO₂ emissions by a combined 44 million metric tons of carbon equivalent. The reduction of methane emission through this program has slightly influenced the overall emission of LFG in USA.

The success of LMOP can be reckoned by observing statistics from 2010 where reductions from all operational LFG energy projects were equivalent to Annual GHG emissions from 18.5 million passenger vehicles. (United States Environmental Protection Agency 2012) A variety of technologies exist to generate electricity from collected methane including, internal combustion engines, gas turbines, and microturbines. Although there is a diversity of technologies, approximately eighty five percent of existing LFG electricity

generation projects use internal combustion engines or turbines. United States Environmental Protection Agency 2012) “ How much energy can Municipal solid waste produce? ” is a common question among existing research. According to “ An Overview of Landfill Gas Energy in the United States” published by U. S. Environmental Protection Agency Landfill Methane Outreach Program, one million tons of landfilled MSW can produce an electricity generation capacity of approximately 0. 8 MW. To further quantify this value, allowing the magnitude of the electricity generation to be understood, Focus on Energy (2003) outlines that 0. 8MW would be drawn to power approximately 8 000 100w light bulbs.

It can be concluded that LFG recovery wrecks benefits environmentally, socially and economically. LFG recovery, particularly methane, also makes an impact on the larger issue termed green house effect, as it is amongst the most cost effective and feasible measures to reduce greenhouse gas emissions. The recovered LFG can be directly or indirectly utilized to produce energy, which is a perpetually small, however; a very important component of an integrated approach to the solid waste management given that the use of landfills continues to remain the predominant method of municipal solid waste disposal in most countries. Global Methane 2012) References Bingemer, H G. , ; Crutzen, P. J. (1987). The Production of Methane from Solid Wastes. ” Journal of Geophysical Research, 90(D2), 2181-2187. Cassia de Brito Galvao, T. and Pos, W. H. (2002) “ Landfill Biogas Management: Case of Chilean Sanitary Landfills. ” Recovering Energy from Waste, 183-194. Conference Board of Canada. (2011). “ Municipal Waste Generation. ” How Canada Performs, ; <http://www.conferenceboard.com>.

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