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Valorization of Household Waste in Algeria Using the Methanization as a Source of Renewable Energy

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ABSTRACT

Currently, the release of gases from landfills constitutes a substantial contributor to air pollution. It is of paramount importance to reduce and efficiently utilize these gases, considering their significant implications for both public health and the global environment. Methanization represents a substantial opportunity as a clean and sustainable energy source. It contributes significantly to lowering greenhouse gas emissions, improving waste management efficiency, and generating renewable energy. This process plays a crucial role in the transition toward more environmentally friendly and sustainable energy systems. The objective of our study is to assess the quantity of biogas (specifically methane) generated at the Algerian landfills using the different mathematical models. Our findings, as derived from the models, indicate a substantial release of biogas, which contributes to the issue of global warming. This energy loss is quantified and it possesses the potential to be converted into electricity. Consequently, this conversion could render the landfill self-sufficient in terms of electricity production, serving as an economically viable energy source while simultaneously reducing greenhouse gas emissions.

Keywords: solid waste, biogas, methanization, landfill.

1. Introduction

Climate change poses a significant environmental challenge globally, with reports indicating that developing countries are particularly vulnerable to severe damages [1]. The planet is witnessing rising temperatures due to the impacts of widespread climate change. Landfill sites, where waste undergoes biological decay, particularly in the advanced methanogen stage of decomposition, are recognized for emitting substantial amounts of landfill gas. This gas is commonly composed of carbon dioxide and methane, with percentages typically ranging from 40 to 60%. Algeria produces significant amounts of household waste that go untreated and unutilized, resulting in a concerning situation. In 2002, Algeria implemented a national plan for environmental and sustainable development (NPAE-SD) with the aim of promoting ecologically sustainable development. This initiative involves significant investments in environmentally friendly practices. Two specific action programs were established as part of this plan: The National Program for Integrated Management of Household Wastes (PROGDEM) and the National Plan for the Management of Special Wastes (PNAGDES) [2].

2. Experimental

In Algeria, household waste typically consists of residues found in bins from homes, offices, and universities, among others. The composition of household waste is linked to various factors, including climate, lifestyle, geographical location, and seasons. According to the national agency of waste, a significant portion of the waste approximately 53.61 %, consists of organic matter (2019). Various mathematical models are used to describe the process of generating greenhouse gases from LHW. The LandGEM model [3] recommended by the US Department of Environmental Protection, is widely used. Other common models of gas formation on LHW are EPER-Germany [3] and TNO [3].

3. Results and Discussion

The landfill gas is produced spontaneously by anaerobic biological decomposition of organic matter of wastes in the SL in presence of specific micro-organism. It is composed essentially of 60–65 % of methane, 40–35 % of carbon dioxide. This process depends on some optimized parameters such as the pH, the

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temperature, the redox potential, the organic charge and the time of hydraulic stay. The valorization of landfill gas involves harnessing its energy potential. When one cubic meter of methane is combusted, it emits 8570 kcal of energy, equivalent to the energy from 1 cubic meters of natural gas, or 10 kWh of electricity. By utilizing one ton of methane through combustion, we prevent the release of 5 tons of carbon dioxide into the atmosphere.

4. Conclusions

The methodology presented can assist decision-makers in evaluating the potential energy production from household waste and the necessary facilities to be installed. These estimates indicate that methane can be recovered as an economical energy source and significantly reduce the greenhouse effect.

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