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Evaluation of processes for landfill gas utilization

Pillay, Odelia

2014-09-05
http://hdl.handle.net/10539/15417

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Abstract

Through many studies and investigations over the years, landfills have evolved into efficiently operated bioreactors to produce methane (CH_4) which can be used and converted into useful fuels as the concern of global warming increases. The processes outlined within this dissertation are a development of a graphical technique that allows various technologies to be developed with syngas production as an intermediate step and considers mass balance to determine the stoichiometric region for syngas production. Energy balances were used to limit the stoichiometric region to autothermal operation, carbon boundaries identified further restrictions on the stoichiometric region and contours of Higher Heating Values (HHV) identified regions to obtain high calorific value syngas.

A comparison of different processes suggests that despite electricity generation being simpler, the process emits the highest amount of carbon dioxide (CO_2) emissions (2.50 CO_2/ mol landfill gas (LFG)) with fuel processes (synfuel (CH_2) and Dimethyl Ether (DME)) yielding lower CO_2 emissions with a high of 1.10 CO_2/ mol LFG. The production of chemicals or syngas through zero CO_2 emission processes, produces zero or very little CO_2 as compared to the other processes and do not require energy intensive steps in order for the process to go to completion.

This dissertation develops a systematic graphical technique that enables the study of possible conversion processes and flow sheets utilising LFG. Furthermore, from this analysis it is shown that there are more possibilities of LFG usage for chemicals and fuel production in addition to traditional electricity generation.