CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
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Project Number
S0618

Project Title
Increasing the Efficiency of Energy Extraction from Landfill Gas

Abstract

Objectives/Goals
The overall objective of this project was to prove the commercial viability of utilizing landfill gas (LFG) to produce renewable energy. Two additional steps, carbon sequestration and the Sabatier reaction, not usually implemented during the processing of LFG, were considered to calculate whether they would increase the total energy extraction from LFG. Another objective was to see if complete carbon dioxide (CO(2)) conversion to methane (CH(4)) could actually be attained.

Methods/Materials
In the laboratory hydrogen (H(2)) and CO(2) from gas tanks were reacted to create CH(4) through the Sabatier reaction. The reaction took place in a reaction chamber filled with catalytic ruthenium covered alumina pellets and zirconium ceramic fibers 450^oC. In the experiment, flow rates of H(2) and CO(2) were measured using flow gauges, and the CH(4) produced was detected using a Non-dispersive Infrared Detector and current produced was measured using a voltmeter.

Results
The detector and voltmeter were calibrated to read 4 mA when there was no methane to 25 mA when the methane concentration was 100%. To arrive at the optimum process parameters, conversion tests were performed at multiple flow rates at constant temperature. Complete conversion of CO(2) to CH(4) occurred at the flow rate of CO(2) at 12 scfh and H(2) at 5 scfh. Using these measurements and the two additional steps, calculations were done to see what the net increase in energy produced would be.

Conclusions/Discussion
This novel way of converting CO(2), from carbon sequeatration of LFG, to CH(4) creates the possibility of providing purified CH(4) to gas turbines to generate electricity. This process increases the net efficiency of the LFG power generation by 250% as the energy density of CH(4) is 980 BTU/SCF compared to the energy density of LFG 480 BTU/SCF. The combustion of CH(4) in LFG reduces the effective GHG emissions, while implementation of the Sabatier reaction increases the total energy output of LFG.

Summary Statement
The project tested if 100% conversion of CO(2) into CH(4) was feasible and calculated the net increase in energy produced from LFG by implementing the additional steps of carbon sequestration and Sabatier reaction.

Help Received
Used lab equipment at Stapelton Tech. Lab under the supervision of Dr. Rangappan; Minimal assitance in setting up equipment (e.g. lifting gas tanks); Had calculations verified by Dr. Rangappan