Methane Generation Using Food Waste

Problem Statement:
Food waste is a goldmine for energy production. It is estimated by the Food and Agricultural Organization that a third of all food produced for human consumption is lost or wasted globally\(^1\). In developing economies it is at the production stages while in developed nations it is from retail and consumer waste. The focus of the study is to capture waste from large food production establishments and convert it into methane. These establishments can be cafeterias, universities, army bases and any other place where a large amount of food waste is generated.

Goal: Design a cost effective solution that can be implemented across the country to reduce the amount of food waste going to landfills and to generate positive returns for the stakeholders.

Design objectives:
- Develop a cost effective and environmental-friendly solution to process food waste into biogas.
- Separation and purification process of gas product into methane, carbon dioxide and other trace gases.
- Determine the initial capital investment and annual cost over a period of 10 years with 12% interest rate.

Background:
- Global anaerobic digester markets are expected to show solid growth, for 2011 through 2021.\(^2\)
- Environmentally friendly way of dealing with waste.
- Food waste is constantly generated, so the input is always guaranteed.
- Presence of halogens in gas when combusted creates dioxins and furans.
- High initial cost of equipment.
- Tuning bacteria mixture to handle waste.

Strength
- Global anaerobic digester markets are expected to show solid growth, for 2011 through 2021.\(^2\)
- Public-private partnerships and municipal bond issuance to raise money.
- Developing similar systems in multiple high density areas.

Opportunities
- Presence of halogens in gas when combusted creates dioxins and furans.
- Over production of methane from traditional sources.
- Lack of support from EPA and other environmental watchdogs.
- Threats

Weakness
- High initial cost of equipment.
- Tuning bacteria mixture to handle waste.

Economic Analysis:
Our economic analysis concluded that selling methane and ammonia generated from the food waste is far more profitable than producing our own electricity for sale. The yearly production of methane and ammonia reach 177946.5 MMBtu and $0.19 tons respectively, which leads to a total revenue of $2,08,605.

Experimental Design:
The theoretical small-scale experiment can be conducted using the experimental apparatus shown below. However, laboratory difficulty such as the complete elimination of oxygen in the apparatus makes conducting the experiment unfeasible. The theoretical production of natural gas from 1 kg of food waste is 0.2045L.

Societal impact:
- Reduce waste to landfill sites
- Generate methane and reduce dependence on fossil fuels
- Create awareness for recycling

Global Impact:
With the growth of interest in conserving natural resources globally, the development of anaerobic digesters is rapidly expanding.

Reference:

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Theoretical small-scale experiment apparatus