



Energy Opportunities Anaerobic Digestion: Restaurants

Pre and post plate losses from restaurants can be an energy source. An anaerobic digester will partially convert the losses into energy in the form of biogas which contains methane (CH₄).

Samples of pre and post plate losses from restaurants were collected in Alberta and analyzed to determine their potential energy production. The average potential energy used (see referenced map) was 2507 MJ/T feedstock and was from these sources in combination with values from referenced literature.

The samples collected for this study were from restaurants with menus containing appetizers, burgers, pasta, salads, sandwiches, and entrees such as steak sandwich, chicken fingers, beef dip, and fish and chips. The samples were collected over a two day span. The methane yield from the food service data was derived from commercial food waste from restaurants and cafeteria style kitchens. The range of characteristics, methane yield and energy production is shown in Table1.

Table 1. Potential energy from pre and post plate restaurant waste.

Source	Description	Total Solids (%)	Volatile Solids (%)	Accumulated CH ₄ (NL/kg VS)	Energy (MJ/T _{feedstock})
Restaurant	Pre Plate	9	90	302	793
Restaurant	Post Plate	28	95	479	4128
Food Service ^{a, b, c}	Pre & Post Plate	9 – 40	55 – 98	72 – 416	115 - 5284

Background for Methane Yields

Volatile Solids (VS) analysis determines the total amount of organic matter (OM) in a feedstock. It is a definitive measure of OM on a mass basis. Feedstocks containing more than 60 or 70% VS on a dry matter basis are good candidates for anaerobic digestion. The non-volatile solids, or ash content, of a feedstock takes up valuable digester volume and will not contribute to biogas production (Hamilton, 2012).

The methane yield is determined by taking a sample of feedstock, seeding it with anaerobic microorganisms, mixing with a nutrient medium, and incubating it. The volume of CH₄ produced during the incubation period is measured and interpreted as specific methane yield or the volume of CH₄ produced per mass of VS added (Hamilton, 2012). The methane yield is reported as normalized litres per kilogram VS added (NL/kg VS).

To convert from methane yield to Energy (Vik, 2003):

- Convert the VS (%TS) to kg of VS/T of feedstock
- Use VS (kg) to convert methane yield from NL/kg VS to m³/T of feedstock
- Apply a 90% efficiency rate to represent commercial operations
- Use the lower heating value for CH₄, 36 MJ/m³, to determine MJ/T of feedstock
- To determine the potential MW the overall supply of the feedstock available must be determined. This is the power output from the feedstock that went into the digester.

NOTE: The energy potential displayed on the map is the pure energy calculated above. The CH₄ can be

used by a combined heat and power (CHP) unit to transfer the pure energy into electrical output and heat. On average, units produce 40% electricity (Clarke Energy, 2013).

A CHP unit is typically a reciprocating gas engine that uses the gas, CH₄, to drive a crank shaft. The crank shaft turns an alternator to produce electricity. Heat is released during the gas combustion process (Clarke Energy, 2013). This heat can be recovered during cogeneration in order to maximize the heating value of the system.

References

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Clarke Energy. 2013. CHP efficiency for biogas. www.clarke-energy.com/2013/chp-cogen-efficiency-biogas/. (Accessed: 2013).
- ^b Danner, W. Unknown. Energy through waste management, a UNIDO initiative. http://www.unidorc.org/pdf/UNIDO_%20Kerala_WM_Seminar.pdf (Accessed: June 2013).
- ^c Dearman, B. and R.H. Bentham. 2007 Anaerobic digestion of food waste: comparing leachate exchange rates in sequential batch systems digesting food waste and biosolids. *Waste Management* 27: 1792 – 1799.

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