Waste-to-Energy – Converting Waste into Useable Power

The NDCEE is demonstrating small-scale waste-to-energy (WTE) converters to assess their applicability at small- to mid-size contingency bases. This demonstration will evaluate small-scale biomass power generation, the availability and maturity of these energy options, cost of the technologies, and advantages and disadvantages for military applications.

Problem Statement

Contingency bases generate large amounts of solid waste which creates a management burden and environmental liability. Waste has to be temporarily stored and then picked up, transported, and ultimately disposed of – regardless if it will be reused, recycled, land filled or incinerated. This takes labor, time, storage space, vehicles, tools, and funding to accomplish. Most solid, nonhazardous waste at a contingency base is buried, burned in the open, or incinerated. Landfills require a large amount of land, generate leachate and cause environmental concerns for the host nation. Open burning may expose soldiers to hazardous air emissions. Incineration requires significant amounts of energy, especially for incinerating food and other moist organic wastes. Alternative waste management approaches are needed to safely and effectively reduce the volume of solid waste with low energy and labor requirements. Technical solutions for managing solid waste at small- to mid-size contingency bases need to be mobile, scalable, durable and easy to operate.

Technology Description

Gasification transforms organic materials such as biomass or municipal solid waste (MSW) into a synthesis gas that can be burned directly in internal combustion engines. The WTE equipment planned for the demonstration is All Power Labs (APL) Power Pallet. The 20-kilowatt (kW) Power Pallet is a complete gasification system. The Power Pallet is comprised of a gasifier, gas engine, and generator that are synchronized and governed by a digital controller. The system automatically calibrates and controls the syngas and air mixture, grate-shaking, and ash take-off. This system includes a gasifier, stainless steel hearth, fuel hopper, gas cowling and ash handling, cyclone, packed bed filter, ejector venturi gas pump, fuel air mixer, swirl burner, and instrumentation.

The Power Pallet is the result of research in electronic control and waste heat recycling. Hot output syngas and internal combustion engine exhaust augment the thermal processes in a gasifier. The result is higher combustion temperature for improved tar conversion, increased tolerance for high moisture fuels, and increased gasifier efficiency. These processes are all controlled by a Process Control Unit (PCU). The Power Pallet includes an air tight hopper which can hold enough feedstock for 6-8 hours of continuous operation. A mechanized auger feeds the waste into the gasifier. The auger is automated and only feeds waste when it is needed. The Power Pallet is designed for ease of service and can be maintained by most engine or generator mechanics.

Demonstration

The objective of the demonstration is to evaluate the ability of this small-scale, mobile WTE technology to generate electrical power and process mixed waste steams typical to a contingency base. The system was designed for biomass in shredded form, so it is necessary to test its ability to handle other waste streams. The demonstration will also document the labor time and skills required to successfully mobilize, demobilize, and operate a small-scale WTE system. The site for the demonstration was selected based upon the ability of the location to support burning of small quantities of MSW and

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provide necessary waste for the burns. The demonstration site is located in Snowflake, Arizona.

Operational data for the technology will be collected using the imbedded PCU and an infrared gas analyzer. Gasifier temperature and gas composition will be measured and logged. This information will be used to determine the impacts of various waste streams on the producer gas. The combustible portion of the producer gas is made up of carbon monoxide (CO), methane (CH_4), hydrogen (H_2), and unspecified hydrocarbons (C_nH_m). The producer gas components H_2 and CO typically contain only ~50% of the energy in the gas, while the remainder is contained in CH_4 and higher (aromatic) hydrocarbons. Monitoring producer gas composition is critical to achieving beneficial power production. Power production will be monitored with the PCU. Additional data such as feedstock weight and/or volume and feedstock characteristics will be collected from each run.

Another aspect of the demonstration is to evaluate the pre-processing needed for the Power Pallet to function effectively using contingency waste streams. Waste materials will be pre-processed in two different ways to further test the relative capacity of power generation by different waste streams. Test runs will include shredded waste and densified waste. Shredded waste will include cardboard, wood pallets, drink cartons, and plastic. Densified waste will represent a typical contingency base waste composition which is shredded and processed into a 1" by 1" briquette.

Data will be analyzed to assess the cost/benefit of the WTE system for contingency bases. Costs will include capital costs, labor costs and operation and maintenance needs. Benefits are based on the amount of trash that can be safely disposed of without requiring fuel (using incineration as the comparison), ability to handle contingency waste streams, and the potential power generated that could be added to the contingency base power grid.

Process Control Unit (PCU)

GM Vortec 3.0L Engine

Environmental, Safety, Occupational Health, and Energy (ESOHE) and Cost Benefits

- **ESOHE Benefit.** Reduced exposure to soldiers from noxious fumes from open burning and incineration
- **Cost Benefit.** Reduced fuel burden of base camps; waste disposal does not require fuel and there is the potential for production of electricity to add to the base's grid

Technology Benefits

- Reduces fuel burden for waste disposal
- Innovative system fits in a smaller footprint than other WTE units
- Easier to operate than other WTE units

Technology Limitations

- Small quantities of waste processed
- Not all waste produced at a contingency base can be processed by the technology
- Some waste may need to be compacted into small briquettes and then processed through the unit
- Additional development needed for repeated deployments

Accomplishments

- Conducted limited feasibility testing in September 2011 at the vendor site
- Produced a test plan
- Procured a 20 kW Power Pallet system
- Initiated preparation of the demonstration site in Snowflake, AZ

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