Enabling the Total Resource Utilization (TRU) Habitat

Tsantrizos P.[1], Curry N.[2,*]

[1] President, CEO, Terragon Environmental Technologies Inc., Montreal, Canada

[2] Director, Business Development, Terragon Environmental Technologies Inc., Montreal, Canada

*corresponding author: e-mail: nathan.curry@terragon.net

Abstract

Terragon Environmental Technologies Inc. has developed a suite of user-friendly technologies to treat solid and liquid byproducts of human consumption now considered "waste" and convert them into "resources" that can be re-used in the same place in which they are generated (*in situ*). These technologies, namely MAGS™ (combustible-waste-to-thermal-energy) and WETT™ (wastewater treatment and re-use), when integrated together in the same location, can enable a "Total Resource Utilization (TRU) Habitat". A technological overview of MAGS and WETT are presented in this paper as well as Terragon's vision of the TRU Habitat.

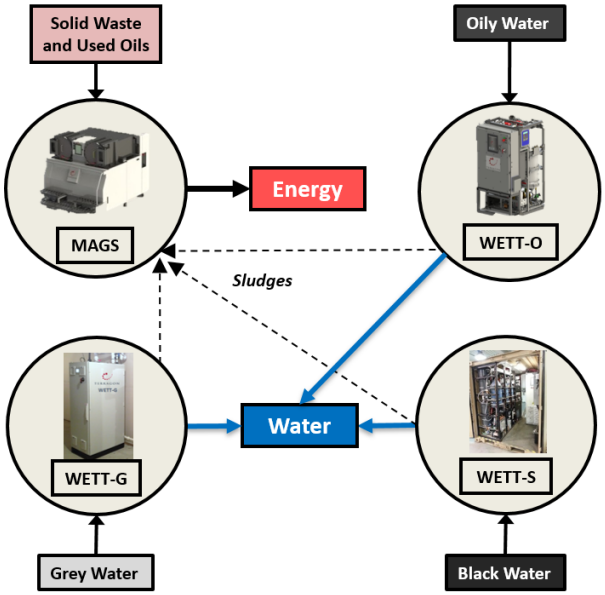
Keywords: resource recovery, waste-to-energy, grey water, black water, on-site waste management

1. Introduction

Over the past century, people all over the world have come to view the by-products of their consumption as "waste", i.e. materials that they reject. Solid "waste" is placed in a garbage bag and transferred to a collection service, while liquid "waste" is sent to a sewer or a septic tank. The responsibility of the typical waste generator involves simply ensuring that there are garbage bags on hand and that their wastewater drains are unclogged. The remaining steps are managed, often through the government, by the waste management industry. Based on this approach, people generate more "waste" every year. Today, in economically developed regions, people generate close to 3.0 kg/d of solid waste and up to 250 L/d of sewage (DeOreo, Humes). This "throw away" culture is arguably the most significant global contributor to unsustainable living.

Terragon has envisioned the Total Resource Utilization (TRU) Habitat, a place where people repurpose all their by-products locally to generate a portion of their energy and water needs and, in the process, completely eliminate the generation and transfer of waste. In the TRU Habitat system, solid by-products are separated into three fractions, namely: compostable, combustible, and recyclable. Combustible waste is used to generate thermal energy and bio-char. The bio-char and the compostable fraction are used for soil enrichment. The liquid wastes are also separated into three fractions, namely: used oils and sludges, grey water and black water. The oils and sludges are used along with the combustible solids to generate energy, the grey water is used to generate clean, unrestricted use water and the black water is used to generate water for irrigation.

Figure 1. Total Resource Utilization (TRU) Habitat



2. Total Resource Utilization (TRU) Habitat Solution

To support its vision, Terragon has developed a suite of unique appliances that enable any habitat, such as a ship, a hospital, a farm, a remote community, a work camp or a factory, to become a TRU Habitat. The use of these appliances is safe, economical and offers excellent environmental and social benefits. It also creates the "zero waste habitat" while maintaining a healthy and prosperous lifestyle.

2.1 Micro Auto Gasification System (MAGS™)

The first appliance developed and commercialized by Terragon is called MAGS™ (Micro Auto Gasification System) and it is a clean, safe and simple hot water generating appliance that can use any fuel, including all combustible waste, such as plastics, paper, used oils, etc. MAGS uses a small gasification furnace to convert hydrocarbons into synthesis gas (syngas) and bio-char. The bio-char stays in the gasifier and is periodically removed and recovered for further use. The synthesis gas is fed into a combustion chamber where it is fully combusted to generate a hot exhaust. The hot exhaust is

used to provide the energy needed by the gasification furnace and then it is quenched with water. Quenching transfers the energy from the hot exhaust to water while, at the same time, preventing any recombination reactions in the exhaust that could form toxic emissions, such as dioxins and furans. The cold exhaust is further treated in a wet caustic scrubber to eliminate acid gases, and a condenser to reduce water loss and maintain a closed loop water cooling system.

MAGS uses about 50 kg/hr of mixed hydrocarbons (previously considered waste) to generate about 2 kg/hr of bio-char and 120 kWh/hr of thermal energy. The technology has been approved by Lloyd's Register, DNV, Class NK, US Coast Guard, and ABS and has won many awards in the United States, Canada, the United Kingdom, and Germany (Terragon). MAGS is a commercial technology that is used in many applications, including commercial shipping, cruise ships, factories, remote communities, work camps and both land-based and marine military operations.

2.2 Wastewater Electrochemical Treatment Technology (WETT^{TM})

The other line of products developed by Terragon to enable the TRU Habitat is called WETT^{TM} (Wastewater Electrochemical Treatment Technology). WETT converts wastewater into clean, reusable water for the habitat where it is generated. There are three distinct versions of WETT that have been developed based on different targeted applications for water reuse. WETT systems use two innovative electrochemical technologies and do not use biological systems or chemicals. Suspended contaminants and emulsified oils are removed through Electro-Coagulation (EC), while dissolved contaminants are removed through Electrolytic Oxidation (EO). EC uses two consumable electrodes to introduce both a coagulant (aluminum ions) and microbubbles (through electrolysis) into the wastewater. The suspended contaminants coagulate and are lifted to the surface of the EC reactor where they are periodically removed. The EO reactor is based on boron-doped diamond electrodes that generate hydroxyl radicals that react and mineralize all dissolved contaminants, while disinfecting the water.

WETT-O is the version of WETT developed for the treatment of oily water, such as the wastewater generated in the bilge of a ship or in a maintenance garage. WETT-O can accept wastewater that is contaminated with over 3,000 ppm of total oil, heavy metals and soot, and generate effluent with less than 2 ppm of oil, which is safe for discharge or can be reused as technical water. WETT-O has been Type Approved by the US Coast Guard and Transport Canada and has both land-based and marine sector applications. The WETT-O is currently being used in applications such as government vessels (i.e. ice breakers), support vessels (i.e. tug boats and OSVs), and maintenance facilities (i.e. highway, train and aircraft garages).

WETT-G is the version of WETT technology developed to treat grey water so that it can be reused within a habitat for multiple applications, including toilet flushing, laundry, and washdowns. WETT-G is also being used to generate on site potable water. In this application, the effluent from the WETT-G is passed through a polishing stage, which can be either Reverse Osmosis (RO) or Ultra-Filtration (UF). WETT-G units are currently in operation in various locations, including Northern communities, farms, and military bases. Hotels, homes/cottages, and recreational centers are also among the habitats that can use this technology.

The third product from the WETT line is WETT-S, which treats highly contaminated streams, such as sewage and black water from toilets and kitchen drains. WETT-S technology uses a combination of EC reactors followed by EO. The water generated from WETT-S is clean, transparent, and fully disinfected and is used for irrigation or can be discharged safely onto land or into water streams. WETT-S pre-commercial units are currently being evaluated in the field for different military (Forward Operating Bases) and Navy operations. Also, due to its unique combination of treatment units incorporated, the technology can also be used for the removal of emerging contaminants (i.e. pharmaceuticals, cyanotoxins, personal care products, nanoparticles, flame retardants, etc.) from different wastewater streams.

3. Conclusion

Together, MAGS and WETT can be integrated to enable the TRU Habitat. The TRU Habitat is able to generate up to 2.5kWh of thermal energy from every kilogram of mixed household solid waste and over 70% of the water needed by any habitat, such as a home, a farm, a hotel, or a ship. Today, MAGS serves the needs of a habitat with about 100-1000 people, while WETT is ideally sized for 5-100 people. Over the coming years, Terragon will develop larger versions of WETT and smaller versions of MAGS so that any habitat from 5 to 1000 people can become a TRU Habitat.

References

DeOreo William B., Mayer P., Dziegielewski B., Kiefer J. (2016), Residential End Uses of Water Version 2. Water Research Foundation. Denver, Colorado. http://www.waterrf.org/Pages/Projects.aspx?PID=4309

Humes E. (2012), Garbology: Our dirty love affair with trash. Avery, 264 pp.

Terragon Environmental Technologies Inc., website, https://terragon.net/awards/.