CHAR HIGH TEMPERATURE PYROLYSIS (HTP) TECHNOLOGY

PROCESS AND PLANT DESCRIPTION:

CHAR & High Temperature Pyrolysis

CharTech Solutions, a division of CHAR Technologies Ltd. (TSXV: YES), has extensive experience in the engineering, supply and delivery of first-in-class thermal processing solutions. CharTech's High Temperature Pyrolysis (HTP) process provides a waste transformation technology to cleanly transform waste feedstocks into renewable and valuable outputs. CharTech's turnkey HTP plants are underpinned by the ability to efficiently balance the twin objectives of high product temperature and zero air ingress, resulting in a cost-effective, widely-applicable and modular processing solution to produce heat, energy and biocarbon.

High Temperature Pyrolysis is the irreversible thermochemical decomposition of organic material at elevated temperatures in the absence of oxygen. The HTP process converts organic material to gas, heat and solid products. Organic volatile species within the material undergo chemical transformation through volatilisation, steam reforming, methanation and water-gas shift (WGS) reactions to produce a clean syngas product. The syngas product is a mixture of hydrogen, carbon monoxide, steam, carbon dioxide and light hydrocarbon species. High calorific value and ideal air-fuel requirements make the syngas a great fit for value-add applications. By having the system consume a fraction of the syngas to provide the requisite heating duty, the process remains energy-positive and sustainable.

Power production

The world's energy mix comprises renewable and non-renewable sources, historically dominated by non-renewable fossil fuel-based power generation. In light of recently heightened concern on the anthropogenic contribution to climate change, the world is increasingly looking to alternative, less carbon-intensive technologies to meet energy demands. While generating power from non-renewable fuels is well established, economies of scale typically result in such power plants being centrally located, reliant on steam cycles and on the scale of tens to hundreds of megawatts.

CharTech's HTP process provides a solution which has a feedstock consumption rate that matches the typical scale of waste stream generation, providing distributed, renewable, baseload power. The syngas produced in the HTP process is suitable for the production of power due to its high calorific value. Syngas is consumed in an array of self-contained spark ignition engines coupled to a generator (genset), producing power for local plant load, wider site power and power for grid off-take.

Plant configuration

A turnkey, HTP plant can be broken down into a distinct number of stages for producing syngas and/or power from a waste derived feedstock. These are summarised as;

1. Receival, sorting, pre-treatment and storage of waste to prepare a homogenous, single-stream feed.
2. Thermal conversion of waste in an indirect fired continuous rotary kiln, operating in temperatures typically from 750°C - 900°C on self-produced syngas.
3. Cooling and collection of the solid biocarbon.
4. Treatment of the syngas stream to create a clean emissions profile when consumed.
5. Consumption of the syngas in a series of spark-ignited gas engine generators (gensets) to produce power.
6. Exhaust gas management through plant stack to meet all current emission regulations.

FEEDSTOCK APPLICATIONS:

Industrial Sludge Streams

Industrial sludges, such as by-products from anaerobic digestion (AD) plants, water treatment plants (WTPs) and wastewater treatment plants (WWTPs), contain significant volatile organic content which can be converted to gas and solid biocarbons. This presents a waste transformation solution to growing sludge transportation and disposal concerns while producing a value-added product. In addition, the HTP system can destroy a number of chemical species through their thermal decomposition, including PFAS and endocrine disruptors. For sludges to be suitable for HTP, the solid residue stream needs to be recovered by dewatering. Pre-drying from flue gas waste heat increases the thermal efficiency of the process.

Manure and Compost Streams

Manure and compost feedstocks, both high in nutrients are favourable feedstocks for thermal conversion, which can effectively remove contaminants to generate clean biocarbon products. Both feedstocks can be sorted and pre-dried prior to pyrolysis, if necessary. In addition to removing contaminants, HTP significantly reduces the volume of these feedstocks, while generating additional energy and a high-quality biocarbon products that can increase soil fertility, crop yields and quality.

Biomass Streams

Biomass and agricultural waste feedstocks are suitable for thermal conversion to solid and gas products. The relative homogeneity of single-stream biomass sources ensures the feed arrangement of the HTP plant remains relatively simple, with considerations for pre-drying, materials handling equipment and storage. Ligneous 'woody' biomass with high fixed carbon content presents an excellent biocarbon and the opportunity for an additional revenue stream. A gas-solid contacting reformer overcomes tarring issues faced by conventional biomass pyrolysis processes.

BIOCARBON APPLICATIONS:

Activated Carbon Substitute - SulfaCHAR™

SulfaCHAR™ works by removing the toxic H_2S from biogas in the same way that a Brita water-filter removes contaminants from tap water. Once H_2S is removed, the clean biogas can be used for multiple energy applications. Unlike other gas cleaning technologies, SulfaCHAR™ is completely zero-waste. When H_2S is adsorbed onto SulfaCHAR™, the contaminant is converted into beneficial forms of sulfur and the spent material can be used as a sulfur rich biochar fertilizer.

Carbon Neutral Fuel - CleanFyre™

CleanFyre™ represents the future of high-energy, low-carbon-footprint industrial fuel. This breakthrough, carbon neutral and sustainable bio-coal offers similar chemical composition of coal, with the same energy potential and ash profile. In addition to delivering coal's energy performance characteristics, CleanFyre™ integrates seamlessly into the existing plant infrastructure, requiring no refit costs for industries that adopt this new product.

Biocarbon/Biochar Enhanced Soil Amendment/Fertilizer

Biocarbon has an abundance of macro- and micro-nutrients and is suitable to blended as an input material for fertilizers. Benefits of adding biochar to compost include shorter compost times, reduced rates of greenhouse gas and ammonia emissions, increased aeration, and reduced odour. Along with the increased nutrient content, soils amended with biochar typically experience an increased pH, cation exchange capacity, water retention, and beneficial microbial growth, resulting in increased plant production.

COMPETITIVE ADVANTAGE

CHAR's HTP Technology retains a competitive edge over other thermal waste to energy processes:

Incineration involves the complete combustion of a waste or biomass stream, with a target of heating water and generating steam for power. Incineration has poor public sentiment due to its emission profile, where combustion gas requires significant post-treatment. Power generation from incineration flue gas requires steam cycles, ensuring the process is economically unfeasible at single feedstock source. For incineration plants to be economically feasible, they are designed as centralised waste solutions which require significant capital expenditures and feedstock aggregation.

CharTech's HTP process overcomes these shortcomings by offering a solution that;

- ✓ Has an absence of air, preventing dioxin formation.
- ✓ Avoids steam cycles, allowing compact and small-scale utilization.
- ✓ Is economical at scales that match typical waste streams.
- ✓ Has a compact installation with a small footprint and no significant height requirements.

Gasification involves the incomplete combustion of a waste steam to produce a syngas which is generally burned in a fired boiler to produce steam for power. Power generation from syngas flue gas requires steam cycles, ensuring the process is economically unfeasible at single feedstock generation site. Syngas produced from gasification processes varies in quality with feedstock moisture content. The calorific value of the gas is low, making it unsuitable for value-add operations. Although the technology is considered bankable, it is historically plagued by reliability and operability issues, and suffers from the same scale-requirements as incineration, requiring significant Capex and feedstock aggregation.

CharTech's HTP process overcomes these shortcomings by offering a solution that;

- ✓ Produces a consistent & high calorific value gas.
- ✓ Avoids steam cycles, allowing compact and small-scale utilization.
- ✓ Is economical at scales that match typical waste streams.
- ✓ Is operationally reliable in harsh conditions.

Standard Pyrolysis technology involves heating waste in the absence of air to produce solid, liquid and gas products. As product temperatures are typically limited to sub 550°C, tarring occurs in the gas/liquid lines which give unreliable operation. The solid fraction requires further upcycle for use, while the gas/liquid fraction contains heavy organic components and requires further upgrading. Operation limitations have limited the bankability of the technology.

CharTech's HTP process overcomes these shortcomings by offering a solution that;

- ✓ Produces a high calorific value gas and high purity char.
- ✓ Limits the amount of tar formation by cracking hydrocarbons at temperatures above 750°C.
- ✓ High thermal efficiency compared to conventional indirect fired kilns.