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Renergi Pty Ltd: Energy from Waste through Pyrolysis Project

Lessons Learnt Report #3

COVER PAGE

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Reporting Period	From 11 January 2022 to 31 March 2022

This Project received funding from the Australian Renewable Energy Agency (ARENA) as part of ARENA's Advancing Renewables Program. This Project also received funding from the WA state government via its Collie Futures Industry Development Fund.

EXECUTIVE SUMMARY

Renergi Pty Ltd has developed a patented, award-winning pyrolysis technology, which is termed as “grinding pyrolysis” technology. The technical feasibility of this patented technology has previously been demonstrated with a 100 kg/hr demonstration plant funded by the ARENA and the WA state government.

During this project, in partnership with the Shire of Collie, WA, Renergi will design, build, commission and operate a pre-commercial demonstration pyrolysis plant in Collie to convert municipal solid wastes, forestry/agricultural residue or other types of biomass feedstocks into three main commercial products – bio-oil, biochar and wood vinegar. The success of this project will contribute to the transition of Collie from a coal-reliant economy to a renewable-reliant economy by developing a negative-emission bio-based circular economy.

Renergi’s pyrolysis plant will have two main types of feedstocks: wastes (e.g. municipal solid wastes) and forestry/agricultural residues. Renergi’s plant will provide a sustainable waste management solution for the Shire of Collie whereby its municipal solid wastes will be processed into biochar, bio-oil and wood vinegar for sale as commercial products. Renergi’s plant will also convert other wastes or forestry/agricultural residue into commercial products.

Renergi's technology can potentially be replicated in many regional areas in Australia and other parts of the world to divert the wastes from landfills while avoiding large amounts of emissions.

The pre-commercial demonstration plant is designed to accept a wide range of wastes having variable and high moisture contents. Herein we report our lessons learnt so far that the drying of feedstock is very important in order to achieve high efficiency and high product quality. The importance of drying deserves special consideration in deploying any pyrolysis technologies. Renergi has developed a new drying technology that can be used together with Renergi's own pyrolysis technology or many other pyrolysis technologies.

KEY LEARNINGS

Lesson learnt: Importance of drying for pyrolysis processes

Category: Technical

Objective: Renergi's patented pyrolysis technology has many unique features, making it a leading pyrolysis technology. In particular, Renergi's pyrolysis technology is able to accept a wide range of feedstocks with diverse chemical composition and physical properties. For example, the particle sizes can be from microns to a few centimetres in the same feedstock.

However, the feedstocks commercially available will contain significant amounts of moisture. The moisture contents could be up to 50 wt% or higher. Drying the feedstock in the most efficient and environmentally friendly way can become an important technoeconomic challenge.

Detail: The project plan included a task to assess the necessity of a dryer for the pre-commercial demonstration plant to be built in this project. The detailed front-end-engineering design (FEED) in this project indeed proved the need for a dedicated dryer for the pre-commercial plant to be built in this project. A dryer is necessary to optimise the energy supply and demand for the whole pyrolysis process to achieve high efficiency. A dryer is also essential to produce a pyrolysis oil product with consistent quality, especially with acceptable water contents.

The design work in this project then revealed that a direct dryer where a stream of hot (flue) gas comes into direct contact with the municipal solid wastes could not be used in the present project for the following reasons:

- Pathogens in the municipal solid wastes could be released into the flue gas and subsequently into the atmosphere. Without sufficient residence time at high temperature, the pathogens may not be completely sterilised, representing a thread to the public health.
- A large flow rate of hot (flue) gas would be required. The small particles in the municipal solid wastes could be entrained into the hot (flue) gas and then released into the atmosphere. This could be a significant environmental concern in terms of the

emissions of particulate matter, which may even be toxic/hazardous. This would require the particles to be burned, which would in turn require the particle-laden gas to be heated to high temperature, incurring significant extra costs.

- The residual oxygen in the hot (flue) gas could cause dust explosion, particularly if the temperature is high.

The design work in this project further revealed that the drying temperature must be low (e.g. <150°C) to avoid unwanted physical changes (i.e. melting plastics) or unwanted chemical reactions (partial pyrolysis) involving various components in the municipal solid wastes. The low drying temperature in turn means that an indirect dryer using hot flue gas would require prohibitive amounts of heat transfer surface area.

To resolve the above-mentioned technical issues, Renergi's technical team has invented a new type of dryer, which is a further invention over Renergi's previous design. The dryer utilises a commercial heat transfer medium (e.g. "thermal oil" comprising principally of hydrocarbons) to carry out the heat transfer in two heat exchangers. In the first heat exchanger, the thermal oil is firstly heated up indirectly (i.e. without directly contacting) with a hot flue gas from the combustion of non-condensable gases produced during pyrolysis. Inside the dryer (acting as the second heat exchanger), the hot thermal oil is used to heat up indirectly (i.e. without directly contacting) the municipal solid wastes or biomass to be dried. The thermal oil is recycled.

By integrating the dryer with the rest of pyrolysis process, no pathogens would be released into the atmosphere. The entrained small particles are easily captured. Renergi's new dryer design also has other unique features. For example, the design has provision to facilitate the easy movement of feedstock from one end of the dryer to another end.

A patent application has been filed to protect the new invention of dryer design.

Implications for future projects: The lessons learnt would include:

- Drying must be an important consideration in the pyrolysis of municipal solid wastes or other types of biomass feedstocks.
- Renergi's drying technology can be easily integrated with pyrolysis or thermochemical conversion technologies.