

Pyrolysis of Spent Coffee Solid Wastes to Produce Energy

Introduction

Problem statement

Producing crude bio-oil by recycling spent coffee grounds solid using high performance microwave system.

Constrains

- **Limited quantity:** The project mainly depends on consumed coffee and tea as feed inputs
- **Economic effects:** Our mission is to offer competitive prices and to ensure that not to lose the customer even if there is no profit based on economic cycle
- **Maintained quality:** Since the efficiency of the system is oscillatory, it's challenging to maintain the high performance each batch
- **Customers:** Our target customers are those who have interests in bio-products and sustainable energy sources, where the process output is a fuel that has the ability to be fractionated to different components.

Target Specifications

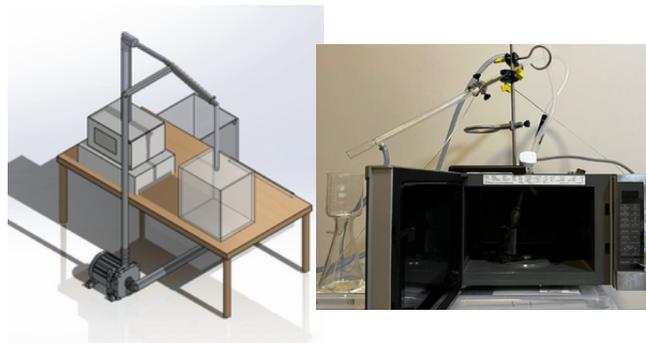
- 300-500 C. Temperature
- > 30 % of coffee waste converted.
- > 40% of product is bio oil.
- Minimum 200 ml reactor volume
- 0.15 L/s minimum Flow Rate of cooling water
- > 12 kj heat duty for the condenser

Project Impacts

The new global trend is to maximize sustained energy with lower operating costs. Additionally, to achieve zero net carbon-dioxide emissions along the years. Our product will have its own impact on the environment for clean energy. The processed wastes can be utilized, which will keep it special by being environmentally friendly in that it achieves one of the Saudi Arabia's visions 2030. The economic will be improved by adding a new source of energy that can be sold with lower operating cost and high profit. It will make KSA unique by the applied method to generate power. Eventually, it will keep the community motivated to create and find other sustainable way to produce energy

Prototype Design

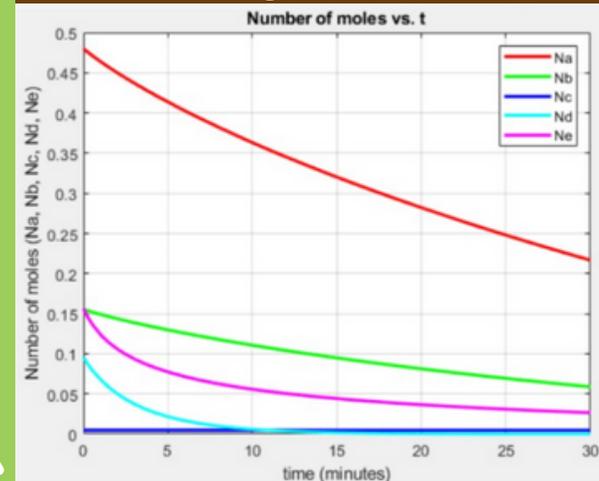
innovative pyrolysis process, converting coffee waste into bio oil. Utilizing a batch reactor as a microwave, it's connected to a glass condenser via a piping system. The condenser, integrated with a water cooling system powered by a submersible pump, efficiently transforms vapors into bio oil, collected in the product tank.



Meeting Target Specifications

- 500 C. Temperature: By using a microwave with 1100 W and silicon-based adsorbent for conductivity.
- 20-30 % of coffee waste converted: overall conversation reached 58% due to the use of zeolite catalyst.
- >40% of product is bio-oil: 21% oil was achieved due to physical and safety limitations.
- Minimum 200 ml reactor volume: By using microwave with 32L volume.
- 0.15 L/s minimum Flow Rate of cooling water: achieved by using submergible pump with 2000L/h max flow rate.
- > 1 kJ heat duty for the condenser: achieved, 200MM condenser and 0.56kg/s m of water was implemented.

Testing & Validation



- Reaction time was 25 minutes
- Reaction was performed under fume hood
- Microwave power set for 900W for five minutes, and 100W for 20 minutes.
- SiC used for absorption
- 500C to 600C Reaction temperature
- Overall conversion 86%
- Elemental analysis showed that 50% of the oil is carbon
- Presence of olefins & aromatics
- Gas chromatography analysis:
 - 14% Paraffins
 - 21% Olefins
 - 65% Aromatics, Napthine, Asphaltenes

Conclusion

The pyrolysis of spent coffee grounds to produce energy via microwave heating is a sustainable solution. Our prototype successfully converts waste into valuable bio-oil, syngas, and biochar, offering an economical and eco-friendly alternative energy source while aligning with Saudi Arabia's Vision 2030 for a cleaner, greener future