BIOENERGY PRODUCTION FROM OLIVE TREE PRUNING USING GASIFICATION TECHNOLOGY

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Introduction

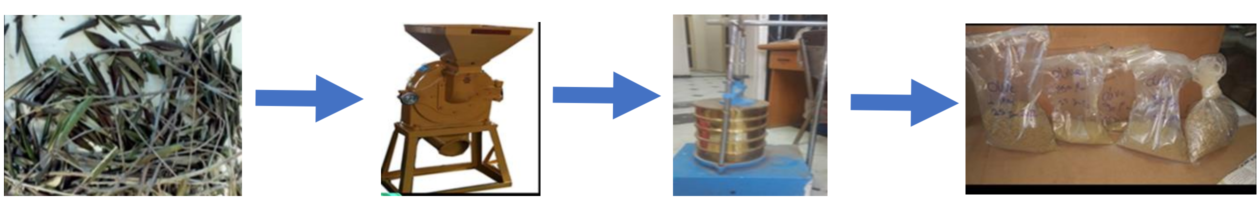
The thermochemical conversion process using biomass gasification for converting the agriculture residues to gaseous fuel using the biomass partial oxidization theory has a very potential to a simple, clean, and sustainable method. This approach producing heat and energy at rural and remote regions with less contamination compared to fossil fuel. The biomass gasification process produced a mixture of gases called the syngas, which contains hydrogen (H_2), carbon monoxide (CO), methane (CH_4), carbon dioxide (CO_2), and nitrogen (N_2) (X. Wang et al., 2016).

Gasification of the olive tree pruning (OTP) can produce clean and affordable energy. This can help in achieving universal access to energy and reducing reliance on fossil fuels. This technology can also be used to develop innovative and sustainable infrastructure for renewable energy, waste management, and bio-based products. This can support the development of resilient and sustainable industries.

The general objective of the current study is to assess and evaluate the optimum operation condition for producing sustainable gaseous fuel from olive pruning residues.

Material and methods

In this study, Olive tree pruning residues (OTP) were used as a biomass material for the gasification process. The olive trees were 4 years old of the 'koroneikil' olive variety. The sample was ground using an analytical mill to homogenize it. Then the ground material was sieved using a high vibratory sieve (CISA). The length of pieces ranged from 90 µm to 1 mm.



OTP residues | Grinded machine | Sieve machine | OTP in different sizes

Figure 1. Diagram for valorization of olive tree pruning residues

Preliminary experiments were conducted to assess the elemental, proximate, chemical, and thermogravimetric values for the examined olive tree pruning (OTP).

A lab scale fixed bed downdraft gasifier was fabricated. The fabricated gasifier consists of two main parts. The upper part includes the reactor, and the lower part is the heating system. The reactor consists of a reaction tube, valves, pressure gage to record the gas pressure, and oxygen supply cylinder.

The heating system consists of double stainless-steel tubes with diameter of 7 cm for the inner tube and 38 cm for the outer one. The distance between the two centric tubes was filled with fiber glass for insulating the heating system. The heating process is conducted throw an electrical heater fixed around the inner tube.

The experimental work was conducted under four different levels of temperature (650,700,750 and 800°C) and four different types of catalysts (Cement kiln dust catalyst, Calcium hydroxide catalyst, Nano-sized Fe-Ni supported on dolomite, and Nano-sized Fe-Ni supported on Alumina (Mohamed et al., 2021)).

Figure 2. Four different types of catalysts used.

In a typical test, olive tree pruning residues (OTP) was used in the reactor (with or without catalyst). The reactor was heated to the required level of temperature where it takes 5-20 min to reach the isothermal heating.

After a given reaction time (30 min) , the reactor was taken out of the heating system to be cooled to the room temperature (It takes about 15 minutes to cool down the reactor to the room temperature). After that, the produced gases were collected for analysis using gas sampler. Char and tar were also collected and weighed after opening the reactor.

Results and discussion

The elemental composition were 46.52, 5.94, 1.35, 0, and 46.19% for the Carbon (C), Hydrogen (H), Nitrogen (N), Sulfur (S), and Oxygen (O). While the tested sample showed zero sulfur, which means a major advantage for the gasification process using the olive tree pruning from the environmental point of view.

The chemical composition of the tested samples included Hemicellulose of 19.7%, Cellulose of 36.6%, Lignin of 20.8%, and Higher heating value of 17.320MJ/Kg which means proper potential energy for suitable gasification process.

the thermal decomposition of the tested samples of olive tree pruning at different levels of heating rate appears to follow the first order reaction mechanism.

high temperatures favored gas production and decreased char, and tar contents. As shown in the Figure (3) , 800°C was chosen to be the best experimental conditions without adding catalyst compared to other levels of temperature. The highest volume of gas produced was about 98 ml. The produced gas composition for the best temperature 800 °C without adding catalyst. This level of temperature was used for the experimental work aims at evaluating the examined types of catalysts.

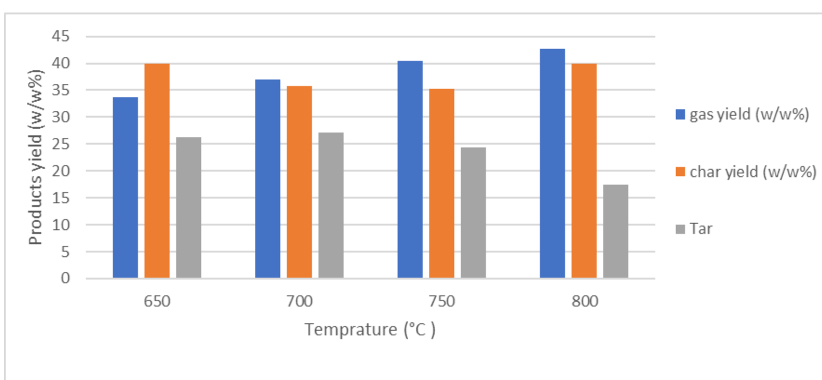


Figure 3. The effect of temperature on the yield of gasification process.

The results showed that the most optimum catalyst for the gasification process was calcium hydroxide which produced the highest amount of gas (158ml) with a high percentage of hydrogen (43.6%) and low percentage of CO, and CO_2

Conclusion

In conclusion, the most proper working condition for the developed gasifier was 800 °C heating temperature and calcium hydroxide catalyst. Meanwhile utilizing olive tree pruning waste in the gasification process offers a promising solution for addressing the waste management and energy needs of the olive industry.

Acknowledgment

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References

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