Effects of Slow Pyrolysis-Based Modification of Coffee Husk Biochar on CO_2 Emissions

Prof. Dr. Ir. Bayu Rudiyanto, S.T., M.Si. (*Undergraduated Thesis*)

Zaka Ainusshofa
Study Program of Renewable Energy Engineering
Department of Engineering

ABSTRACT

Indonesia is one of the world's largest coffee-producing countries, with a total production of 774,960 tonnes in 2023, generating substantial amounts of coffee husk waste. One promising solution for utilizing this waste is converting it into biochar through pyrolysis, which is well known for its potential as a soil amendment to improve soil fertility and store carbon. However, the application of unmodified biochar to soil has been shown to increase CO_2 emissions through a positive priming effect driven by elevated microbial activity. Therefore, this study aimed to investigate the effect of modifying coffee husk biochar using Low Pressure Cold Plasma (LPCP) technology at two power levels (10 W and 20 W) on the physicochemical properties of biochar and CO_2 emissions from three soil types: coffee plantation soil, peat soil, and coastal soil. Biochar was produced via pyrolysis at 500°C for 2 hours and subsequently modified with LPCP for 20 minutes. Biochar characterization included pH measurement, electrical conductivity, proximate analysis, and surface functional group identification using FTIR spectroscopy. CO_2 emissions were measured at three incubation temperatures (4°C, 10°C, and 25°C). Results showed that LPCP treatment significantly altered the physicochemical properties of biochar, as indicated by a decrease in volatile matter from 70.33% (NP) to 56.64% (P20), an increase in fixed carbon from 5.13% to 19.01%, and the identification of new active functional groups in the FTIR spectra. The P20 biochar proved to be the most effective in suppressing CO_2 emissions across all three soil types, with an effectiveness hierarchy of NP > P10 > P20. CO_2 emissions increased with rising incubation temperature, and a consistent emission hierarchy of peat > coffee > coastal soil was observed throughout all treatments. This study demonstrates that LPCP modification is an effective method for enhancing the adsorption capacity of biochar, making it a viable strategy for mitigating greenhouse gas.

Keywords : *biochar, CO_2 emissions, coffee husk, low pressure cold plasma, FTIR, greenhouse gas mitigation, pyrolysis, surface modification*