Pretreatment of spent coffee grounds for biofuels production

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The utilization of spent coffee grounds has the potential to provide various environmental and economic benefits. However, it's important to ensure that the utilization processes are sustainable and do not create any negative environmental impacts.
Recently, the amount of coffee produced worldwide has been increasing, and global coffee production reached 166.63 million begs (60 kilograms per bag) in 2020/2021 (International Coffee Organization, 2022).
The growing consumption of coffee leads to an increase in the amount of byproduct in form of spent coffee grounds. For example, each kilogram of instant coffee yields approximately 2 kilograms of wet spent coffee grounds (and around 10-20% of the weight of each coffee bean is converted into spent coffee grounds during brewing what resulting in the production of several million tons of spent coffee grounds annually worldwide (Martinez-Saez et al. 2017).
Spent coffee grounds are characterized by a high moisture content, typically around 60-80%, due to their previous use in brewing coffee, which is the main reason for the challenges in utilizing them in other industrial processes. Therefore, spent coffee grounds require proper preparation, including drying, in order to be used as biofuel.

The paper presents a proposed technological line that includes a proprietary solar drying method, pelletizing, and torrefaction, which allows to prepare of spent coffee grounds for application in energy processes.
The first stage of the pretreatment of spent coffee grounds involved the use of solar drying. Tests were conducted in a solar greenhouse dryer equipped with a specially designed mixing system to determine the drying time and thickness of the layer of dried spent coffee grounds in weather conditions in the southwestern part of Poland. The dried spent coffee grounds with a moisture content of about 10% were then subjected to the pelletization process. Additionally, a portion of the produced pellets underwent torrefaction to compare their energetic and mechanical properties.
The torrefaction of samples was done in the laboratory scale rotary reactor. Testes was done in the range of temperature 240-300ºC and time 30-40 min in N_2 atmosphere.
Additionally, thermogravimetry (TG-DTA) coupled with Fourier transform infrared spectroscopy (FTIR) was used to investigate the differences in combustion process for raw pellets and pellets after torrefaction. The reaction regions, initial devolatilization and ended process temperatures and gas products were analyzed and compared for both materials.

References

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