Evaluation of the Suitability of Defined SRF in Mixture with Wood and as a Standalone Fuel for Gasification Processes

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Keywords: Gasification; SRF; Autothermal Reactor; Energy Conversion
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Abstract

This study evaluates the suitability of defined solid recovered fuel (SRF) both in mixture with wood and as a standalone fuel for gasification processes. The experiments were conducted using an autothermal gasification reactor with a moving bed and atmospheric air as the oxidizing medium. The results indicate that both fuel configurations are suitable for gasification, producing a stable process and a gas with high methane content.

Introduction

The increasing global demand for sustainable and renewable energy sources has driven significant interest in the development and optimization of gasification technologies. Gasification, a thermochemical process that converts carbonaceous materials into syngas (a mixture of hydrogen, carbon monoxide, methane, and other gases), offers a versatile and efficient method for energy production from a variety of feedstocks, including biomass, municipal solid waste, and industrial residues (Breault, 2010; Śpiewak, 2024).

Gasification has a long history, dating back over 200 years, with its initial applications in producing town gas for lighting and heating (Speight, 2020). The technology has evolved significantly, with modern advancements focusing on improving efficiency, reducing emissions, and expanding the range of suitable feedstocks . The development of Integrated Gasification Combined Cycle (IGCC) systems has further enhanced the efficiency and environmental performance of gasification processes.
One of the key advantages of gasification is its ability to process a wide range of feedstocks. Biomass gasification, for example, has been extensively studied for its potential to produce renewable energy and reduce greenhouse gas emissions (Gao et al., 2023; Suryawanshi et al., 2023). Similarly, the gasification of municipal solid waste and industrial residues offers a sustainable solution for waste management while generating valuable energy (Arena, 2012; Molino et al., 2016).
This study aims to evaluate the suitability of defined solid recovered fuel (SRF) both in mixture with wood and as a standalone fuel for gasification processes.
The specific objectives are to:
-Assess the thermal and chemical characteristics of the produced syngas.
-Determine the conversion efficiencies and gas production rates.
-Compare the performance of the two fuel configurations with findings from the scientific literature.

Materials and methods

The fuel was provided by the client in the form of pellets, with a maximum size of 5 x 20 mm, in sufficient quantity. In one instance, the fuel was solely derived from these waste materials, with a moisture content controlled to not exceed 2% by weight, a calorific value of 23.82 MJ/kg, a higher heating value of 25.47 MJ/kg, and a bulk density of 650 kg/m³. In another instance, the fuel was pelletized in a mixture with wood, maintaining a moisture content of up to 3.5% by weight, a calorific value of 19.93 MJ/kg, a higher heating value of 21.51 MJ/kg, and a bulk density of 541 kg/m³.

Figure 1. SRF (left); SRF/wood (right).

The gasification process was conducted using a medium-scale sliding bed cross/updraft reactor with a power input of 200 kW. This reactor operates in an autothermal gasification/combustion regime, utilizing air as the gasification medium. The fuel is decomposed over a circular grate with tangential air intake, creating a vortex within the gasification zone. The producer gas is extracted from the upper part of the reactor, while the residual char falls through the grate either spontaneously or due to manual oscillation, and is collected in a vessel.

During the analytical measurement and sampling of the produced gas, the temperature in the reactor for SRF ranged from 643.2 to 730.3°C, with an average value of 681.2°C. For SRF in blend with wood, the temperature ranged from 612.4 to 704.7°C, with an average value of 638.2°C. The vacuum in the reactor was maintained at -0.1 kPa throughout the analysis for both fuel types. The average fuel flow rate for SRF was 9.8 kg/h, while for SRF in blend with wood, it was 11.2 kg/h. The average flow rate of the oxidizing medium was 9.7 kg/h for SRF and 9.4 kg/h for SRF in blend with wood, corresponding to stoichiometric coefficients (λ) of 0.4 and 0.2, respectively.

Conclusion

The defined SRF, both in mixture with wood and as a standalone fuel, has been proven suitable for gasification processes. The stable operation and high methane content of the produced gas highlight the potential of SRF as an alternative fuel for sustainable energy production.

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