In this research, the performance of a small scale, downdraft gasifier internal combustion engine is evaluated. Varying compositions of agricultural wastes, such as wood chips and walnut shells as means of biofuel, affect the efficiency and overall performance of the gasification processes and engine combustion. Operational parameters, such as the temperature of the gasification bed, electrical output, feedstock consumption, specific gasification rate and emissions, are analyzed to observe the characteristics of the gasification system using different biomass fuels. The experiments indicated that the downdraft gasifier engine operated at higher bed temperatures and higher specific gasification rates when using woodchips at various electric loads. However, the system’s overall efficiency is higher when using walnut shells, ranging from 13% to 17% compared to 9% to 11% when using woodchips. In addition, the experiments established the optimum air-to-fuel ratio set points for both biofuels by evaluating the emissions.

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Friday, September 20, 2019
11:45 am-12:45 pm
UAA College of Engineering, EIB 211