ABSTRACT

The main goal of this doctoral dissertation is to examine the entire renewable methanol production process, starting from the use of electricity from renewable energy sources, through the production of methanol in a modernized installation to achieve the highest efficiency, to finally recovered electricity. Power-to-Fuel-to-Power technology will contribute to increasing energy efficiency and reducing greenhouse gases emitted into the atmosphere.

As part of the work, analyzes of the renewable energy production process using a solar and wind farm were performed, which allowed to determine the amount of hydrogen produced in hydrogen generators powered by this energy (111.14 kg/h for FW and 45 kg/h for FS).

Hydrogen storage using metal hydride technology with the additional use of a tank cooling system was carried out, and the impact of adding hydrogen to methane on the composition of exhaust gases in the gas turbine cycle was examined.

A model of the methanol production installation was made and analyzed in terms of the impact of changing parameters in the reactor on the obtained efficiencies (the highest efficiency of the installation for 190 °C and 8 MPa is 0.7669). The installation was modernized by replacing two heat exchangers with ORC modules and Stirling engines, which increased efficiency. The efficiency of the entire system was also determined (from electricity production to devices using methanol as fuel).

Additionally, a model of a methanol production installation in the gas turbine cycle was made, which is also an installation using methanol to produce electricity (energy application).

Subsequently, economic analyzes were performed to determine the costs of the methanol production process and to determine the component that has the greatest impact on the change in costs. Difficulties in predicting the cost level of individual components in the future were solved thanks to the Monte Carlo method, which allowed to determine the cost of hydrogen with various random variables.