Laboratory study of pilot module of the compact electrostatically enhanced condensation system for pyrolysis gases

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Keywords: condensation system, gas composition, ionizer, corona discharge, current-voltage characteristics
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The current work is directed to the development and experimental study of a pilot module of the compact electrostatically enhanced condensation system for pyrolysis gases. The module includes a tube-form casing through which the pyrolysis gas could flow in upstream/downstream direction (Figure 1). The pilot module is equipped with a jacketed cooler. An external system is applied for cooling/heating of the heat transfer liquid (HTF). The ionizer includes star-form corona discharge electrodes maintained on the high voltage (HV) rod, connected with the output of HV power supply unit. A DC negative polarity corona discharge is used in the pilot module which is designed for the gas flow up to several cubic meters per hour.

Figure 1. Pilot module

The task of the study is the optimization of design and operation parameters of the pilot module in dependence air flow rate trough the apparatus and HTF temperature. Experiments were carried out without and with air flow up to 3 m³/h and HTF temperatures in-between 0-80°C.

At constant values of HTF temperature and applied voltage, the increase of air velocity in the corona discharge zone results in increase of corona discharge current and power consumption. Without air flow, the increase of HTF temperature from 0°C up to 80°C results in a slight increase of corona current during the tests. With growing of air flow rate from up to 3 m³/h, the spark-over voltage decreases from 19 kV to 14,5 kV, what results in decrease of maximum value of operation corona current, and consequently, in decrease of corona discharge power consumption. At constant air flow rate and HTF temperature, no any difference is observed between “direct and “indirect” current voltage characteristics of corona discharge measured during corresponding increase and decrease of applied voltage (Figure 1).

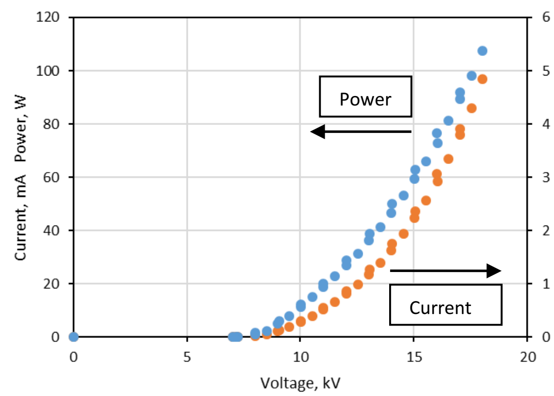

Figure 2. Corona discharge current and power consumption, T_{HTF}=9,8°C, air flow 3 m³/h

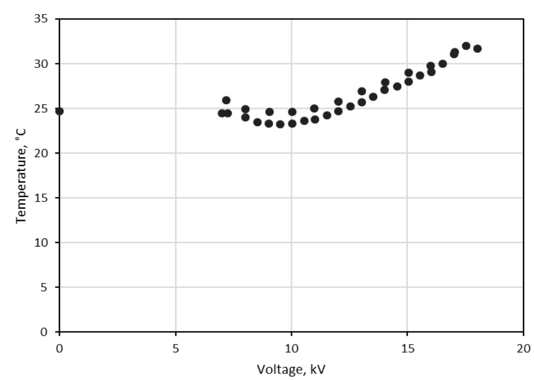

Figure 3. Air temperature at the output from pilot module, T_{HTF}=9,8°C, air flow 3 m³/h

The use of corona discharge enhances heat transfer process. In comparison with the test without air flow (room temperature conditions), the generation of corona discharge results in the change of air temperature at the module output. At low values of corona power consumption, air temperature decreases due to enhance of heat transfer at cold wall of the cooler due to corona discharge electric wind. Further increase of corona power consumption results in heating of air inside the module what results in increase of air temperature at module output.

The results of the tests are used for optimization of module parameters being applied for condensation of pyrolysis gases downstream the pyrolysis reactor.