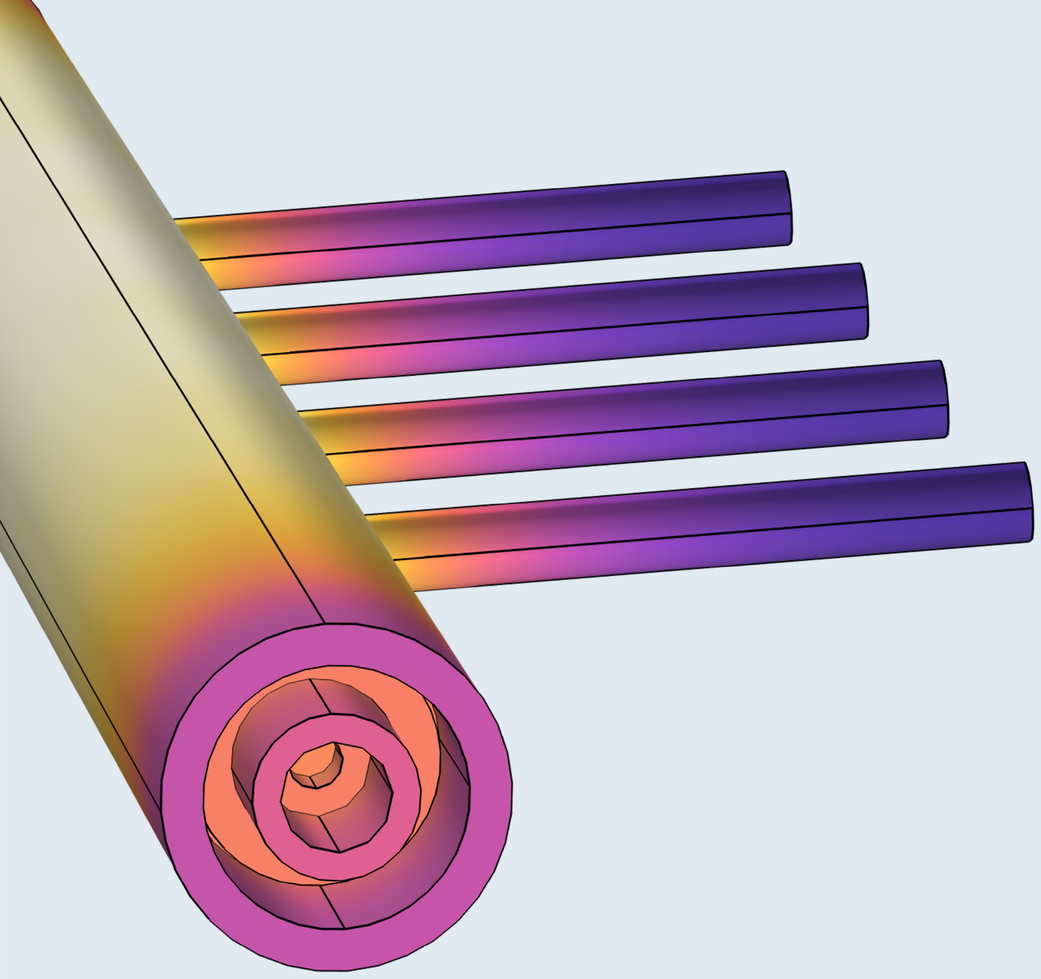

Investigation of the Electrical Conductivity of an Electrically Heated Reactor

Investigation of an electrically heated fixed bed regarding its electrical and thermal conductivity. Comparison of experimental (four temperature probes and thermal image) and simulation results.

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Introduction

An electrically heated fixed bed (19 mm diameter, 200 mm length) is investigated regarding its electrical and thermal conductivities. Various electrically conductive activated carbons are used. The fixed bed is constructed from activated carbon pellets and/or activated carbon fabric. Electrical heating is provided by axially arranged electrodes to which a voltage of about 20 V is applied. In addition, nitrogen flows through the vessel.

Experimentally, the resulting current, the resulting resistance, the temperatures at four points and a thermal image are recorded. The applied voltage and measured current are used to calculate the electrical power introduced into the fixed bed. Although the integral power is easy to calculate, it must be considered that the power does not drop homogeneously across the fixed bed but as a function of the local electrical conductivity.

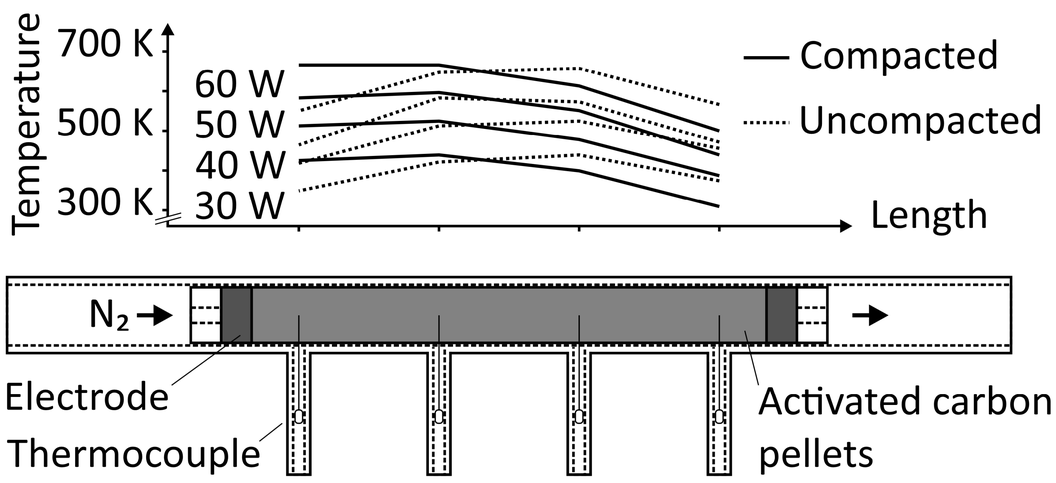

FIGURE 1. Above: Temperature data for compacted and uncompacted activated carbon pellets at different power levels. Below: Sketch of the apparatus.

Methodology

The electrical conductivity of semiconductors such as activated carbon is temperature dependent. Thus, one needs the temperature distribution in the fixed bed for the calculation of the local introduced power. In addition, it is expected that the electrical conductivity of bulk materials depends on their compression.

COMSOL® is used to describe a multi-physics model of the experiment. A simple heat balance shows that the nitrogen flow has only a small influence on the energy balance. Most of the electrical power introduced is dissipated through the vessel or flanges in steady state. The electrical conductivity of the bed as well as the thermal conductivity of the bed are crucial.

Results

The model is used to compare the simulated temperature distributions with the experimental temperature distributions and thus allows assumptions about, for example, the electrical conductivity of the packed bed. The results show the significant influence of the compression of the packed bed on the electrical conductivity and thus on the temperature distribution. Further investigation results are the simulated behavior for homogeneous material properties and a parameter estimation for the description of the temperature dependence of the electrical conductivity under defined assumptions.

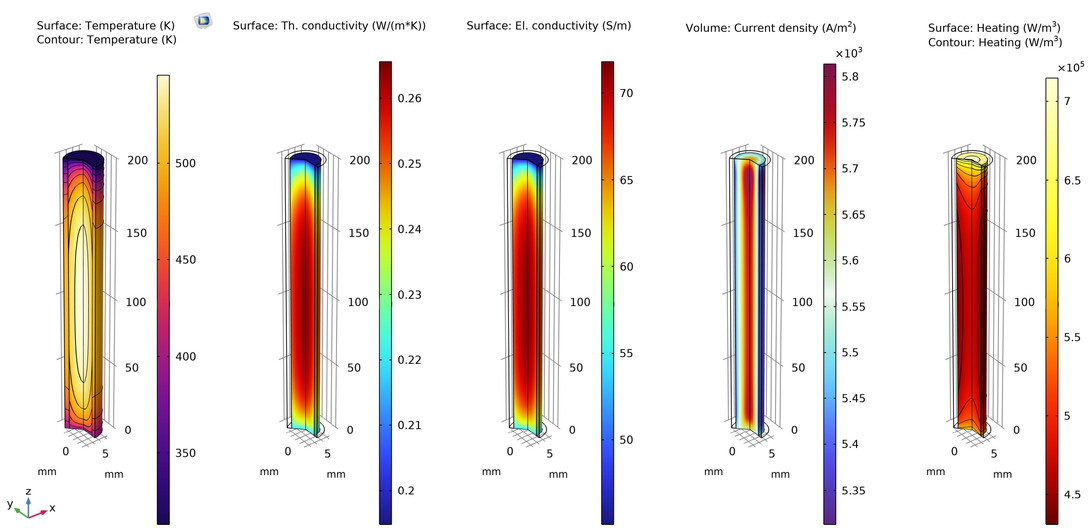

FIGURE 2. Results of the two-dimensional rotationally symmetric model. The distributions of the temperature, the conductivities, the current density and the heating are shown.

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