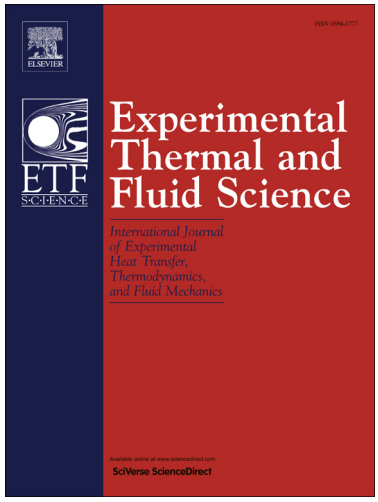

The experimental study of natural convection within the space of a bundle of rectangular sections

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The experimental study of natural convection within the space of a bundle of rectangular sections

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Abstract

Bundles of rectangular steel sections are examples of porous charge that can be found in the industrial practice of heat treatment. Due to voids within the sections, this type of charge is characterized by porosity even exceeding 85%. This makes the thermal properties of these elements, as expressed by the effective thermal conductivity, k_{ef}, are totally different from the thermal conductivity of the solid steel. The value of the k_{ef} coefficient is determined, *inter alia*, by the intensity of gas convection within the sections. In view of the geometry of the system under examination, this phenomenon should be treated as convection in horizontal gaps.

The presented paper describes experimental studies concerned with the qualitative and quantitative analysis of natural convection occurring within the space of unidirectionally heated rectangular steel sections. For qualitative examination, the Schlieren method was used. While for quantitative examination, was a Poensgen apparatus employed.

The primary goal of the studies was to determine the natural convection occurring within the space of heated section bundles and the effect of this phenomenon on the intensity of overall heat flow. The tests were performed for square sections, dimensions 40 x 20 mm, wall thickness 2 mm. The quality tests, despite the fact that the critical value of the Rayleigh number was exceeded in the heated sections, did not demonstrate a proceeding convection. This situation was confirmed by the quantitative tests. The latter showed that the direction of the section heating, which determines the possible occurrence of the convection phenomenon or its lack, does not affect the intensity of the total heat flow. It was also pointed out that, for the range of the Rayleigh number which occurs during the heating of square sections of the side dimensions up to 80 mm in a chamber furnace, the heat flow related to the occurrence of free convection can be expressed as an intensification of the thermal conductivity in the