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METHOD EXPERIMENTAL DEFINITION OF EFFICIENCY FUELBURN IN A GAS REACTORS WITH MINI CHANNELS

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Abstract. Approbation of a method of experimental definition of efficiency of a fuelburn in minichanneling gas reactors has been carried out. The method of visualisation of a field of temperatures by the temperature transducer made of fine-meshed with low-inertia use for definition of thermal structure of gas streams. A field of temperatures on an outlet the simulator of a gas reactor with minichannels registered on thermogram by infrared imager. Experiments have shown that the thermal imaging method provides the good resolutions on spatial and on time for a field of temperatures both in stationary and in non-stationary regime of gas flow and of heat release. Qualitative and quantitative character a change a temperatures on thermograms correspond to classical physical representations about nature of a gas flow in lengthy channels. The study showed that the method of thermal imaging allows in a regime real time defined a parameters of gas flow on outlet a channels of reactor which are necessary for definition of fuelburn efficiency.

1 Introduction

The mini-microchannel gas reactors and the heat-exchange apparatus become an integral part of innovative directions a machine industry of heat power and energy-chemical. Data about composition and temperature the gaseous reaction products, gained immediately on an outlet from such apparatuses, allow to optimise their operation.

The thermographic method an experimental study a definition of thermal structure a gas flow [1] is applied. For visualisation a pattern of temperature a medium which transparent in an infrared light, possible used thin filaments or fine-meshed heated up in a stream as a indicators of temperature. The thermographic method possible to trace changes both common and an local pattern a changing a temperature in a gas flow. In the present paper results of approbation the thermographic method [2] for heat exchangers with minichannel are presented.

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2 A measurement procedure

Experiments on measuring non-stationary a field of temperature on an outlet from six longitudinal minichannels of quasitriangular cross-section have been carry out on the model framework organised by seven cylindrical heaters of equal diameter. On fig. 1 the cross-section and the passing channel in framework are schematically presented. In a quartz tube 1 outer diameter 23 mm and length 0.5 m disposes framework from seven electric heaters 2 diameter 5.9 mm and length 0.5 m which organising six passing minichannels 3 (№ 1 ÷ № 6) the quasitriangular shape (triangle ABC organised by archs AB, BC, CA). Kaolinite wool 4 in thickness 7 mm and landlocked an air spaces 5 reduced heat loss from heaters in a circumambient.

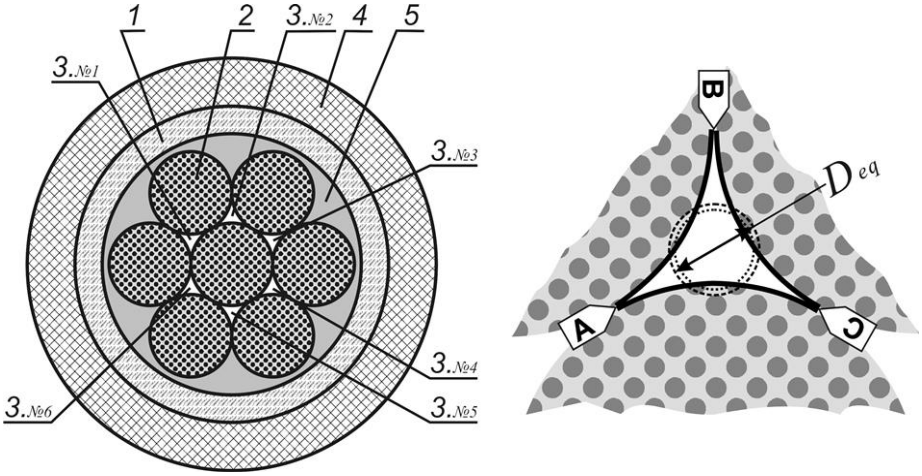

Fig. 1. A cross-section (a) and the shape (b) the passing quasitriangular channel of minichannel framework: 1 - a quartz tube; 2 - a heater; 3 - the passing channel (№ 1 ÷ № 6) for gas; 4 - thermo insulation; 5 - an air space; A, B and C - vertex of the quasitriangular channel.

The total heat exchange area passing quasitriangular channels is 0.0275 m^2. On fig. 1b the visual relationship a sizes the passing channel and its hydraulic diameter D_{eq} is shown. By shaped lines rounds for minimum (1.2 mm) and maximum (1.3 mm) meanings of hydraulic diameters in framework are shown. The odds in diameters is caused by inaccuracy at mount a electric heaters in a bundle and some ovality of cylindrical heaters. According to planimetric measuring of photographs the sectional area the passing channels varied from 2.7 to 3.0 mm^2. The brass mesh-thermode from a wire in the thickness about 80 microns with meshes 0.3 × 0.3 mm press oneself to surface of channels on outlet framework. Thermogram have been obtained by infrared imager NEC TH7100 with wavelength thermal radiation $\lambda = 8 \div 12$ microns.

3 Discussion of results

The thermographic method has been approved for various a flow rate of air and an intensity of its heating by cylindrical heaters in stationary and nonsteady conditions. Processing a thermograms has allowed determine a changes type a flow temperature in each a passing minichannels of framework. On fig. 2 four sample thermograms from the beginning (000) and after 99, 304, and 557 seconds after heat load 4.8 Wt surge on a central heater are shown, under the total flow rate a air 0.45 g/s. It is possible to see inhomogeneity a warm-up of framework because of a thermogravitational convection by volume assembly and

variations a heating on the separate passing channels, caused by differences of their flow areas, noted previously.

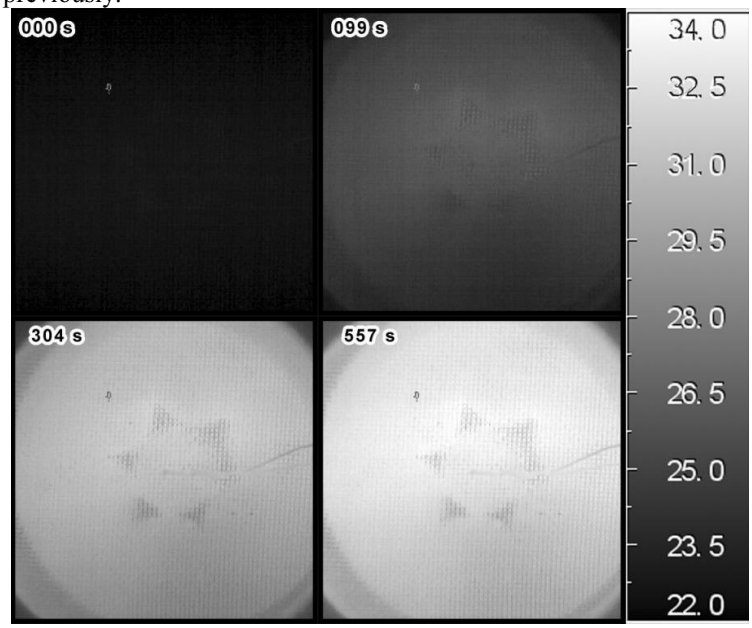

Fig. 2. The thermograms of mesh-thermode on outlet of a framework after heat load surge only on a central heater in a assembly.

Analogously on fig. 3 thermograms for case a decrease total flow rate air with 0.45 g/s to 0.26 g/s are shown, under a heat load 33.6 Wt proportioned uniformly on all a heaters. The thermograms allow to see as all panoramic pattern of nonsteady preheating a air in quasitriangular minichannels, and full details a dynamic preheating of model framework.

Processing a thermograms has shown, that after transition to a stationary conditions the temperature of air on outlet a framework correspond to a calculated values for a stationary flow, taking into account changing a conditions of heat exchange along length of the channel [3, 4]. Let's note, that for uprating accuracy of measuring by operation with channels of a smaller size it is necessary to use infrared imagers with smaller wavelength thermal radiation λ for traceable caloradiance.

4 Conclusion

Approbation the thermographic method flow with using fine-meshed grids-thermode for definition a thermal structure a gas flow on outlet the simulation framework with minichannels has shown its good a spatial-time resolution. Qualitative and quantitative character a change a temperatures on thermograms correspond to classical physical representations about nature of a gas flow in lengthy channels [3].

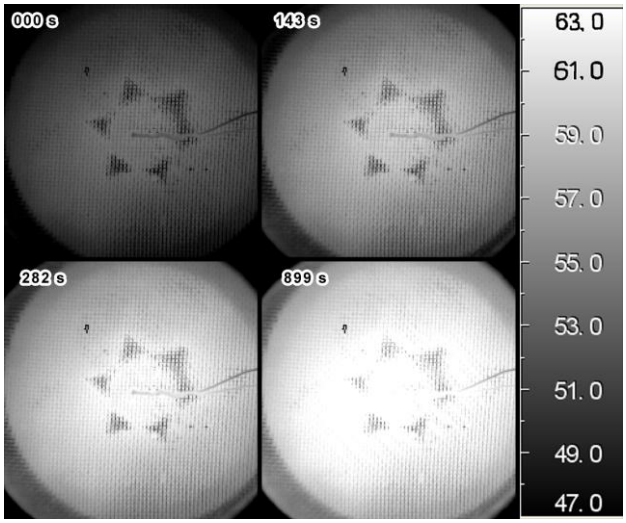

Fig. 3. The thermograms of mesh-thermode on outlet of a framework after a decrease total flow rate air.

The thermographic method is universal, its specific application for study a processes of stationary and nonsteady heat exchange, dependent from a specificity a subject of inquiry and engineering possibilities a equipment for thermal imaging.

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