# EXPERIMENTAL DETERMINATION OF THE PROPERTIES OF A GAS-PERMEABLE MATRIX MADE OF COMPACTED FECHRAL WIRE

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**Abstract:** Methods for determining the key thermophysical parameters of gas-permeable matrices made from compacted Fechral wire (Fechral is a precision iron-based alloy designed for high-temperature applications, commonly used in high-power electric heating elements; functionally similar to Kanthal (FeCrAl) in terms of stability, oxidation resistance, and a long service life in industrial heating systems) have been developed. These matrices are employed in matrix reforming technology and other gas-chemical processes. Experimental values for a certain type of matrix made of Fechral wire (0.2 mm in diameter) twisted into a spiral were obtained: porosity (free volume fraction) $0.749 \pm 0.004$, specific surface area of the matrix $5300 \pm 400$ m$^2$/m$^3$, inertial resistance coefficient $5700 \pm 1600$ m$^{-1}$, and matrix effective thermal conductivity 0.14 W/(m·K). It was established that the matrix effective thermal conductivity is isotropic and the heat transfer coefficient between the gas and the matrix material is sufficiently high to heat the gas to the matrix temperature during its passage through the matrix. The obtained results provide the necessary information for the development of an adequate computational fluid dynamics (CFD) model of matrix reformers for comprehensive analysis of their operation and for formulating recommendations for their optimization.

**Keywords:** porous gas-permeable materials; Fechral; partial oxidation; matrix reforming; CFD modeling

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## Figure Captions

**Figure 1** Schematic representation of the matrix conversion unit (*a*) and the heat flows in it (*b*): *1* — convective heat transfer; *2* — conductive heat transfer; *3* — radiative heat transfer; and *4* — flame front

**Figure 2** Structure of the front side and cross sections of a matrix fragment extracted for the studies described below

**Figure 3** Installation diagram for determining the inertial resistance coefficient of the matrix

**Figure 4** Installation diagram for determining the thermal conductivity of the matrix via synchronous cooling from both sides

**Figure 5** Dependence of the dimensionless temperature at the center of the studied matrix sample on time: *1* — experimental data; and *2* — calculated curve according to Eq. (3) with the optimal value of $k_s$

**Figure 6** Installation diagram for determining the matrix thermal conductivity using the approximation of a semi-infinite homogeneous rod

**Figure 7** Time-dependent profiles of the dimensionless temperature based on thermocouple measurements T1 (*a*) and T2 (*1*) (*b*) and the matching calculated profiles for several values of effective thermal conductivity: *2* — $k_s = 0.14$ W/(m·K); *3* — 0.1; and *4* — $k_s = 0.19$ W/(m·K)

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