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Experimental Assessment of Porous Material Anisotropy and its Effect on Gas Permeability

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Abstract

The results of experimental research upon the assessment of porous material anisotropy and its effect on gas permeability of porous materials with respect to the gas flow. The conducted research applied to natural materials with an anisotropic gap-porous structure and - for comparative purposes - to model materials such as coke, pumice and polyamide agglomerates. The research was conducted with the use of a special test stand that enables measuring the gas permeability with respect to three flow orientations compared with symmetric cubic-shaped samples. The research results show an explicit impact of the flow direction on the permeability of materials porous, which results from their anisotropic internal structures. The anisotropy coefficient and permeability effective coefficient of such materials was determined and an experimental evaluation of the value of this coefficient was conducted with respect to the gas stream and the total pressure drop across the porous deposit. The process of gas permeability was considered in the category of hydrodynamics of gas flow through porous deposits. It is important to broaden the knowledge of gas hydrodynamics assessment in porous media so far unrecognised for the development of a new generation of clean energy sources, especially in the context of biogas or raw gas production.

Keywords: Anisotropy; Gas Permeability; Biogas; Raw Gas.

1. Introduction

In this context, our own research experimental assesses conditions of hydrodynamics of the gas flow through backbone (skeletal) porous materials with an anisotropic structure. The results of research upon the assessment of gas permeability of one type solid porous materials have been presented and the assessment of process conditions concerning hydrodynamics of the gas flow through materials with a diversified internal structure has been conducted.

The porous medium is a natural or artificial material characterised by a vast number of channels and empty spaces with relatively dimensions in comparison with the weight of the material itself. Empty spaces, irrespective of their shape, are called pores whose form and size are affected by a kind of granular deposit. The porous structure is characteristic for both natural and artificial materials, including soil, pumice (volcanic soil), ceramic construction materials, metal agglomerates and the so-called metal foams. Porous media are divided into two fundamental groups, viz.: a) porous media constituting loose deposits comprising granular materials that take the space resulting from the geometrically-shaped volume Figure 1a; b) frame-based media that are a solid and stiff porous structure in the form of the homogeneous material deposit Figure 1b.

In both cases, in a particular porous medium there usually occur pores with diversified and irregular shapes that most frequently create the gap-porous space as illustrated in Figure 1b. For circular-shaped pores (channels) or similar ones

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