DOCTORAL THESIS

"THERMAL FILTRATION MODEL IN THE AREA OF INFLUENCE OF THE COAL GASIFICATION GENERATOR"

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ABSTRACT

Purpose of the doctoral thesis was to develop a thermal filtration model in the area of influence of the underground coal gasification generator. Despite the fact that the history of underground gasification of coal already has more than 100 years, there are still numerous aspects related to this exploitation manner that remain unexplained. This refers mainly to notions regarding the process impact on the environment. The work presents a proposal for describing the notions of filtration flow of underground waters in the surroundings of the gas generator, i.e. In conditions of a variable field of temperature and pressure. The thematic model of liquids (gases and fluids) thermal filtration was provided from equations of thermodynamics related to irreversible processes. The paper is composed of eight chapters divided in substantive terms into sub-chapters.

The first sub-chapter poses an introduction that presents general information on the underground coal gasification and describing the notion of thermal filtration. It demonstrates main objectives and scope of the dissertation. The introduction is carried on in the second chapters, devoted to literature review. The literature studies were carried out in division into three main notions. The first are themes regarding the underground coal gasification. It presents information on the technological process itself, as well as a brief historical outline related to research works in this field. Attention was also focused on a highly significant aspect that refers to achievements in the field of the underground generator impact on the environment. Another topic of the literature studies was a broadly understood process of filtration liquid flow through the porous media. The third topic for an analysis of previous achievements is the thermal filtration process. For the needs of the doctoral dissertation, detailed studies over both Polish and foreign literature were carried out, with consideration of classical positions, as well as the latest achievements of the researchers in the scope of notions related to the paper.

The third chapter is the first substantive one, where discussion over the existing mathematical models for underground waters filtration was performed, and an original mathematical description of the flow process was proposed, with consideration of this model's consistency with the consolidations theory for a two-phase medium by Biot-Darcy.

The fourth chapter of the doctoral dissertation includes a proposition of a thermal filtration model with flow continuity, equations for liquid motion through the porous media and constitutive

media, and an equation for heat flow, resulting from thermodynamics law for irreversible processes. The presented mathematical model was introduced on the basis of two different assumptions: the first one assuming that heat is distributed in the porous media evenly, with an average speed for the solid and liquid phases, and the second one - assuming the the heat flow takes place with different speed levels for the solid and for the liquid phase, with consideration of heat exchange between both those phases. Theoretical deliberations lead to a set of differential equations for thermal-filtration. The chapter also defines effective parameters for the thermal filtration model. The mathematical model proposed in the chapter poses a basis for numerical calculations presented in the further part of the work.

Results from the numerical calculations are presented in chapters five and six. The fifth chapter presents results from calculations over the filtration flow, carried out for several variants of the mathematical model. In order to picture the differences in the course of the process for the proposed mathematical model of the filtration flow, numerical calculations were referred to the classical model, and presented in a form of a finite elements method for an axially symmetric three-dimensional sample, which the pressure gradient was applied to in the moment t=0. Results from calculations include, among others, diagrams for the case of liquid and solid phase flow. Furthermore, there is a presentation of examples for numerical models of flow, with consideration of inertia components in the equation of motion (a dynamic model) and without their consideration (a quasi-static model).

The sixth chapter presents results from numerical modeling of the thermal-filtration model, which were obtained from examinations carried out on two objects: on flat and spatial models considering a complex geological structure in the gas generator surrounding. The calculations process considers the transformation of water into vapor in the land formations, located in direct contact with the gas generator. Furthermore, results from calculations over filtration in thermal filtration and thermal consolidation mathematical models, based on the Biot-Darcy's equations.

The seventh chapter presents a different example of application of the thermal filtration mathematical model. It presents results of calculations for the notion of the so-called quicksand in desert areas. This examples refers to an analysis over filtration stability of fine desert sands, as a result of the flow of air, generated by the differences in temperatures.

The last, eight chapter of the doctoral dissertation poses a summary. It presents conclusions related to the liquid flow model in the porous media, for isothermal conditions, as well as conclusions from the presented thermal filtration model.It also presents proposals for practical application of the model, as well as possibilities of its expansion in the future. As a result of the performed works, impact of the underground generator on the surrounding land and rocky environment was presented.