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Summary of the doctoral dissertation

EVALUATION OF GEOLOGICAL CONDITIONS OF GEOTHERMAL INVESTMENTS USING NUMERICAL MODELING ON THE EXAMPLE OF THE LOWER JURASSIC AQUIFER OF THE SZCZECIN-MOGILNO-ŁÓDŹ TROUGH

The following PhD thesis applies numerical modeling to evaluation of geological conditions and to optimization of the operation of geothermal dublet exploiting the Lower Jurassic groundwater aquifer of the Szczecin-Mogilno-Łódź Trough. Considering the remarkable size of the study area, evaluation of geological conditions was based upon the analysis of two local test areas, which provided information crucial to the potential investors about possibility of development of geothermal aquifer. An important aspect was the proper selection of local test areas, which would ensure the collection of a wide spectrum of data describing various geothermal reservoir conditions. The analysis included also the participation of potential consumers of thermal energy. The names of test areas originated from deep wells located within them, which were used in modeling procedures as a production well (Choszczno IG-1 in the Choszczno study area) and as an injection well (Malanów-1, in the Malanów study area).

The modeling was preceded by comprehensive analysis of geological and geophysical data including the latest results of research projects run in the test areas. Numerical simulations comprised two stages. In the first stage, static models were constructed, which provided the basis for characterization of spatial distribution of parameters decisive for exploitation of geothermal system: clay content, porosity, permeability and potential discharge. The static models were constructed using the PETREL software. Moreover, the static models were the basis for construction of structural, thickness and parametric maps, which were subsequently used in optimal localization of geothermal dublets within the analyzed test areas. Estimated values of reservoir parameters were applied in the second stage of simulations, to modeling of operation of geothermal dublet. This stage included additional

analyses comprising the influence of pattern of calculation grid on the results of modeling (variables were both the grid density expressed by the area of calculation cell in the vicinity of wells and the minimum angle of grid pattern affecting the rate of changes of grid cells, starting from the vicinity of the wells and continuing to the boundaries of the model) as well as the influence of the spacing of wells forming the geothermal dublet on particular parameters, e.g. reservoir temperature and pressure in the vicinity of wells, related to various discharge values. Dynamic modeling was carried on with the TOUGH2 simulator, a tool widely applied to the modeling of geothermal dublets operation.

Static, structural and parametric models added to conceptual models enables the researcher to improve the detailed distribution of parameters influencing the exploitation of geothermal waters and to optimize the localization of geothermal dublet. Analysis of the results of dynamic modeling of dublet operation confirmed that the simulation procedures can be optimized using the relevant selection of parameters of calculation grid (its pattern and density) in order to reduce the calculation time and to ensure the obtaining of most realistic results. It was demonstrated that if the simulation concerns changes of dublet wells spacing and discharge of the geothermal waters intake, the multivariant modelings enable the researcher to optimize the selection of spacing between the wells and the range of discharges from the production well, in order to avoid the cooling of geothermal waters reservoir.