Course: GW Flow and Contaminant Transport Modeling

Assignment #1: Determination of breakthrough time of a well system

The problem to be investigated:

A well system consist of two production and three injection wells is established, the task is to determine the breakthrough time (shortest transit time from injection to production well) at different production rates and to determine the function time vs production rate.

Hydrogeological conditions:

There is a shallow sandy gravel, gravelly sand aquifer suitable to establish fully penetrating wells. The shallow aquifer is phreatic (unconfined) with 3 m/km horizontal hydraulic conductivity. The groundwater flow direction is free to choose. The hydraulic parameters of the aquifer can also be freely chosen but the different parameters (horizontal and vertical hydraulic conductivity, effective porosity) should be coherent to each other. The thickness of the aquifer is also up to the student but at least 2/3 of the aquifer must be saturated.

Hydraulic problem:

There are two production wells downgradient and three injection wells drilled in upgradient drilled and fully screened to the aquifer to support an open water to water heat-pump system. The production rates of the two wells are the same and the total amount of produced water is injected into the three injection wells (in equal fluxes). The position of the wells is not given but the minimum distance of the wells is at least 50 m. The maximal production rate is the rate calculated for single well using the Dupuit-Thiem formula at 1 m saturated water column in the well. The calculation should be done at 100, 75, 50, 30 and 10% of the maximal production rate. The breakthrough time vs. production rate curve should be determined using the five different production rates.

Materials to be presented:

In printed form a short expert opinion about the problem with

- geometrical settings
- the details of the chosen hydraulic data
- graphic presentation of potential fields, pathlines
- breakthrough-time vs. well distance function
- the description and evaluation of results

Digitally (only at the end of semester)

- report in document form
- full dataset of the model
- plots in graphical form