Geophysical Research Abstracts
Vol. 15, EGU2013-13165, 2013
EGU General Assembly 2013

Estimation of the hydraulic parameters of a confined geologic formation from slug test in fully penetrating well using a complete quasi-steady flow model in a forward and in an inverse optimal estimation procedure

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Slug tests offer a fast and inexpensive means of estimating the hydraulic parameters of a geologic formation, and are very well suited for contaminated site assessment because no water is essentially withdrawn. In the great majority of slug tests performed in wells fully penetrating confined geologic formations, and for over-damped conditions, the response data are evaluated with the transient-flow model of Cooper et al. (1967) when the radial hydraulic conductivity K_r and the coefficient of specific storage S_s are to be estimated. That particular analytical solution, however, is computationally involved and awkward to use. Thus, groundwater professionals often use a few pre-prepared type-curves to fit the data by a rough matching procedure, visually or computationally. On the other hand, the method of Hvorslev (1951), which assumes the flow to be quasi-steady, is much simpler but yields only K_r-estimates.

Koussis and Akylas (2012) have derived a complete quasi-steady flow model that includes a storage balance inside the aquifer and allows estimating both K_r and S_s, through matching of the well response data to a (dimensionless) type-curve. That model approximates the model of Cooper et al. closely and has the practical advantage that its solution type-curves are generated very simply, even using an electronic spreadsheet. Thus, an optimal fit of data by a type-curve can be readily embedded in an exhaustive search. That *forward* procedure, however, is semi-automated; it involves repeated computation of the quasi-steady flow solution, until finding an optimal pair of K_r and S_s values, according to some formal criterion of optimality, or visually. In addition, we have developed a fully automated *inverse* procedure for estimating the optimal hydraulic formation parameters K_r and S_s. We test and compare these two parameter estimation methods for the slug test and discuss their strengths and weaknesses.

Cooper, H. H., Jr., J. D. Bredehoeft and I. S. Papadopulos. 1967. Response of a finite-diameter well to an instantaneous charge of water, *Water Resour. Res.*, **3**(1): 263-269.

Koussis A. D. and E. Akylas (2012) Slug test analysis for confined aquifers in the over-damped case: Quasi-steady flow model, with estimation of the specific storage coefficient, *Ground Water*, **50**(4): 608–613.