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Field application of a constant head circulation flow test and parameter estimation

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The constant head circulation flow test (CHCFT) is a single-well hydraulic test for the estimation of the horizontal and vertical hydraulic conductivity (K_r and K_z) and the storage coefficient S. In the test well, a pneumatic packer separates the well screen into an upper section of a length L_u and a lower section of L_l. With respect to the initial water table, a positive constant head H_l is maintained in L_l by water injection while a constant drawdown H_u is maintained in L_u by pumping with automatic flow rate adjustment. As a result, the injected water moves form L_l through the aquifer into L_u in a vertical circulation fashion. The injection rate Q_I(t) and the pumping rate Q_P(t) are measured above ground for the parameter estimation. As H_l is easily controlled unequal to H_u, Q_I(t) is not equal to Q_P(t) even if L_u = L_l, resulting in an asymmetric vertical circulation flow field that takes a relatively long period to reach the steady state condition. A mathematical model for the CHCFT is developed, and the type curves of Q_I(t) and Q_P(t) are generated for a curve matching technique of determining K_r, K_z, and S. A CHCFT was performed in a silty sand unconfined aquifer, where recharge due to the water table decline was negligible. The curve-matching results in K_r = 5.21$\times 10^{-6}$ m/sec, K_z = 3.39$\times 10^{-6}$ m/sec, and S = 8.6$\times 10^{-2}$. The value of S is higher than the upper bound of 5x 10^{-3}, possibly due to the negligence of some recharge from the water table decline. The K_r value compares favorably with the estimate of 2.8$\times 10^{-6}$ m/sec determined by a constant-head injection test in a nearby well, K_z could not be determined in that constant-head injection test.