Analysis of Diffusion in An Observation Well from Multi-level Tracer Observation

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Tracer test is a very popular method for determination of the solute transport parameters of subsurface. But it is a very expensive and complicated method, especially in fractured rock aquifer.

The need for efficient and clear but low cost methods of tracer testing has led to an investigation on the factors affecting tracer test results and the test instruments which can enhance the efficiency of the tracer test. Effects of injection intensity (concentration and total quantity) are examined. Efficient injection instruments for instantaneous introduction and homogeneous mixing are proposed. A device of simple, cheap, and useful for multilevel point-sampling by using vacuum hand pump and slender tube was designed and used in the field tests. Five tracer tests (four times under natural gradient flow condition and one under forced gradient condition) and five laboratory tracer tests (four times with instantaneous injection and one with continuous injection) were conducted. From the results of field tracer tests, the observed breakthrough curves show vertical variation. The vertical variation is analyzed in terms of fracture zone location.

The effect of well diffusion is also investigated. The term well diffusion is used to represent the vertical diffusion of tracer in a well after it is entered into the well through a transmissive fracture. Semianalytical solutions for one-dimensional diffusion equation with time-dependent boundary conditions are derived using a superposition scheme. The peak concentration arrival time at observation point is proportional to square of distance from the fracture location and it proportional to the inverse of the diffusion coefficient. From the

applications of the semianalytical solutions to the results of laboratory tests, it is known that the proposed semianalytical solution can be useful to where diffusive transport dominates the mixing process in a well. By using the semianalytical solutions, the location of single fracture or major fracture zone can be identified if exact diffusion coefficient value is known and two breakthrough curves are obtained at different depths.

Key words: tracer test, solute transport, injection/sampling instrument, fractured rock aquifer, *well diffusion*, semianalytical solution, fracture location.