II -273 Experimental Study of Solute Transfer in Layered Porous Media.

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1. Introduction.

Layered porous medium is a natural nonhomogeneous aquifer that we practically face on earth profile. Prediction of the characteristics of solute movement with dispersion mechanism [1] is important subject especially in dealing with groundwater pollution. Two types of laboratory experiments were carried out to determine the longitudinal and lateral dispersion coefficients using the solute concentration profile and to fit with numerical results to obtain the solution of the basic differential equations. Also illumination of dispersion mechanism in layered media was considered in the study.

2. Experimental Methods.

Fig. 1. schematically shows the concentration detecting technique in layered glass bead in column to determine the longitudinal dispersion. This method is based on a kind of permeability tests when a sudden head difference is imposed between inflow and outflow end, while 1% NaCl solution is continuously fed with a constant head level to keep longitudinal dispersion. Voltage recorded through computer via four channels are analyzed to get the break- through curves (B.T.C) for different cases of the experiments.

Fig. 2. corresponds the horizontal concentration distribution measuring device in a layered porous media box. Data collecting method is the same as that of column experiment. Several runs were taken for different cases of the two experiments with changing the combination of layered media as well as head difference.

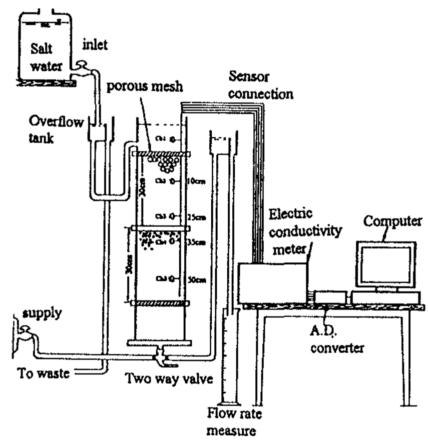

Fig.1. Two layer column set up.

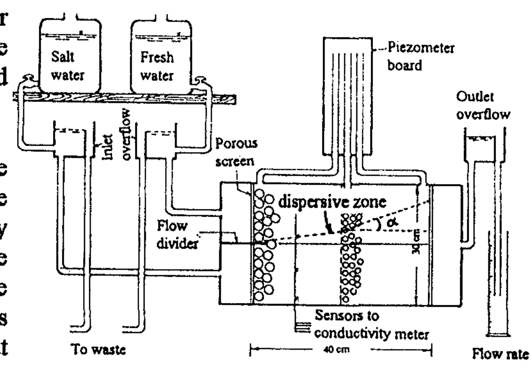

Fig.2. Schematic lay out of lateral dispersion test

3. Obtained Results.

Based on the experimental B.T.C's in column test, the numerical scheme is formulated with a set of convective dispersion equations under initial and boundary conditions in FEM technique. Only for four cases of the experiments are adopted here to get B.T.C's. The dispersion coefficients resulting from the best fit curves are correlated with Reynolds number. It is found that the dispersion coefficients changes with a sudden pore velocity change at the layer interface. In lateral dispersion, the transition angle α of dispersive zone increases as it passes from small grain size to large grain size(Fig.5 & 6). Also in doing averaging operation to find the dispersion coefficients, two possibilities may arise, one is taking the average of Dxi, Dyi (longitudinal and lateral disp. coeff. in ith layer) i=1,2,3.. and average R_e as well, another lies in taking the average pore velocities u_i, and correlating with average R_e, Considering both cases we are able to propose two parameter equation as : $Dxi / v = 2.15\ R^{1.2}$ and $Dyi / v = 0.033\ R^{0.7}$ for longitudinal and lateral dispersion respectively, keeping the exponent value n in R_e^n for homogeneous porous medium.

Keywords: Solute transfer, Dispersion, Reynolds number.

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This might be an acceptable postulation in the sense of practical application . The break through curves and the relationship of *Dxi* , *Dyi* , with Reynolds number are furnished bellow :

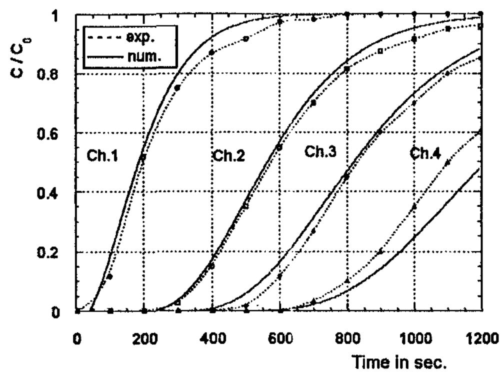

Fig. 3. Longitudinal B.T.C of 2layer(1-5)* and it's best fit with numerical result.* 1mm.medium in upper &5mm.in lower layer.

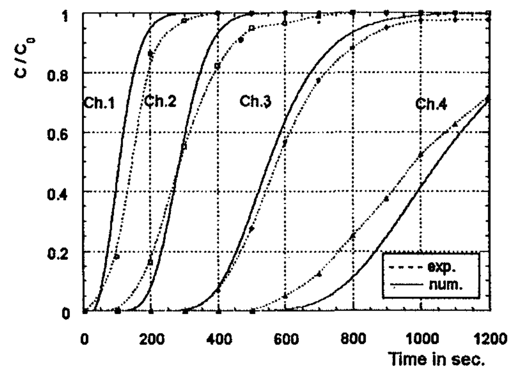

Fig.4. Longitudinal B.T.C. of 3 layer (1-3-5) and it's best fit with numerical result.

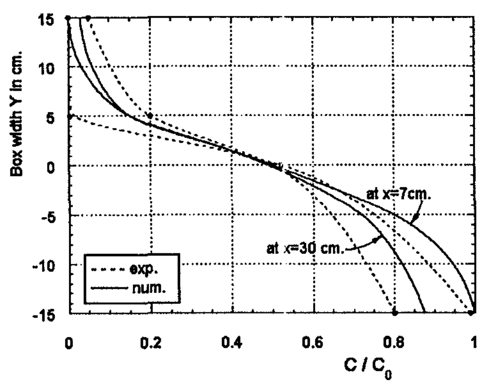

Fig.5. Normalized profiles of lateral dispersion in 2 layers(1-5 and it's best fit with numerical result.

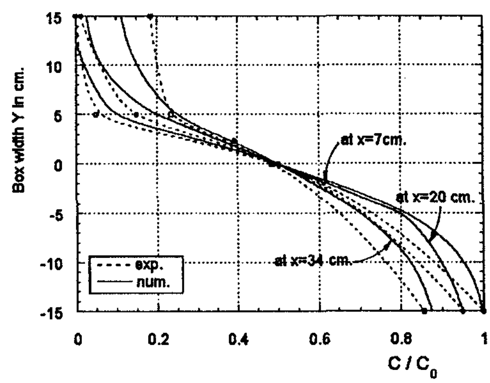

Fig.6. Normalized profiles of lateral dispersion in 3 layers(1-3-5 and it's best fit with numerical result.

4. Conclusion .

(a) The relationship of dispersion coefficients with Reynolds number holds an acceptable trend with existing one.

(b) The average dispersion coefficients in layered aquifer composed of smaller particle size may be affected by pore velocity when the flow passes from one layer to another.

(c) The transition angle of mixing zone increases when flow passes from one medium to larger one.

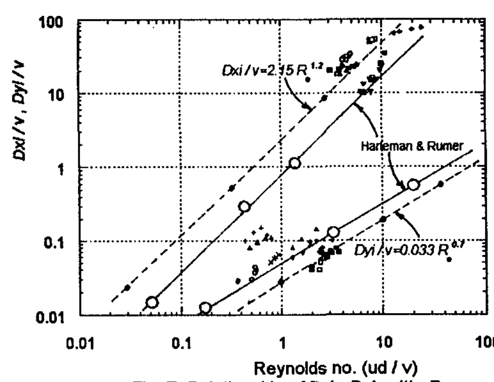

Fig. 7. Relationship of Dxi , Dyi with R_e

5. References.

[1] Harleman D.R.F. and R.R.Rumer. 'Longitudinal and lateral dispersion in an isotropic porous media.' Hydrodynamic lab. M.I.T. 1963.pp. 385-394.

[2] Shamir U.Y. and Harleman D.R.F. 'Numerical solution for dispersion in porous medium'.Vol 3.No.2 Water Resource Research. 1967.pp. 557-580.

[3] Greenkorn R.A. , D.P. Kessler, 'Dispersion in heterogeneous non uniform anisotropic porous media.' 'Flow through porous media symposium' Vol. 61. No. 9., Sept. 1969.pp.14 -32.