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# Research on Measurement of Dispersion Parameters in Subsurface Hydrology

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## 1. Introduction

In this paper the author will be describe measurement of contaminant flow in the saturated condition. During the experiment to take place, conductivity probe and resistivity tomography method were used for measurement of concentration NaCl. Continuous sources are presented for determining the dispersion coefficients. The instrument in this research was designed two dimensional model. For contaminant solution was chosen NaCl solution 0.2%. The sucrose solution was used as resident fluids, because the effect of density differences between resident and dispersing fluids was eliminated, in addition the viscosities of fluids were approximately equal.

# 2. Basic Equation of Advection Dispersion

The change in concentration with time at probe location can be described by advection dispersion equation

$$\frac{\partial Cs}{\partial t} + Vs \frac{\partial Cs}{\partial y} = D_T \frac{\partial^2 Cs}{\partial x^2} + D_L \frac{D^2 Cs}{\partial y^2} \qquad (1)$$

Where the Cs is the tracer concentration at probe location at time t,  $D_T$  and  $D_L$  are the transversal dispersion coefficient and longitudinal dispersion respectly.

Final solution for calculating longitudinal dispersion is written such as follow

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$$Cs(x, y, t) = \frac{Co}{2} \operatorname{erfc} \left[ \frac{y - Vs t}{2(D_L t)^{1/2}} \right] \qquad (2)$$

And final solution for calculating transversal dispersion

Cs 
$$(x, y) = \frac{\text{Co}}{2} \text{erfc} \left[ \frac{x}{2(\frac{\text{Dr } y}{\text{V}_s})^{1/2}} \right]$$
 .....(3)

Obtaining Cs, Co, Y, Vs and t from the experiment and using equation (2) and (3), Longitudinal and transversal coefficient can be determined. 1)

#### 3. Instrument and Experiment Method

The experiments were performed of Plexiglas test box that is 80 cm high, 80 cm wide and 10 cm deep. The facility of the experiment equipment can be shown in Fig. 1.

The input region is at the top, and Plexiglas box is divided in to three section. Salt solution flowed in the middle section, and the sugar solution is inserted on the either sides. The flow rate through the system was controlled by a valve at the bottom of instrument. Flow rate measurement or seepage velocity will be determined with volumetrically at outlet. The experiment will be started when the sugar solution is established in the apparatus and at t = 0, the salt solution was introduced into the center section. The salt solution then passed through the sand, dispersing out proceeded down ward as it passes line work. Resistance for each conductivity probe and apparent resistivity for each line will be measured simultaneously.

Stainless steel was chosen as the electrodes with diameter 2 mm. The pole-pole array was used for calculating apparent resistivity of each line. The test will be terminated when a constant value of concentration was recorded in the conductivity probe.

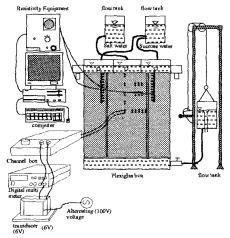


Fig.1 Experiment Equipment

## 4. Experimental Results

The tracer consisted of a solution 0.2 % NaCl. Conversion from resistances to concentration was achieved by calibrating each probe in situ by performing one dimensional test at different initial tracer concentration with in range 0 - 0.2% NaCl.

Concentration-Resistance Calibration curves were found for each probe. The temperature range of the experiment (8 - 9 degree Celsius). The soil sample was used river sand with the porosity 0.38, permeability 0.079444 cm/sec. Tests were run at several seepage velocity (0.0026 cm/sec, 0.0039 cm/sec, 0.0052 cm/sec, 0.0065 cm/sec, 0.0078 cm/sec) and breakthrough curves for each probe were obtained. Longitudinal dispersion coefficients for various seepage velocity were determined and the results were shown in Table.1, Transversal dispersion coefficients were also determined by substituting the steady state concentration at lateral direction of probe and the results were shown in Table.2.

Table.1. Longitudinal Dispersion Coefficient

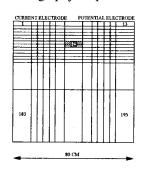
Velocity (cm/sec)	DL (cm2/sec)	(x ,y) cm
0.0026	0.014029	(0,15)
0.0026	0.021761	(0,25)
0.0026	0.032879	(0,45)
0.0039	0.020792	(0,15)
0.0039	0.021888	(0,25)
0.0039	0.032151	(0,45)
0.0052	0.021387	(0,15)
0.0052	0.022399	(0,25)
0.0052	0.043434	(0,45)
0.0065	0.027239	(0,15)
0.0065	0.038431	(0,25)
0.0065	0.046162	(0,45)
0.0078	0.034906	(0,15)
0.0078	0.039513	(0,25)
0.0078	0.045171	(0,45)

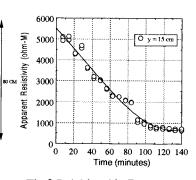
Table.2. Transversal Dispersion Coefficient

Velocity (cm/sec)	DT (cm2/sec)	(x,y)cm
0.0026	0.000758	(10,15)
0.0026	0.000776	(10,25)
0.0039	0.0015024	(10,15)
0.0039	0.0017104	(10,25)
0.0052	0.0028299	(10,15)
0.0052	0.0034936	(10,25)
0.0065	0.0059442	(10,15)
0.0065	0.0080246	(10,25)
0.0078	0.0131011	(10,15)
0.0078	0.0188461	(10,25)

### 5. Inversion Tomography Result

Apparent resistivity data from the experimental result for velocity 0.0026 cm/sec was generated by inversion tomography finite element method. 2) Pole-Pole electrode configuration was used for calculating apparent resistivity each block number. In this research for pole-pole array all the combination of 22 electrodes position was used to collect data. The finite element mesh for computation in this research can be shown on Fig.2. The result of calculation by inversion tomography for position X = 0.0 cm and y = 15 cm shown in Fig.3 and Fig.4.





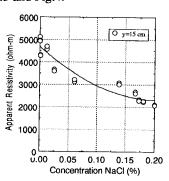


Fig.2 Finite Element Mesh

Fig.3 Relaltionship Between Apparent Resistivity and Time

Fig.4 Relationship Between Concentration and Apparent Resistivity.

#### 6. References

- 1) J.C Bruch et.al, Two dimensional Dispersion, Sanitary Engineering Division, ASCE SA6.
- 2) Yutaka Sasaki, Automatic Interpretation of Resistivity Sounding Data Over Two Dimensional Structure, Geophysical Exploration, Vol. 35. No.5, 1981.