CEL744 Groundwater Flow and Pollution Modelling

Postgraduate Course, Water Resources Engineering, Dept. of Civil Engineering, IIT Delhi
Course Coordinator: Dr. A. K. Keshari
Major Test — Full Marks: 40
II[nd] Semester, 2007-2008 — Time: 2 hrs.

Answer all questions

[1.] (a) Write down the Darcy's law for unsaturated flow in pressure form assuming unsaturated hydraulic conductivity as a scalar quantity. (4)

(b) If a contaminant is injected and stopped instantaneously at a point in an aquifer, what type of plume will be observed in the downstream of the injection point? Explain your answer. (3)

[2.] (a) Derive the advection-dispersion equation for 1-dimensional uniform flow through a saturated porous media. What modifications are required for a contaminant that can be adsorbed by aquifer media? (6)

(b) A landfill is leaking leachate with a chloride concentration of 1000 mg/l which enters an aquifer having hydraulic conductivity of 3×10^{-5} m/s and effeetive porosity of 0.23. A hydraulic gradient of 1 in 500 exists in the aquifer. Some village people are taking drinking water from a hand pump loeated at 15 m from the point where the leachate entered the groundwater. Investigate whether village people ean draw potable water from this pump for one year. Assume longitudinal dispersivity to be 1.5 m and molecular diffusion to be 0.25% of hydrodynamie dispersion. Following values for complementary error funetion ean be taken:

$$\text{erfc}\,(x \approx 0.966) = 0.172, \qquad \text{erfc}\,(x \approx 3) = 0$$

For intermediate values, linear interpolation may be adopted. (6)

[3.] (a) Deseribe the analytical solution for a eontinuous injection of a eontaminant at the origin into an uniforn steady flow in an infinite plane. (5)

(b) How mueh chloride ion will be produced in a 0.01 molal solution? Assume atomic weights of sodium and chlorine to be 23 and 35.5 gm, respeetively. Also obtain the ionic strength of this solution. (5)

[4.] (a) What do you mean by order of error in a FDM numerical scheme? Obtain the expression of the truneation error for Crank-Nicholson scheme. (5)

(b) Differentiate between followings: (6)
(i) Wetting and non-wetting fluids (ii) MOC & VOC
(iii) Langmuir & Freundlieh Adsorption isotherms (iv) LNAPLs & DNAPLS

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