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Benzene plume behavior in a saturated subsurface system: Influence of the mass transfer and dispersion coefficients

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Understanding of contaminant transport in porous media has improved greatly in recent years; there is enormous interest in developing computerized contaminant transport models. The present study investigates laboratory scale dissolution kinetics using numerical simulations of benzene releases and dissolved phase transport in homogeneous sand tank of 120 cm×40 cm×35 cm dimensions. A finite element numerical model developed to solve the three-dimensional transport equation. The benzene-water interface dissolved concentration assumed to be equal the solubility concentration. Five interstitial velocities were adopted. The longitudinal dispersion coefficient D_x at all velocities were determined from tracer transport analysis experiments, the upper and lower values were 0.284 and 1.014 cm^2/hr respectively. D_y, and D_z were computed to be 0.1 of D_x value. To study the plume distribution from pool area along the centerline (x) in the horizontal-vertical (x-z) plane of the aquifer, a daily concentration values for 60 day at depths of 1, 3, 6, 9, and 12 cm in the laboratory aquifer were found at low and high velocities. The vertical spreading of benzene dissolved phase was noticed to be relatively weak as the concentration increased from 140.5 mg/l (7.94% of solubility) to 270.6 mg/l (15.29 % of solubility) when time increased from 1 day to 60 days at velocity of 0.90 cm/hr. Benzene reached to zero concentration at vertical distance between about 7 cm and 9 cm. In general, concentration levels decrease as the vertical distance from the pool increases. The average mass transfer coefficient increased with increasing interstitial velocity towards a limiting value. The dimensionless mass transfer behavior was expressed in terms of the modified Sherwood number. The calculated characteristic pool length, and effective molecular diffusion coefficient in the porous medium were 13.29 cm and 2.47×10^{-2} cm^2/hr respectively. The average Peclet numbers; which are representing the advective –dispersive mass transfer in the x and y directions of pool area; values were from 23.73 to 26.63 in x-direction and from 237.34 to 266.30 in y-direction. While the average Sherwood number were from 8.66 to 32.82.

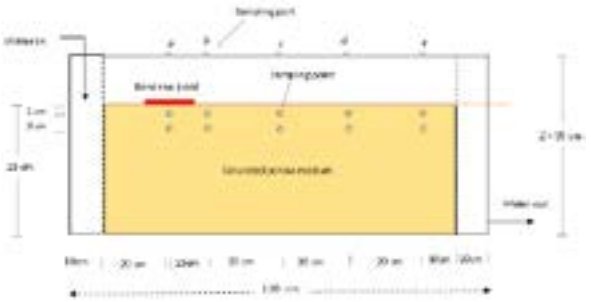

Figure (1): Sampling points location in the aquifer model. The points located at depths of 1 cm and 3 cm.

Biography

Hatem Asal Gzar received his PhD in Environmental Engineering from University of Baghdad 2010, Iraq. He works as lecturer in Environmental Engineering Department for higher studies at University of Baghdad from January 1999 to October 2013. He was a Member in Foundation of the Undergraduate Program in Environmental Engineering Department in 2005 at University of Baghdad. From October 2013, till present he has been working at Wasit University, Iraq. He works as Assistant Professor in Civil Engineering Department. At the same department, he was a Member in Foundation and Staff of Water Resources Engineering Branch for higher studies, he was Lecturer for two subjects, the first is groundwater and seepage and the second is advanced wastewater treatment. He has been supervisor for many thesis and dissertations. He has been a Member in many Examination Committees of higher studies inside and outside of Iraq. He has huge expertise in evaluating many research papers for many international and local scientific journals and conferences. He has worked for about 15 years as a Member in Environmental Consultancy Bureau, Baghdad University.

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