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Groundwater Solute Transport Modeling: Effects of Transport and Fate

Pappu Kumar, Anshuman Singh

Abstract*: In this paper, the solution of the advection-dispersion equation with different sorption values is used for the prediction of solute concentration in groundwater. Sorption process in the groundwater is complex, due to increasing the groundwater pollution the effect of different chemical transport plotted. The fate and sorption process of different chemical different degradation constant. We used the analytical solution to evaluate the transport phenomenon and analysis of the chemical dissolved in groundwater. The solute transport model simulated with the analytical solution and final result obtained using MATLAB software. The solution of a test problem based on the sequential degradation of the different chemical in the groundwater. This solution of equilibrium and rate of sorption dynamics of processes is imperative for accurate fate and transport modeling. The present study shows the effects of advection, dispersion/diffusion, and sorption equation on the saturated media of soil. MATLAB software used for analyzing the solution of groundwater and showing the different case taking care of saturated aquifer and with different void ratio of soil its shows that the soil parameter is also impotent parameter and its effect can see in plot between concertation vs time. The solute transport model simulated with the analytical solution and final result obtained using MATLAB software. The solution of a test problem based on the sequential degradation of the different chemical in the groundwater. This study compares the solute concentration with respect to distance and its different hydraulics conductivity of dense sad and lose.

Keywords*: Groundwater, Advection, Dispersion, Sorption, MATLAB Software, pollution.

I. INTRODUCTION

The distribution of Contaminant affects the sorption process, the advection-dispersion of groundwater modeling equation involves chemical and hydraulics parameter. The sorbing chemical equation uses the evaluation of such parameters at every point in the groundwater. In this steady one-dimensional groundwater sorption model developed, migration of contaminants through groundwater. In this study, many assumptions are taking. Now a day groundwater contamination due to landfill, according to the European Environment Agency, about 2.5 million affected [1]. The characterization of solute dispersion plays the most central risk assessment adopted many national environmental agencies. Quantitative solute understanding of kinetics and sorption mechanisms heavy metal adsorption-desorption and transport processes, contaminant flow through the groundwater can be represented by advection-dispersion diffusion equation [2]. the saturated flow the soil is saturated, homogeneous and hydrodynamics. Now a day's industrialization and human activity Groundwater contamination increase from toxic wastes leaching from industries and saturating water derivative from rain or snowmelt that has traveled from landfills, lagoons, or dumps of refuse or garbage, etc., is one of the most burning problems to the groundwater system. The groundwater solute transport research area is over the past few years. The soil above the groundwater or between the top surface and groundwater table is known as the unsaturated zone or vadose zone. Water flows in the vadose zone due to capillary fringe or pressure head and it affects the groundwater solute transport model. the soil property changes due to contamination and many toxic gases like nitrous oxide carbon dioxide and methane. The contamination by physical processes advection, dispersion, and diffusion and sorption, biodegradation many processes have been considered in governing equation are used [3]. The analytical solution of ADE of solute transport is obtaining is vast and tedious so numerical solution by finite difference method (FDM) and finite element methods (FEM) have proved difficult especially for advection dominated problems. The mathematical models of saturated porous media considering the bacterial growth and biologically reaction is taken for solute transport [4]. The solution for a semi-infinite and finite system for the first type concertation. The effluent concentration solution is taken as a concentration-type boundary condition [5]. The determining of contaminant transport parameter environmental tracers and determining flow velocity traditional hydraulics methods is used the hydraulic property of aquifer are knows as a spatial variable [6]. In the saturated porous media reactive solute transport model developed it is modified by RT3D (reactive transport model) and many published contaminant transport models like HYDRUS-1D, VS2DT, and SUTRA [7]. These models used to verify the pore water was partitioned into their inter and intra-aggregate regions. In this model, the basic is the Fick's second law of diffusion described solute transport or solute transfer by pore water [8]. These model result and laboratory test result indicates that the one-dimensional advective-dispersive transport model estimates compression. Many limitation and restrictions used for design and respective guideline are developed for earthen west disposal application [9]. The groundwater fluid flow is compacted and incorporated in macropore, spatial variability and uncertainty via probability theory [10].

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***** Correspondence Author
Pappu Kumar*, Research Scholar, Department of Civil Engineering NIT Patna. pappusobh@gmail.com
Dr. Anshuman Singh, Associate Professor National Institute of Technology, Patna. asingh@nitp.ac.in.

the landfill of time-dependent for the finite mass of contaminant affects the profile of landfill [11]. Many researchers had developed a numerical and analytical solution. In this paper analytical solution is used for determining the solute transport by the different condition of soil properties. The source term is derived and as compared with the numerical solution. The ADE is solved with the Dirichlet and the Neuman boundary condition. Contamination is mathematically described in term of advection-dispersion and is affected by sorption and diffusion; the hydraulic parameter is used to predict the concentration vs time. In this paper analytical solution used to obtained graphically with many assumptions. the groundwater contamination due to the landfill are affected according to the European Environment Agency, about 2.5 million affected [1]. The national environmental agencies analyze the groundwater solute transport plays a significant role in risk assessment. Quantitative solute understanding of kinetics and sorption mechanisms heavy metal adsorption-desorption and transport processes, contaminant flow through the groundwater can be represented by advection-dispersion diffusion equation [2]. the saturated flow the soil is saturated, homogeneous and hydrodynamics.

II. HYDRAULIC CONDUCTIVITY AND POROSITY

The hydraulic conductivity is the soil and rocks property that describes the ease with a fluid particle can move through the pore of soil it depends upon the material property. Hydraulic conductivity is proportional constant is Darcy's law. The material property of soil consequence the solute is transported modeling through the porous media. The porosity or void fraction is measure property of soil it is similar to the hydraulic conductivity for two similar sandy aquifers. The porosity of the soil is also depending upon the grain size of the particle typically clays have very low conductivity and but have very high porosity.

III. ADVECTION, DIFFUSION, AND DISPERSION

Advection is the process by which groundwater flows with Darcy velocity and bulk mass transport [12]. The advection-dispersion problem as a function of viscosity, density, and porosity.

$$V = -\frac{K}{n}.\Delta h$$

V= average interstitial fluid velocity.
K= hydraulics conductivity.
n= effectivity porosity.
h= head gradient.

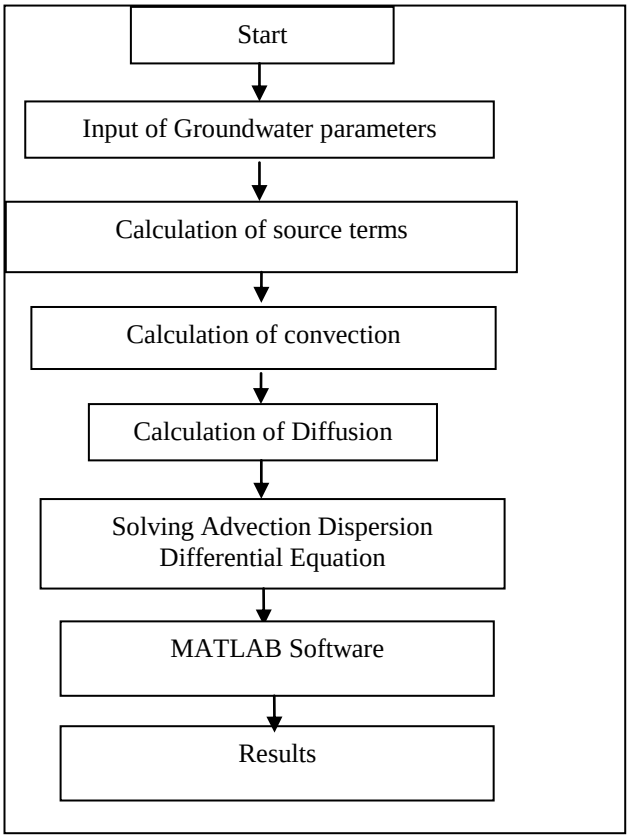
The advection-diffusion is occurring in the groundwater, flow of contaminant in the aquifer water due to molecular action. It can be seen experimentally. The random molecular motion solute moves from one location to other location, it can be predicted using software and analytical solution using MATLAB. Equation). "Float over text" should not be selected.

IV. PURPOSE AND SCOPE

This paper describes the groundwater sorption and transport model. The analytical solution of the advection-dispersion of the chemical diffusion, the solution of one dimensional given by [13]. all the solution is used as many assumptions, all solutions are given in the analytical solution and used as MATLAB Script and plot between distance and concertation. Advection is the process that can be solute transported by the velocity of subsurface water. The fluid-particle moves along with the intensity of fluid-particle flow. the average intestinal fluid velocity represents the advection-dispersion mathematical equation. it is also describing the mixing of solute particle. The groundwater flowing water moves with average velocity.

V. RESEARCH METHODOLOGY

The groundwater solute transport model is based on the partial differential equation, and the (figure. 1) is the flow chart for finding a solution. In the MATLAB software creating the script of analytical solution and prediction, concentration becomes easy. The input value of concentration soil parameter hydraulics conductivity, void parameter, PH and electrical conductivity these properties of soli affect the concentration of solute particle. The calculation of result out is obtained by MATLAB application.



Mathematical formulation

The general equation of the transport equation [14, 15],

$$\frac{\partial c}{\partial t}+\frac{\rho_b}{\theta}\frac{\partial c}{\partial x^2}=D_x\frac{\partial c}{\partial x^2}-v\frac{\partial c}{\partial x}-\lambda C \quad (1)$$

Model Initial and Boundary Conditions

The partial differential equation for groundwater solute transport modeling with sorption term. This equation can be analytically solved by initial and boundary condition. Initial and boundary condition complete the model of groundwater. The dependent variable in the given advection-dispersion equation, concentration is variable in this topic the simple analytical solution to our model.
We will keep the initial and boundary conditions simple. Complex initial and boundary.

Initial Conditions

$$C=M\partial(x), s=0, t=0, \quad -\infty\le x\le\infty \quad (2)$$

Boundary conditions

$$\frac{\partial C}{\partial x}=0, \quad x\to\pm\infty \quad (3)$$

Analytical solution

$$c\ (x,\ s)\ =\frac{M}{v-D_x r}e^{rx} \quad (4)$$

The solute transport model is based on an earlier solution given by [16, 17];

Parameter Value

Table 2. Parameter Value for different organics chemical

Porosity	0.25
Bulk density	1.5 g/cm^3
Dispersion coefficient	0.1 cm^2/d
Pore velocity	1
Degradation rate constant	0.03 d^{-1}
First order mass transfer rate constant	0.1 d^{-1}
Sorption distribution coefficient k_d	3

Groundwater contaminant flow through subsurface with the groundwater velocity.

VI. RESULT

The saturated zone of the aquifer movement of water and any contaminants across the soil surface. It occurs when irrigation, rain or snowmelt adds water to a surface faster than it can enter the soil having necessity to solve a problem related to groundwater contamination using analytical solution and numerical solution mathematical modeling of mass transport in vadose zone are driven by necessity mainly to solve groundwater solute transport problem. The below fig.2 shows that concertation is increasing with time and it's the effect hydraulics conductivity of the soil. The result shows that the soil parameter that hydraulics conductivity more than concentration will be more. The sensitivity analysis of the groundwater variable like transport velocity advection, coefficient of conductivity and dispersion coefficient**.** In this paper, the degradation effect can be plotted between concentration and distance. The result determines the concentration any distance and degradation rate are taken for different condition and compare the concentration distribution. we can analyze by the given curve of fig.1 seen that the benzene of maximum values of λ= 3 is more fast degradation. First, a set of curves taking assumption heterogeneous aquifers; second, the curve is the minimum value of λ= 0.05.y, the curve is the minimum value of λ= 0.05.

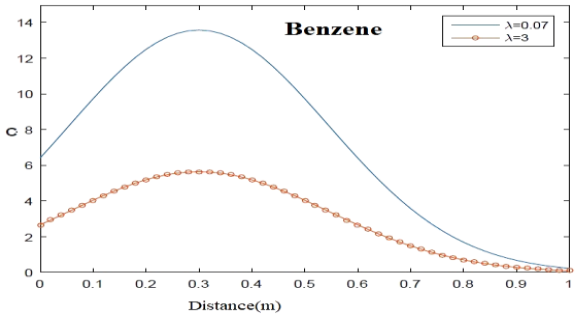


Figure.1 Caparison of the Benzene sorption value minimum (λ= 0.05) with the maximum λ= 3

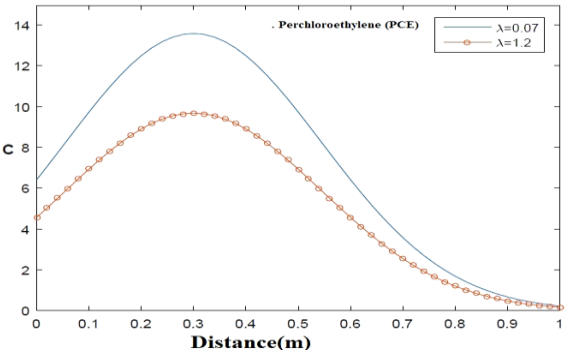


Figure.2 Caparison of the perchloroethylene (PCE) sorption value minimum (λ= 0.07) with the maximum λ= 1.2

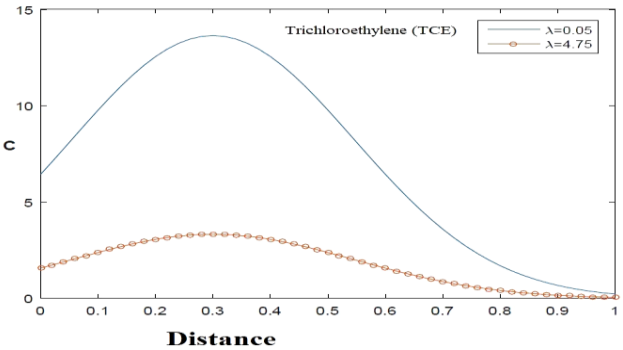


Figure.3 Caparison of the Trichloroethylene (TCE) sorption value minimum (λ= 0.05) with the maximum λ= 4.75

This comparison is shown for different degrees of heterogeneity, represented by lognormally distributed random conductivity fields. The results show that, with a growing degree of heterogeneity, ‘‘measured’’ degradation rate quantities become uncertain with a high changeability around the true constant. Measured rate constants tend to overestimate the true constant by up to one order of magnitude.

VII. CONCLUSION

The groundwater pollution due to industrialization and urbanization and it’s become a critical problem. In this study deals with groundwater modeling of the saturated porous aquifer. The groundwater having soil property the taking in the modeling of groundwater solute transport model. The hydraulic conductivity and void ratio taking in the account and the organics pollutant like Benzene, perchloroethylene (PCE) and Trichloroethylene (TCE) having degradation and sorption affect the contaminant transport in the saturated soil. The analytical solution is used and predicting for the different case using MATLAB softer. This solution gives different case and the different void ratio is taken and it shows the groundwater solute transport is more in case of the densely saturated aquifer. In this analysis the analytical solution used for ADE with variable of sorption parameter, we used benzene of the sorption value (λ= 0.05 to λ= 3 the minimum and maximum value shows that concentration of benzene transportation more at minimum value and less at minimum value of sorption same as perchloroethylene (PCE) (λ= 0.07 to λ= 1.2) and Trichloroethylene (TCE) (λ= 0.05 to λ= 4.75). This study considered the sorption value is an important parameter in the groundwater solute transport model.

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AUTHORS PROFILE

Pappu Kumar received the M. TECH degree in Water engineering and management from central university of Jharkhand in 2016 and pursuing PH. D from national institute of technology. research interests are groundwater solute transport modeling. He is currently at NIT Patna research scholar.

Dr. Anshuman Singh is currently working at the national institute of technology Patna, India in the civil engineering department, as associate professor interest includes environmental and water resources engineering and groundwater contaminant transport modeling and having 6 publications in journals and 6 conferences.