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Modelling of Ground Water and Contaminant Transport through Soil Column - A State of the Art Review

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Abstract: A broad and detail study of contaminant and ground water flow through a soil column is presented. Various techniques used for making a model of contaminant transport in soil are studied and discussed. Different parameters are studied which affect the mathematical model, numerical and experimental results. The major finding in the present study covers different approaches and treatments adopted by researchers in the study of ground water in soil column and how the contaminant causes pollution.

Keywords: soil, contamination, pollution, mathematical modelling, ground water,

I. INTRODUCTION

A. Soil Contamination and Its Sources

Soil contamination means soil pollution. Soil contamination occurs because of change in the environment of natural soil. It happens because of human made chemicals. The human activities such as industrialization, agricultural chemicals, improper waste disposal and many more are also causes of soil contamination. Now we are saying that chemical causes soil contamination, but which chemicals? So, common chemicals are petroleum hydrocarbons, poly-nuclear other heavy metals, naphthalene etc. Contamination is highly related to degree of industries and intensity of chemical usage.

B. Effects of Soil Contamination

Now it is clear that, pollution of anything is dangerous. Similarly soil pollution is also dangerous. From above pints we come to know about sources of soil contamination, but what are the effects of soil contamination? So the first and important impact is on human health risk. This can be treated as direct effect. The soil also carries water within and underlying the ground. So contaminated soil causes water pollution also. It again affects human health. This can be treated as indirect effect. From above discussion, it can be noticed that, soil contamination is one of the major factors in environmental pollution it creates, many dangerous problems. So now question arises how to overcome this problem? It requires detailed study of contaminated soil columns. It includes geology, hydrology, chemistry, computer modelling skills, industrial chemistry, history of soil and land at site and many more. Groundwater is a valuable natural resource of water supply from many ages. In many developing countries like India, rural as well as urban population depends on groundwater for their basic needs like drinking. The groundwater is not only fulfilling basic needs, but also important in agriculture and industrialisation. But from last few decades, groundwater suffers through few threats like ever increasing demands, wastage and contamination. Such contamination results into hydro-geological and environmental problems. It is important to note here that; groundwater is one of the important media of transportation of minerals and many more useful articles. The contamination of such media affects many systems dependant on it. It is an obvious fact that to face this challenge, a good planning and policies should be practiced. The main requisite for this is to model the movement of fluids and contaminants both under subsurface structures and to focus on development of detailed theoretical and experimental research. Soil contamination is one of the important factors in the study of health of environment. Groundwater is key media for the transformation of minerals, drinking water and many more useful articles. The detailed study of soil contamination will not only help us to find the solution for it but also have higher impact on societal health and it starts a new branch of study of soil. In developed countries like North America and Western Europe, the techniques have been developed so that the extent of contaminated land can be known. Many countries have developed a legal framework for identification of problems related to contaminated land and to deal with their solutions. Some of the causes of soil contamination are : many things get disposed off in a wrong way like oil and fuel dumping, direct discharge of industrial wastes to soil, coal ash, electronic waste, mining activities, corrosion of

underground storage tanks and piping, agrochemicals such as pesticides, herbicides, and fertilizers, road debris, drainage of contaminated surface water into soil etc.

C. Saturated And Unsaturated Media

Patil have focused on saturated and unsaturated porous media. They have worked on numerical modelling of contaminant transport through saturated and unsaturated porous media like soil.

In this paper, authors have studied many advanced computing methods for numerical study such as finite difference method (FDM), finite element method (FEM), finite layer etc. out of these authors found that fem is suitable method for contaminant transport study. They model the contaminant transport in the landfills where clay is used as barrier beneath the surface.

They also have discussed the phenomenon of advection. Advection is the movement of dissolved solute with flowing groundwater at the seepage velocity in porous media. They noticed that advection and hydrodynamic dispersion are the properties which govern the solute flow.

Authors in their paper mentioned the points where the works need to be carried out. There is a scope of developing more efficient numerical model which is taking into account the uncertainties in various flow parameters such as saturated hydraulic conductivity, saturated soil-water moisture content, residual soil moisture content, dispersion and sorption coefficients and many other parameters in which uncertainty lies.

D. Column Percolation Test

In this paper, authors have studied the column percolation test and batch leaching tests. In both the tests, the time consumption of testing is different. Hence authors have analysed the parameters of testing and change it, which decreased the testing time without affecting the results.

E. Mathematical Modelling

In many scientific and research articles, we often find the word ‘mathematical model’. Then question arises what is the mathematical modelling? It is an accepted scientific practice, which provides the mechanism for comprehensive representation of basic processes. Here we construct the model that better represents the natural system and physical phenomenon, so that we get guidance in current practices and future planning. S. A. Mirbagheri in his research work focused on such mathematical modelling. Shackelford et al had also presented analytical model in their paper. This model is for evaluation of mass leaching from the contaminated soil. Leaching of chemical simply refers to the flow of harmful chemicals into the ground. The model is mainly based on contamination transport due to advection, dispersion and retardation. Advection is the movement of dissolved solute with flowing groundwater at the seepage velocity in porous media. Dispersion is the result of two processes - molecular diffusion and mechanical mixing. The mechanical dispersion or mechanical mixing occurs when contaminated groundwater mixes with non-contaminated groundwater resulting in a dilution of the contaminant, which is called dispersion.

Sorption is nothing but the exchange of molecules and ions between solid phase and liquid phase. It includes adsorption and desorption both. Adsorption is attachment of molecules and ions from the solute to the solid phase causing a decrease of concentration of the solute and this is called as retardation.

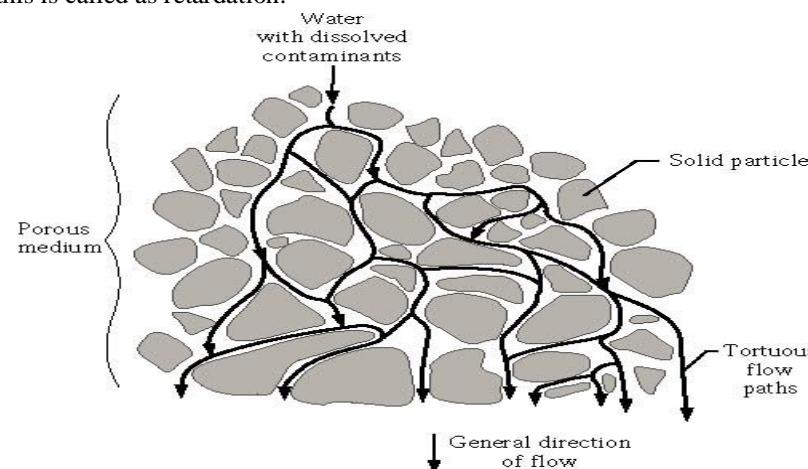


Fig. 1 Schematic of mechanical dispersion [1]

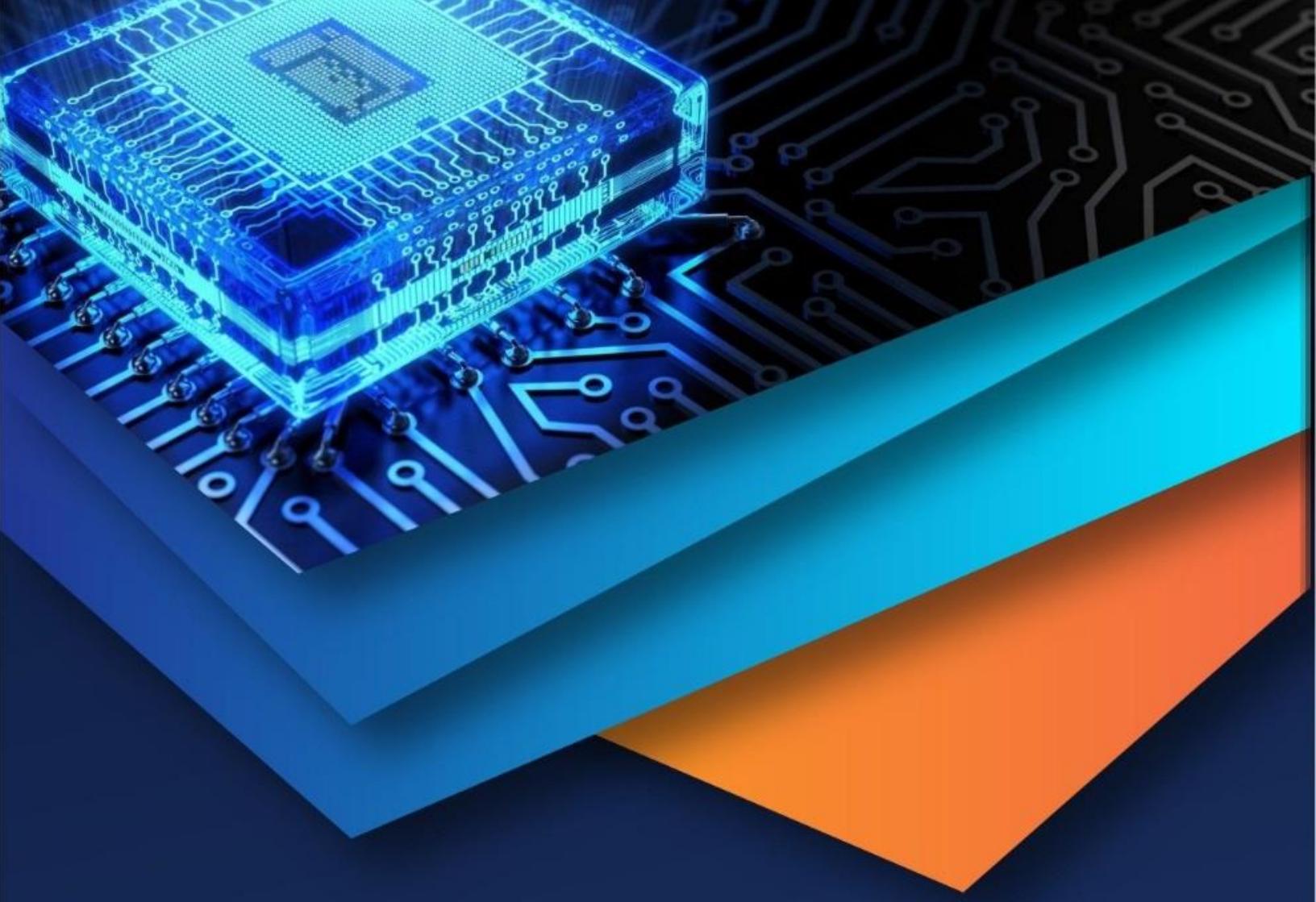


II. CONCLUSION

In a research community, many people have studied the phenomenon of soil contamination from many aspects. But, it is a common conclusion we can draw, that there is a still scope for the development and testing of detailed numerical model for contamination in soil column at a particular landfill location. Some of the scientist have taken a specific area of land for their study and had carried out an experimental study along with testing. The main finding of the current work is to have overlook or to watch bird's eye view over the work done so far in soil contamination. It leads one to the new area where still scope of work exists.

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