INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title:		Detection and Management of Virus Sources in an Aquifer under Equilibrium and Kinetic Sorption
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SHORT ABSTRACT

The thesis focuses on detecting virus sources in an aquifer followed by managing the sources to remediate the aquifer. The work is divided into five objectives, each of which accomplishes a different goal and is linked to remediating the aquifer. The first objective is to develop a Darcy-scaled model directly applicable to field-scaled numerical simulations. The developed model uses the Finite Volume Method (FVM), and it can handle the parameters that are spatially and temporally variable. The model is validated with MODFLOW and MT3DMS models by the end of the first objective. The second objective is to develop a pore-scaled model representing a Representative Elementary Volume (REV) in the Darcy scaled model. The pore-scaled model is developed using the traditional methods along with an addition of estimating the isotropic parameters of the aquifer as a result of the Pore Network Model (PNM). The generated PNM is optimized with the pore sizes appropriately to accomplish the desired parameters using an optimization model, Shuffled Frog Leaping Algorithm (SFLA) by the end of this objective. The flow through a single pore is solved in the third objective using the Hagen-Poiseuille law, and the velocities along each pore throat are identified. The correlation equations of a single pore are used to estimate the upscaled parameters as a function of nine pore-scaled parameters. By the end of this objective, the sensitivity of these parameters for temperature is ranked first, followed by the radius of pore throats and the virus particles, and the last is the velocity in a pore. The fourth objective focuses on the identification of virus sources in the aquifer. For this objective, a new methodology is proposed to use the information from the observation wells to reduce the search space to probable locations near the source. The methodology proposed in this objective identifies the number of sources as well as the locations of those sources with the probability of finding the locations as the initial step. Later, a modified genetic algorithm combined with a gradient-based search method is used to identify the source locations and source strengths with high accuracy. The thesis's fifth and final objective focuses on managing the virus sources by injecting hot water into the aquifer. The dependencies of the parameters on the temperature are taken from existing evidence and the result from the second and third objectives of the research. The dependencies are modeled by solving the heat transport equation and incorporating the results as time-dependent parameters using the first objective of the research. The final condition of the aquifer is obtained as a result of the fourth objective, by modeling the aquifer for virus transport. The locations, schedule, and injection discharge are obtained as a result of an optimization model solved using gradient-based and pattern search methods. Three solutions are proposed by the end of this objective, to inject the hot water at the highest virus concentration location, into the existing wells, and into the existing observation wells. All the three solutions are found to have the field applicability as the aquifer could be remediated by 97-99% by the end of the remediation period.