

徑向兩區受壓含水層的溶質傳輸之精確解析解

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摘要

過去幾十年來，地下水污染問題在世界範圍內變得越來越嚴重。隨著對地下水污染對人類健康潛在威脅的議題關注逐漸上升，人們開始對地下水系統中溶解污染物的去向和遷移進行許多理論和實驗研究。以移流-延散方程為基礎的解析解模式和數值傳輸模式已持續發展且以作為研究各種地下水污染物傳輸行為的建模工具。本研究建立了徑向兩區受壓含水層系統中注水井污染物傳輸的解析解模式，該模式由注水井周圍的井膚層(skin zone)和地層區組成。該模式包含兩個描述污染物濃度分佈的連續方程；一種是污染物在井膚層(skin zone)的傳輸，另一種是在地層區的傳輸。透過 *Laplace* 變換和廣義型積分轉換法來求解井膚層和地層區的移流-延散方程。本研究的解析解模式的計算結果會與使用改進的拉普拉斯變換有限差分法 (LTFD) 來驗證解的正確性。

關鍵字：徑向對流-延散傳輸，井膚層，*Laplace* 變換，廣義型積分轉換

Explicit analytical solution for the advection-dispersion transport equation in a radial two-zone confined aquifer

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Abstract

Problems with groundwater contamination have grown increasingly severe worldwide over the past few decades. Growing concern for the potential threat of contaminated groundwater to human health have motivated many theoretical and experimental studies on the fate and transport of contaminants dissolved in the groundwater system. Both analytical models and numerical transport models in which the advection-dispersion equations (ADE) are solved are continually being developed to serve as modeling tools for investigating the migration behaviors of a great variety of groundwater contaminants. This study develops a mathematical model for contaminant transport due to well injection in a radial two-zone confined aquifer system, which is composed of a wellbore skin zone around the injection well and a formation zone. The model contains two continuity equations describing the contaminant concentration distributions: one is for contaminant transport in the skin zone while the other is for transport in the formation zone. This solution of the model derived by the method of Laplace transforms and Generalized integral transform technique (GITT) to solve two ADEs that represent the reactive transport in the skin zone and aquifer respectively. The computational results of the analytical solution model of this study will be compared with the use of the modified Laplace transform finite difference method (LTFD) to verify the correctness of the solution.

Keywords: Radial advective-dispersive transport, skin zone, Laplace transform, Generalized integral transform