

Accepted Manuscript

A block-centered finite difference method for an unsteady asymptotic coupled model in fractured media aquifer system

Wei Liu, Jintao Cui, Jie Xin

PII: S0377-0427(18)30003-7
DOI: <https://doi.org/10.1016/j.cam.2017.12.035>
Reference: CAM 11454

To appear in: *Journal of Computational and Applied Mathematics*

Received date: 21 December 2016
Revised date: 20 September 2017

Please cite this article as: W. Liu, J. Cui, J. Xin, A block-centered finite difference method for an unsteady asymptotic coupled model in fractured media aquifer system, *Journal of Computational and Applied Mathematics* (2018), <https://doi.org/10.1016/j.cam.2017.12.035>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



A block-centered finite difference method for an unsteady asymptotic coupled model in fractured media aquifer system *

Wei Liu^{1,2} Jintao Cui^{2,3}, Jie Xin⁴,

1-School of Mathematics and Statistics Science, Ludong University, Yantai, 264025, China.

2-Department of Applied Mathematics, The Hong Kong Polytechnic University, Kowloon, Hong Kong.

3-The Hong Kong Polytechnic University Shenzhen Research Institute, Shenzhen, China.

4-School of Mathematical Sciences, Qufu Normal University, Qufu, China.

Abstract. A block-centered finite difference method is proposed for solving an unsteady asymptotic coupled model, in which the flow is governed by Darcy's law both in the one-dimensional fracture and two-dimensional porous media. The second-order error estimates in discrete norms are derived on nonuniform rectangular grids for both pressure and velocity. The numerical scheme can be extended to nonmatching spatial and temporal grids without loss of accuracy. Numerical experiments are performed to verify the efficiency and accuracy of the proposed method. It is shown that the pressure and velocity are discontinuous across the fracture-interface and the fracture indeed acts as the a fast pathway or geological barrier in the aquifer system.

Keywords: Karst aquifers; block-centered finite difference method; asymptotic coupled model.

1 Introduction

In Karst aquifer system, the fracture is considered to be the storage space of drinkable groundwater and occurrence site of environmental pollution. It is important to gain a better understanding of groundwater flow in Karst aquifer with fractures, in order to assess groundwater risk and control groundwater pollution. Due to the close connection between the fracture and surrounding medium, a coupled model is usually applied to demonstrate the groundwater flow process in fractured media aquifer system, where the flux exchange occurring on the interface between the fracture and surrounding medium is treated as the coupling term (see [1, 2, 3, 4] for details). The coupled model is given as follows:

$$\begin{cases} s_i \partial_t p_i + \operatorname{div} \mathbf{u}_i = g_i, & \text{in } \Omega_i \times J, & i = 1, 2, f, \end{cases} \quad (1.1)$$

$$\begin{cases} \mathbf{u}_i = -\mathbb{K}_i \nabla p_i, & \text{in } \Omega_i \times J, & i = 1, 2, f, \end{cases} \quad (1.2)$$

$$\begin{cases} \mathbf{u}_i \cdot \mathbf{n}_i = \mathbf{u}_f \cdot \mathbf{n}_i, & \text{on } \gamma_i \times J, & i = 1, 2, \end{cases} \quad (1.3)$$

$$\begin{cases} p_i = p_f, & \text{on } \gamma_i \times J, & i = 1, 2, \end{cases} \quad (1.4)$$

$$\begin{cases} \mathbf{u}_i \cdot \nu_i = v_i, & \text{on } \Gamma_i \times J, & i = 1, 2, f, \end{cases} \quad (1.5)$$

$$\begin{cases} p_i(\cdot, 0) = q_i^0, & \text{in } \Omega_i, & i = 1, 2, f, \end{cases} \quad (1.6)$$

where Ω_f is the region of fracture, Ω_1 and Ω_2 are the domains of porous media divided by the fracture Ω_f , $\gamma_i = (\partial\Omega_i \cap \partial\Omega_f) \cap \Omega$, $\Gamma_i = \partial\Omega_i \cap \partial\Omega$, ν_i is unit outer normal direction to Ω_i ($i = 1, 2, f$), the time interval $J = (0, T]$, $\mathbf{u}$ is the Darcy velocity, p is the pressure, s is the storage coefficient,

*The work is supported by the National Natural Science Foundation of China Grant No. 11401289, No. 11771367 and No. 11371183, Shandong Province Higher Educational Science and Technology Program No. J16LI05, and The Hong Kong Polytechnic University General Research Grant G-YBME.

Download English Version:

<https://daneshyari.com/en/article/8902072>

Download Persian Version:

<https://daneshyari.com/article/8902072>

[Daneshyari.com](https://daneshyari.com)