Available online at www.sciencedirect.com
ScienceDirect
Mathematics and Computers in Simulation 81 (2011) 2270–2281
MATHEMATICS AND COMPUTERS IN SIMULATION
www.elsevier.com/locate/matcom

Original article

Three-dimensional numerical simulation of single-phase transient compressible flows and well-tests in fractured formations

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Received 15 November 2009; received in revised form 8 June 2010; accepted 8 December 2010
Available online 21 December 2010

Abstract

A general three-dimensional numerical model for single phase, slightly compressible flow through fractured porous media is described. It is based on a discrete fracture representation. Three sets of applications are presented. In the first one, pressure drawdown well tests in closed oil reservoirs are simulated for complex model situations where the well intercepts a random fracture network with various fracture densities and conductivities. Then, the hydrodynamic response of a fractured aquifer is investigated by simulating on the field-scale single- or two-well pumping tests in the Poitiers Hydrological Experimental Site. Finally, a complete field-scale simulation of the production history in an oil reservoir with multiple wells is presented.

Keywords: Porous medium; Fracture; Reservoir; Well flow

1. Introduction

This work addresses single phase, slightly compressible flow through fractured porous media. A very general, three-dimensional numerical model based on a discrete fracture representation is proposed, together with applications involving a single or multiple interacting wells.

Due to the specific transport properties of fractures, the flow through a naturally fractured porous medium differs drastically from that in a conventional porous medium. The key feature is that the porous matrix provides the main storage for the fluids while transport takes place mainly through the fracture system. Furthermore, matrix/fracture flow interactions govern many of the medium transport properties. Because of the complexity and diversity of most natural fracture systems, the determination of fractured porous media transport properties remains an open issue of great practical importance. For instance, the present numerical tool can be applied for the interpretation of well test data, in order to quantify the characteristics of a reservoir, or conversely, to optimise the design of a producing well, given the reservoir characteristics.

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0378-4754/$36.00
doi:10.1016/j.matcom.2010.12.014