岩石力学与工程学报 2006 26 (2006-S1): 3098 ISSN: 1000-6915 CN: 42-1397/O3

岩石渗透试验瞬态法的水动力学分析

王旭升1，陈占清2

(1. 中国地质大学 水资源与环境学院，北京 100083；2. 中国矿业大学 理学院，江苏 徐州 221008)

收稿日期 2005-9-9 修回日期 2006-1-5 网络版发布日期 2007-1-26 接受日期 2005-9-9

摘要

压力脉冲瞬态法是一种专门进行岩石渗透率测试的新方法。对多孔介质渗流的水动力学分析表明，在岩石渗透试验的瞬态法中，水流动量方程可以不考虑流速的变化率。对于致密岩石，出现高速非Darcy流的特征不显著，在一般条件下Darcy定律仍然有效。给出压力脉冲瞬态法的物理模型和数学模型，采用等梯度假设简化连续性方程，针对上下游压力容器的不同控制条件，推导各种情况下压力测试曲线的解译公式。这些解译公式为分析不同控制方式下的试验过程和计算岩石渗透率提供了方便。实例表明，基于等梯度假设的解译公式对压力脉冲瞬态法所产生的渗透率测试曲线基本适用。

关键词

岩石力学；岩石；渗透率；瞬态法；解译方法；水动力学

分类号

HYDRODYNAMIC ANALYSIS OF TRANSIENT METHOD IN ROCK SEEPAGE TESTS

WANG Xusheng1，CHEN Zhanqing2

(1. School of Water Resources and Environmental Science，China University of Geosciences，Beijing 100083，China；
2. College of Sciences，China University of Mining and Technology，Xuzhou，Jiangsu 221008，China)

Abstract

Transient pulse method is a newly developed technique in rock seepage tests to measure permeability of rocks. The theory of fluid dynamics in porous media is applied to analyze the hydrodynamic characteristics of transient method in rock seepage tests. It is identified that，in the momentum equation，the variation of flow velocity is able to be neglected for seepage in rocks. High-speed non-Darcy flow as shown by Forchheimer¢s equation is insignificant for seepage in tight rocks and Darcy Law is normally valid. As one of the fundamental hydrodynamic equations describing the transient seepage in rocks，the continuous equation is applied to explain the change of pressure in the rock seepage tests with initial and boundary conditions. Physical and mathematic models of the transient method are presented. Interpretative formulas are derived for time-dependent pressure curves at several controlled conditions of the upstream and downstream reservoirs，with the assumption of equal pressure gradient. This assumption simplifies the solution process of partial deference equation in the mathematic model.

The interpretative formulas provide conveniences for the analysis of the test process and calculation of permeability with defferent control methods：(1) water capacities of both the upstream and the downstream pressure vessels are fixed；(2) water capacity of the upstream pressure vessel is fixed and the pressure of the downstream boundary is constant；(3) flux of water from the upstream pressure vessel，which is determined by moving speed of the plunger，is constant and the pressure of the downstream boundary is constant. For the third control method，a formula is derived to predict the decrease of the pressure in the upstream reservoirs after stopping the plunger from moving. Validity of the interpretative formulas is identified by the well fitting of the pressure-time curves in permeability test cases for the three types of control methods. It shows the application of the assumption of equal pressure gradient.

Key words rock mechanics；rock；permeability；transient method；interpretative method；hydrodynamics

DOI:

通讯作者