

论文

川东南龙马溪组页岩孔裂隙及渗透性特征

汪吉林, 刘桂建, 王维忠, 张善进, 袁雷雷

- 1.中国矿业大学 资源与地球科学学院, 江苏 徐州 221116;
- 2.中国矿业大学 煤层气资源与成藏过程教育部重点实验室, 江苏 徐州 221116

摘要:

采集了川东南龙马溪组页岩样品, 开展了页岩孔-裂隙结构的测试, 分析了孔-裂隙结构特征, 根据孔-裂隙相对发育优势程度, 将页岩孔-裂隙结构分为孔隙优势发育型、裂隙优势发育型和孔-裂隙均等发育型等3种类型。在不同轴压、围压和气体压力梯度下, 对页岩试样进行了三轴应力条件下的CH<sub>4</sub>渗流实验, 计算并分析了有效应力、气体滑脱效应等因素对页岩绝对渗透率K<sub>0</sub>的影响。揭示出在较低压力梯度下的K<sub>0</sub>与应力差近似呈负指数相关关系, K<sub>0</sub>与压力梯度之间亦呈负指数相关关系, K<sub>0</sub>在压力梯度0~0.2 MPa阶段衰减最显著。认为有效应力增大导致页岩微裂隙趋于闭合, 渗透率降低; 在压力梯度增大的过程中, 基质收缩逆效应与滑脱效应并存, 但滑脱效应对渗透率的贡献小于基质收缩逆效应; 在不同应力条件下, 页岩渗透率存在差异; 页岩渗透率自身也具有非均一性, 与微裂隙的发育差异有关。

关键词: 页岩 孔裂隙 渗透率 龙马溪组

Characteristics of pore-fissure and permeability of shales in the Longmaxi Formation in southeastern Sichuan Basin

Abstract:

The shale samples were collected from the Longmaxi Formation of Lower Silurian in southern Sichuan Basin. The pore-fissure structures of shale samples were measured and their characteristics were analyzed in this study. Based on the different superiority distribution of pore-fissure, the structures of pore-fissure was divided into three types: pore-superior distribution, fissure-superior distribution and pore-fissure equipotent distribution. In different conditions of axial compression, confining pressure and gas pressure gradient, the CH<sub>4</sub> seepage experiments of some shale samples were carried out in three-dimensional stress field. Also, the effect of effective stress and gas slippage effect on the absolute permeability(K<sub>0</sub>) of shale were calculated and analyzed. It reveals that the permeability K<sub>0</sub> and stress difference have negative exponential correlation on the condition of low pressure gradient. The permeability K<sub>0</sub> and pressure gradient also have negative exponential correlation. The permeability K<sub>0</sub> attenuates observably as the pressure gradient ranges from 0 to 0.2 MPa. It concludes that the effective stress increase will lead to micro-fissures closing and permeability decreasing. The adverse effect of matrix shrinkage and gas slippage effect coexist in the process of pressure gradient increasing while the contribution of slippage effect to permeability is lower than the adverse effect of matrix shrinkage. The shale permeability is different under the condition of different stresses. The shale permeability itself shows non-uniformity which implicates the difference of its micro-fissures development.

Keywords: shale; pore-fissures; permeability; Longmaxi Formation

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通讯作者: 汪吉林

作者简介: 汪吉林(1969—), 男, 安徽桐城人, 教授, 博士

作者Email: wjl\_cumt@163.com

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