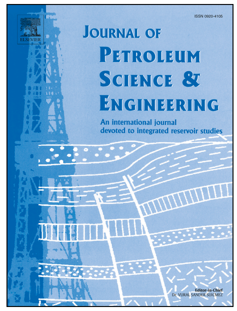
Accepted Manuscript



Investigation on the adsorption kinetics and diffusion of methane in shale samples

Jie Zou, Reza Rezaee, Yujie Yuan

PII: S0920-4105(18)30676-4

DOI: 10.1016/j.petrol.2018.08.010

Reference: PETROL 5190

To appear in: *Journal of Petroleum Science and Engineering*

Received Date: 5 May 2018

Revised Date: 31 July 2018

Accepted Date: 6 August 2018

Investigation on the adsorption kinetics and diffusion of methane in shale samples

Jie Zou [a], Reza Rezaee [a], Yujie Yuan[a]

[a] *Department of Petroleum Engineering, Curtin University, Perth, 6151, Australia*

Abstract

Shale gas is becoming increasingly important to mitigate the energy crisis of the world. Understanding the mechanisms of gas transport in shale matrix is crucial for development strategies. In this study, methane adsorption kinetics in shale samples were measured under different pressures and temperatures. The results of methane adsorption rate were fitted by the bidisperse diffusion model. Pore structure of the shale samples were characterized by low-pressure N_2 and CO_2 adsorption. The results showed that pressure has a negative effect on methane adsorption rate and diffusion, while the effect of temperature is positive. Combining the total organic carbon (TOC) and pore structure, methane adsorption rate and effective diffusivity were compared between all the shale samples. The methane adsorption rate under high pressure (50bar) is positively related to the TOC content. The micropore volume showed a moderate positive relation with the methane adsorption rate at 30bar. A weak positive relation exists between the TOC and effective diffusivity at low pressure and the effective diffusivity at low pressure shows an increasing trend with micropore(<2nm) volume. A hypothetic pore model is proposed: micropore in shales controls gas diffusion as pore throat which connects pores.

Keywords: shale gas, adsorption rate, diffusion, bidisperse model, methane

1. Introduction

With the consumption of the fossil fuels increasing rapidly, shale gas has drawn much attention as unconventional natural gas all over the world. However, the mechanisms of gas storage and transport in shale differ significantly from conventional gas reservoirs. Shale consists of both organic and inorganic matter, with complex and heterogeneous geological properties (Bustin and Bustin, 2012; Liu et al., 2017). Moreover, shale gas is stored not only as free gas in pores, but also as adsorbed gas on pore surface and dissolved gas in organic matter such as bitumen (Chalmers and Bustin, 2007; Curtis, 2002; Ross and Marc Bustin, 2007). These specific features make it impossible to directly apply knowledge of conventional gas reservoirs for shale. Considering that the percentage of the adsorbed gas could be significant, the contribution of the adsorbed gas to the gas storage and transport in shale is a very important subject.

With respect to gas storage in shale, gas adsorption capacity has been well documented on its controlling factors, including reservoir conditions (pressure, temperature and moisture) and shale properties (organic matter content, clay mineral content and pore structure) (Chalmers and Bustin, 2010; Guo, 2013; Ji et al., 2012; Ross and Marc Bustin, 2009; Wang and Yu, 2016; Zhang et al., 2012). With respect to gas transport in shale, the mechanisms related to the adsorbed gas include the gas adsorption, desorption, diffusion and Darcy flow. Given that a large proportion of pores in shale are nano-scale (Kuila et al., 2014; Labani et al., 2013), gas flow in nano-scale pores is mainly limited by the gas diffusion rather than the Darcy