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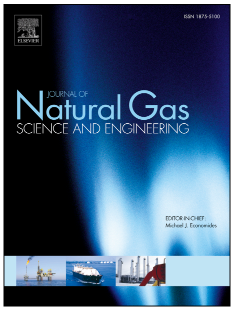

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Study of Adsorption Behavior in Shale Reservoirs under High Pressure

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Abstract:

Understanding adsorption behavior is of critical importance for the development of shale reservoirs. However, most extant adsorption models cannot properly describe isothermal adsorption when the pressure exceeds a specific value at which the Langmuir volume is obtained. In this study, a modified bi-adsorbent simplified local density/Peng-Robinson model (SLD-PR) was developed in which adsorption in both organic and inorganic components of shale was considered at the same time, and a new modification was imposed on the covolume parameter in equation of state. The model was demonstrated on high pressure methane isothermal adsorption tests of terrestrial shale samples and the high pressure methane adsorption data for marine shales available in the literature samples. It is found that the proposed model can fit isothermal adsorption well for both terrestrial and marine shales with different shapes of adsorption curves, especially in the high pressure range. With the application of the model, it was determined that the methane adsorption capacity of Yanchang Formation terrestrial shale exhibits a positive correlation with its TOC content. Other factors, such as specific surface area, clay content and temperature, also significantly affect adsorption capacity. Furthermore, in the calculation of *in-situ* gas storage in shale reservoirs, the proposed model produces more reliable results generally when compared with the original SLD-PR model and the Langmuir model.

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Keywords: gas adsorption; bi-adsorbent simplified local density model; high pressure; shale gas-in-place calculation.

1 Introduction

The development and production of shale gas are frequently conducted all over the world. The major forms of gas in place include free gas in pores and fractures, and adsorbed gas in organic matter and inorganic minerals (Zhang et al., 2012). The contribution of adsorbed gas to original-gas-in-place varies from 20% to 85% in several U.S. shale basins (Curtis, 2002; Montgomery et al., 2005). Therefore, measuring adsorption data at a proper temperature and pressure, and describing adsorption behavior through an appropriate model have become primary tasks for reservoir engineers (Chalmers and Bustin, 2008; Jiang et al., 2017; Ross and Bustin, 2008, 2009; Zhang et al., 2012).

Some types of theories and models have been developed to model the adsorption behavior of pure gas for coal and shale reservoirs (Ambrose et al., 2012; Bae et al.,