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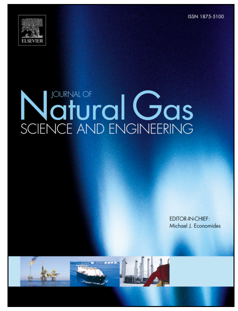


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# Research on shale gas transportation and apparent permeability in nanopores

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Abstract: Shale gas transport mechanisms in matrix nanopores include the Knudsen diffusion, transition diffusion, slip flow of free gas and surface diffusion of adsorbed gas. Previous research focused on shale gas Knudsen diffusion, slip flow and surface diffusion. In this paper, we present a shale gas mass flux model for the shale formation matrix that incorporates transition diffusion, slip flow and surface diffusion. A set of shale formation data was used to analyse the sensitivity of the gas mass flux to the pore radius and pressure for each gas transport mechanism. The results show that each gas transport mechanism mass flux contribution varies with the pore radius and pressure. The results of the gas mass flux sensitivity analysis are as follows: (1) the slip flow mass flux increases with increasing pore radius and pore pressure, (2) the surface diffusion mass flux decreases with increasing pore pressure and pore radius, and (3) the transition diffusion mass flux decreases with increasing pore pressure and has only a slight dependence on the pore radius. Furthermore, the gas type notably influences the apparent permeability. We recommend this model for the description of the shale gas mass flux in matrix nanopores. It provides insights into the effects of transition diffusion, slip flow and surface diffusion on the shale gas transportation in nanopores.

Key Words: Shale gas; Matrix nanopore; Transport Mechanism; Transition Diffusion

## 1 Introduction

Many nanopores are involved in shale formation. The shale gas transportation in nanopores follows certain rules, including Knudsen diffusion, gas slippage effect, Darcy seeapage, adsorbed gas surface diffusion, etc (Wang et al.,2013；Li et al.,2013). Research on shale gas transportation in nanopores has been the basis for the evaluation and numerical simulation of shale gas production. The gas mass flux model for shale formation nanopores has been emphasized in shale gas development. Much research has been carried out in the past several years. Klinkenberg (1941) was the first person to identify the gas diffusion phenomenon in porous media. He introduced the slippage factor $b_k$ to explain that the actual gas flow is higher than that predicted by Darcy's