NUMERICAL MODELING ON METHANE HYDRATE ACCUMULATION
AT SHENHU AREA, NORTHERN SOUTH CHINA SEA

Zheng Su a,b, Nengyou Wu a,b •

a Guangzhou Center for Gas Hydrate Research, Chinese Academy of Sciences, Guangzhou 510640, China
b Key Laboratory of Renewable Energy and Gas Hydrate, Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences, Guangzhou 510640, China

ABSTRACT

Geological conditions for gas hydrate formation have been naturally prepared on the northern continental slope of the South China Sea. Shenhu area is regarded as a promising target for gas hydrate exploration and exploitation. However, the methane hydrate in Shenhu area concentrates at base of the gas hydrate stability zone and is of high saturation. The feature differs from typical hydrate systems dominated by diffusion. The reservoir-forming mechanism and controlling factors are not clearly understood. In this paper a one-dimensional kinetic model is constructed for investigating the evolution of the special hydrate. The model includes sedimentation compaction, hydrate formation, and penetrability variation of sediment, and has two controlling parameters of seafloor sedimentation rate and water flux determining methane supply. The model is applied to compute the process of the hydrate accumulation in Shenhu area. The hydrate reservoir and distribution under the given conditions of sedimentation rate and water flux are discussed extensively, and the model results are compared with the observed data. The research shows the modeled results are different from the measured values to some extent in the cases of non-sedimentation, fixed water flow and sedimentation rates, decreasing water flux, and piecewise sedimentation rates. Surprisingly the simulation at a precondition of 25% hydrate preexisting in the sediment perfectly matches the hydrate distribution. The results also imply that the resource of Shenhu hydrate is reducing due to the rapid sedimentation and low water flux. The hydrate evolution from the preexisting hydrate is testified by the fluid conducting system. The modeling research also indicates hydrate has the saturation balance in the marine hydrate system dominated by water flow and sedimentation.

Keywords Shenhu area, Gas hydrate, Hydrate saturation, Hydrate accumulation, Numerical modeling

1. INTRODUCTION

Gas hydrates are crystalline substances composed of water and gas, in which a solid water lattice accommodates gas molecules in a cage-like structure \[1\]. Natural gas hydrates in geological systems involve mainly \(\text{CH}_4\), although hydrate-forming gases of thermogenic origin may also include \(\text{CO}_2\), \(\text{H}_2\text{S}\) and \(\text{N}_2\) as guests \[1\]. Natural gas hydrates can precipitate in pore space of deep-sea (>300m) sediments when gas concentrations exceed saturation at appropriate stability conditions \[2-4\], and is promoted by low temperatures \(T\) and high pressures \(P\), with significant heat exchange occurring during the reaction \[4\]. The depth interval appropriate for sub-bottom gas hydrate formation is commonly called the gas hydrate stability zone (GHSZ), and its lower boundary is often underlain by free gas \[2-3\], and indicated by the bottom-simulating reflector (BSR) on seismic records \[5-6\].

The northern South China Sea (SCS) is the most important field for marine hydrate investigations at present in China, and Shenhu area is one of the most promising blocks. As shown in Figure 1, Shenhu hydrate field is near southeast of Shenhu Underwater Sandy Bench in the middle of the northern continental slope of SCS, between Xisha Trough and Dongsha Islands. Tectonically the research area is located in the Zhu