ABSTRACT

Due to the increasing energy demands natural gas hydrates become more and more of interest as a potential source of natural gas, but the production of gas from natural gas hydrates is challenging. Natural gas hydrates remain stable as long as they are in mechanical, thermal and chemical equilibrium state with their environment. Thus, for the production of hydrocarbons from hydrate bearing sediments, at least one of these equilibrium states must be disturbed by depressurization, thermal stimulation or addition of chemicals such as methanol or CO₂. In the framework of the German national gas hydrate research project SUGAR, the latter two reaction routes are tested at the GFZ to find the most flexible and efficient method for gas production. In this context thermal stimulation using in situ combustion is tested in a pilot plant scale. For this purpose a heat exchange reactor was designed for the catalytic oxidation of methane which is placed in a large scale reservoir simulator (Volume 425 l). The latter was realized to synthesize hydrates in sediments under conditions similar to nature and to test the efficiency of the reactor with respect to hydrate dissociation and gas production rates. Thermocouples and methane sensors placed in the reservoir simulator collect data regarding the propagation of the heat front and the methane release, respectively. These data are used for numerical simulations to scale up from laboratory to field conditions. Thermal stimulation may be used alone or in combination with CO₂ sequestration. Therefore, laboratory studies on methane recovery from bulk hydrate phases via CO₂ injection (gaseous, liquid) are performed using several analytic tools such as microscopic observation, confocal Raman spectroscopy and X-ray diffraction.

The experimental set up of the large scale reservoir simulator, the reactor design and results from the in situ combustion experiments will be presented. In addition, results of the laboratory studies on the conversion of simple CH₄ hydrates or mixed CH₄/hydrocarbon hydrates into CO₂-rich hydrates will be discussed with respect to gas production efficiency.

Keywords: natural gas production, thermal stimulation, CO₂ injection, hydrate conversion