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Gas hydrate dissociation via in situ combustion of methane – lab studies and field tests

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In general, three different methods for gas hydrate production are known: thermal stimulation, pressure reduction, and chemical stimulation. In the framework of the German joint project SUGAR (Submarine Gas Hydrate Reservoirs: exploration, extraction and transport) a countercurrent heat exchange reactor was developed at GFZ which has been designed to decompose gas hydrates in sediments via thermal stimulation. The heat is produced by the catalytic oxidation of methane. The advantage of this method is that the heat is generated in place i.e. within the borehole on the same level like the hydrate-bearing sediments. The system is closed which means that there is no contact between the products or catalyst and the environment. The power output and the temperature of the reactor are regulated via the volume flow of the feed gases air and methane. Therefore, the catalytic reaction runs temperature-controlled, autothermic and safe.
So far, a lab-scale prototype of the reactor (outer diameter 40 mm, length 457 mm) was successfully tested in a large reservoir simulator (LARS) which was set up at GFZ. Pt, Pd and Ir on ZrO_2 as carrier material turned out to be a robust and reliable catalyst. This work presents results of the latest reactor test for which LARS was filled with sand, and ca. 80 % of the pore space was saturated with methane hydrate. To form hydrates the pore pressure and the confining pressure were kept at 8 MPa and 12 MPa, respectively, and the temperature was set to 278 K. During the start sequence the reactor was ignited at room temperature with hydrogen. By the time the reactor temperature reached ca. 523 K (ca. 15 min after hydrogen ignition) the fuel flow was changed to methane. After 9 hours all temperature sensors which are spatially distributed in LARS showed a temperature above the equilibrium temperature of 282 K at 8 MPa. All in all, the reactor was run for 12 h at 723 K. The data analysis showed that 15 % of the methane gas released from hydrates would have to be used for the catalytic combustion of methane. However, only a part of the hydrate-bound methane gas could be produced during the experiment. The residual gas remained in the pore space.
Currently the pilot-scale reactor is developed to a borehole tool with an outer diameter of 90 mm and ca. 5 m length. The first field test is planned for summer 2013 at the continental deep drilling KTB in Windischeschenbach, Germany. In future, we aim for a field test in hydrate-bearing sediments.