Geophysical Research Abstracts
Vol. 12, EGU2010-5379, 2010
EGU General Assembly 2010

Peculiarities of CO2 sequestration in the Permafrost area

Olga Guryeva (1), Evgeny Chuvilin (1), Igor Moudrakovski (2), Hailong Lu (2), John Ripmeester (2), and Vladimir Istomin (3)

(1) Geological Faculty, Moscow State University, Moscow, Russia (chuviline@msn.com), (2) National Research Council of Canada, Ottawa, Canada (John.Ripmeester@nrc-cnrc.gc.ca), (3) Joint-stock company "Novatek", Moscow, Russia (vlistomin@yandex.ru)

Natural gas and gas-condensate accumulations in North of Western Siberia contain an admixture of CO2 (about 0.5-1.0 mol.%). Recently, the development and transportation of natural gas in the Yamal peninsula has become of interest to Russian scientists. They suggest liquifaction of natural gas followed by delivery to consumers using icebreaking tankers. The technique of gas liquefaction requires CO2 to be absent from natural gas, and therefore the liquefaction technology includes the amine treatment of gas. This then leads to a problem with utilization of recovered CO2.

It is important to note, that gas reservoirs in the northern part of Russia are situated within the Permafrost zone. The thickness of frozen sediment reaches 500 meters. That is why one of the promising places for CO2 storage can be gas-permeable collectors in under-permafrost horizons. The favorable factors for preserving CO2 in these places are as follows: low permeability of overlying frozen sediments, low temperatures, the existence of a CO2 hydrate stability zone, and the possibility of sequestration at shallow depths (less then 800-1000 meters). When CO2 (in liquid or gas phase) is pumped into the under-permafrost collectors it is possible that some CO2 migrates towards the hydrate stability zone and hydrate-saturated horizons can be formed. This can result on the one hand in the increase of effective capacity of the collector, and on the other hand, in the increase of isolating properties of cap rock. Therefore, CO2 injection sometimes can be performed without a good cap rock.

In connection with the abovementioned, to elaborate an effective technology for CO2 injection it is necessary to perform a comprehensive experimental investigation with computer simulation of different utilization schemes, including the process of CO2 hydrate formation in porous media. There are two possible schemes of hydrate formation in pore medium of sediments: from liquid CO2 or the gas. The pore water in the sediment may be either in frozen or liquid states.

To study these processes, an experimental investigation of hydrate formation kinetics from liquid and gaseous CO2 has been performed using the method of NMR imaging*. Experiments were made with samples of quartz sand (particles' diameter 0,21-0,297mm) with different water saturation in the range of temperatures between -3 and +8oC and pressures between 3 and 6 MPa. The experiments performed revealed the main regularities of hydrate accumulation from liquid CO2 in sediment.

The influence of temperature on the rate of pore hydrate growth was analyzed. For example, the rate of hydrate growth at +7.2oC was 6 times smaller then at -3 . Fast hydrate formation from liquid CO2 was observed in sand samples with water saturation below 20-30%. With an increase in water saturation to 50%, the rate of hydrate formation decreased significantly, and when water saturation was 60% or more, nucleation was not observed during the time of the experiment (1-3 days). Experimental results revealed that pressure variation in the range between 4 and 6 MPa does not have any influence on the kinetics of hydrate formation from liquid CO2. Comparison of kinetics of hydrate formation from liquid and gas CO2 showed that hydrate accumulation is faster from gas CO2 then from liquid CO2. Thus, 50% of pore water that reacted with liquid CO2 transformed into hydrate in 0.8 hours after nucleation, and when reacted with CO2-gas, it transformed in 0.3 hours.

The completed experiments allowed us to consider the peculiarities of hydrate formation and filtration of liquid and gaseous CO2 towards the hydrate stability zone, which is important to take into account during the elaboration of industrial techniques of CO2 injection in under-permafrost collectors.

* Experiments have been made in the laboratory of NRC of Canada.