

Gas Hydrate and CCS Research: An Interface between CH-Exploration Industry, Science and Climate Change

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In the current discussion about still growing energy demands, decreasing carbon resources and climate change it has become obvious that alternate energy resources are in great demand in the future. With the extended installation of sun- and wind-driven power generators flexible power plants are required to compensate variations in production. Here gas-driven power plants provide the best performance, while their CO₂ emission is only 50% of a similar coal plant. In terms of fossil carbon energy supply, natural gas is the most environment friendly source. Moreover, it turned out that the anthropogenic effect on climate change by CO₂ emissions cannot be reduced to large extends in short time. Consequently efforts to collect existing gases and store them elsewhere are necessary to decrease the input of CO₂ into the atmosphere. Land deposits for CO₂ are, on first sight, easy to find and offer easiest access for storing CO₂. However storage safety, influence of other pore fluids and in particular possible interaction of economic activity within the storage area may not be easily assessed. Within this context marine gas hydrates offer a two-fold chance to gain access for new gas reservoirs and CO₂ storage sites. Gas hydrates (GH) are a cage structure formed by water molecules, which incorporate natural gas (mainly methane) in a solid matrix. GH is present in marine sediments at about 700 m water depth where temperature and pressure provide the gas hydrate stability field. Increasing temperature or decreasing pressure in the reservoir will immediately result in dissolution of the hydrate and provide free gas. Injecting liquid CO₂ into methane hydrate deposits will decompose the methane hydrates and form CO₂ hydrates in the pore space. CO₂ storage as a solid hydrate in the marine subsurface provides the most secure sequestration technique (immobile, away from urban communities). Due to higher temperature stability of CO₂ hydrates, diffusion of CO₂ by leakage and/or dissolution may be prevented. Through the release of methane in the associated process, this kind of sequestration can be combined with methane exploitation, which improves the economic balance of the procedure and makes it easier to obtain acceptance. The volume of CO₂ stored is 2 to 5 times higher than the released volume of methane, i.e., more CO₂ is stored than subsequently produced by the combustion of the methane leading to an overall positive carbon dioxide balance. The German network project SUGAR develops, in an integrated approach, new technologies for the entire potential hydrate exploitation chain extending from the exploration of new CO₂ deposits to the CO₂ and methane transport in suitable ships.

Until today gas hydrates were recovered in more than 20 locations worldwide. At about 100 locations their presence was inferred indirectly by geophysical, geochemical or geological observations. Analyses of gas hydrate deposits have shown that the content of gas hydrates in sediments is very variable. Finely distributed hydrates, which fill only a few per cent of the pore space, are widely spread but economically of small significance, because they can only be removed at high energy and cost expenses. Massive hydrate deposits, in which the sediment pore space is filled to a large degree with hydrate, form mostly in sandy sediment horizons, which are fed by migrating methane gas. New studies show that economically interesting hydrate deposits are formed mainly by methane gas bubbles, which are produced through microbial decomposition of organic material at great sediment depth (approx. 1-5 km). These bubbles rise to the surface where they freeze out as hydrate (Haeckel et al.

2004; Wallmann et al. 2006). The highest hydrate concentrations are found in thick sediment layers at continental slopes in medium water depths of approx. 400-2000 m (Buffett and Archer 2004). These methane hydrate deposits offer ideal conditions for the sequestration of CO₂ through the substitution of the contained methane.

Among the most prominent findings of massive hydrate layers are the recent findings in the Krishna-Godavari Basin (KGB) and the Andaman Island (AI). While calculations from the drill logs assume up to 60-80 % of GH saturation in the KGB the AI seems to host the thickest GHSZ of the world. Such reservoir conditions provide the most promising environment for future field tests of the proposed methane production with an integrated CO₂ sequestration. The SUGAR network program and project partners are interested in joint cooperation with Indian scientists and industry partners to further develop this technology.

References:

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