HYDRATE FORMATION IN SUPERSONIC JETS OF VAPOR AND GAS

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The aim of the present work is an experimental study of gas hydrate formation in the condensation of nanoclusters in supersonic molecular beams of rarefied water vapor and gas in vacuum.

Formation of gas hydrate was observed in a vacuum chamber with walls cooled by liquid nitrogen. The pressure in the chamber before the experiment was no more than 10^{-3} mm Hg. Counter-directed molecular beams of rarefied steam and ethane were simultaneously admitted to the chamber through the nozzle of Laval, which accelerated them to supersonic speeds. Adiabatic expansion of the rarefied vapor molecular flow at the nozzle outlet provides temperature decrease and formation of crystalline ice nanoclusters of cubic diamond-like structure. The formation of ice clusters is accompanied by the capture of gas molecules and the formation of a crystal hydrate phase. The change in pressure at the inlet to the supersonic nozzle regulated steam consumption and, as a consequence, the performance of gas hydrate. Cooling of the chamber walls with liquid nitrogen allowed to keep it unlimited time.

When heated, the crystalline condensate remained up to the melting point of the sample. Self-preservation ensured its stability in a metastable state at temperatures well above the equilibrium dissociation temperature of ethane hydrate.

The gas content in the crystallized water and the gas product exceed 50 mass. %. This content was achieved due to the additional sorption of the gas in the for-mation of crystalline condensate, which was a gas-saturated nanoporous medium containing crystallohydrate phase and crystalline ice.

The results of these experiments are of interest in connection with the develop-ment of economical and safe gas storage and transport technologies.

The work was supported by the Russian Foundation for Basic Research (Grant No 18-08-00352-a, No 18-38-00443mol-a) and the Program for Basic Research of the Ural Branch of the RAS (Grant No 18-2-2-3).