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Ecological and climatic consequences of phase instability of gas hydrates on the ocean bed

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Nowadays, an intensive development of shelf zone in relation with hydrocarbons production and underwater pipelining is in process. The order of the day is execution of engineering works in non-consolidated sediment and investigation of underwater slopes instability. The problem of reliable operational behavior of underwater constructions poses completely new tasks for engineers and developers.

Wide spread of has hydrates in bottom sediments is not only the possibility of hydrocarbon reserves increase but, in the same time, is a serious industrial and ecological problem. One of the most complicated engineering problems under the condition of instability of has hydrate deposits on the sea bed is operation of the sea fields, oil platforms construction and pipelining. The constructors faced the similar problem while designing the “Russia-Turkey” gas pipeline.

Because of instability and specificity of gas hydrates bedding their production is very problematic and is related mostly to the future technologies. Nevertheless, they attract more and more attention due to limited hydrocarbon reserves all over the world. On a quarter of the land and on nine tenth of the World Ocean thermodynamic conditions are favourable to accumulation and deposition of natural gas hydrates. Sufficiently high pressure and low temperature necessary for gas hydrates formation are observed usually on the sea bed at depths more than 1000 m. Mean water temperature in the World Ocean at depths 1 km don’t exceeds 5°, and at depths 2 km and more - 2°. In sub-polar zones the mean water temperature is close to 0° for the whole year. In the tropic regions gas hydrates are able to form and accumulate from the depth of 300 m and in the polar regions – from the depth of only 100 m. Being warmed up, gas hydrate melts and dissociated into free gas and water. Drilling of the gas hydrate deposits is very dangerous because the heat produced by the bore can melt gas hydrate and release huge amount of energy and gas that leads to explosion.

Methane is the main natural source for power engineering specialists. It is transported by pipelines, and gas hydrate is dangerous in this case too. It can block the gas pipeline system forming the so-called “trombus” of “thermal ice”. After that the pipes have to be opened. The mess of this strange ice discovered melts immediately releasing methane and water vapor. The trombus formation can be prevented by the temperature increase or the pressure decrease. Both methods are very uncomfortable under the conditions the pipelines work. The better method is thorough drying up of the gas because gas hydrate obviously cannot be formed without water.

Gas hydrates attract attention not only as a fuel and chemical stuff but in relation to a serious anxiety of strong ecological and climatic problems that can occur as a result of methane release to the atmosphere due to both gas hydrate deposits development and minor changes in thermodynamic conditions in the vicinity of a threshold of gas hydrate phase stability. One of the most probable causes is the global warming of the Earth due to the hothouse effect because the specific absorption of the Earth heat radiation by methane (radiation effectivity) is 21 times higher than its absorption by carbonic gas. Analysis of the air trapped by polar ice show that contemporary increase of methane concentration in the atmosphere is unexampled for the last 160 thousands of years. The sources of this increase are not clear. Observer and latent methane bursts during natural gas hydrates decomposition can be considered as a probable source.

Amount of methane hided in natural gas hydrates is 3000 times higher its amount in the atmosphere. Release of this hothouse potential would have terrible consequences for the humanity. The warming can cause further gas hydrates decomposition and released methane will cause the following warming. Thus, self-accelerating process can start. The most vulnerable for the climate changes are gas hydrate deposits of the Arctic continental shelves.

Thanks to sea level rise gas hydrates are washed by the waters of the Arctic Ocean and suffer of the surface water temperature increase by 100 and more for the last 10 thousand years.
For this gas hydrates source the temperature 0-2C is crucial. For the higher temperature the self-conservation effect stops and avalanche gas hydrate decomposition starts. The natural thermal and pressure conditions are very close to the stability threshold of gas hydrates. Because of this even minor changes can lead to gas hydrates decomposition and uncontrolled bursts, gas leakage to the atmosphere, explosions, fires, increase of the hothouse effect and can be a cause of mechanical instability of engineering constructions.