NATURAL GAS HYDRATES - A PROMISING ENERGY SOURCE

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Abstract. Currently, there are several successful research programs in a number of countries for the exploration and development of gas hydrate deposits. Gas hydrate resources are distributed in most countries in a way that is favorable for development. Effective means of extracting gas from hydrate deposits, new technologies for the development of gas hydrate deposits are being developed. There is commercial production of natural gas from hydrates in Siberia. Researchers continue to study the properties of natural gas hydrates in reservoir conditions, and to develop new technologies for the exploration and production of gas from hydrate deposits in various geological formations.

Keywords: crystals, hydrate, gas-water interface, and gel

Аннотация. В настоящее время в ряде стран осуществляется несколько успешных исследовательских программ по разведке и разработке месторождений газогидратов. Ресурсы газогидратов в большинстве стран распределены таким образом, чтобы они были благоприятны для разработки. Разрабатываются эффективные способы добычи газа из гидратных залежей, новые технологии разработки газогидратных месторождений. В Сибири ведется промышленная добыча природного газа из гидратов. Исследователи продолжают изучать свойства гидратов природного газа в пластовых условиях и разрабатывать новые технологии для разведки и добычи газа из гидратных залежей в различных геологических формациях.

Ключевые слова: кристаллы, гидрат, граница раздела газа и воды, гель

Annotatsiya. Hozirgi vaqtda bir qator mamlakatlarda gaz gidrat konlarini qidirish va o'zlashtirish bo'yicha bir nechta muvaffaqiyatli tadqiqot dasturlari mavjud. Gaz gidrat resurslari aksariyat mamlakatlarda rivojlanish uchun qulay tarzda taqsimlanadi. Gidrat konlaridan gaz olishning samarali vositalari, gaz gidrat konlarini o'zlashtirishning yangi texnologiyalari ishlab chiqilmoqda. Sibirda gidratlardan tabiiy gazni tijorat yo'li bilan ishlab chiqarish mavjud. Tadqiqotchilar suv omborlari sharoitida tabiiy gaz gidratlarining xususiyatlarini o'rganishni davom ettirmoqdalar va turli geologik tuzilmalardagi gidrat konlaridan gazni qidirish va qazib olishning yangi texnologiyalarini ishlab chiqmoqdalar.

Kalit so'zlar: kristallar, gidrat, gaz-suv interfeysi va jel

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Introduction

The problem of gas hydrate development and production is a significant problem of the twenty-first century. A number of countries, including the United States, Japan, India, China, Korea, and Germany, have national programs for the study of hydrates and the industrial production of natural gas from hydrates. In addition, significant research on gas hydrates is being conducted in many laboratories in many other countries, including Russia, Canada, and England. However, even a basic review of publications on gas hydrates shows that most research projects are carried out separately, at different scientific levels, and the published results are often ignored by the energy industry. The scientific community should be more focused on improving the technologies necessary for the detection, measurement, and production of gas from gas hydrate deposits.

The morphology of gas hydrate crystals depends on the water and gas composition, pressure, temperature, water (liquid, vapor, or solid), and the phase state of the gas. More than ten thousand different crystal forms have been studied. Hydrate crystal nuclei usually begin to form at the gas-water interface and grow until the interface is completely covered (does it grow to completely cover the interface?). After that, the crystals grow in the free gas phase or in water. There are three main morphological forms of hydrate crystals: massive, whisky, and gel-like (Figure1).

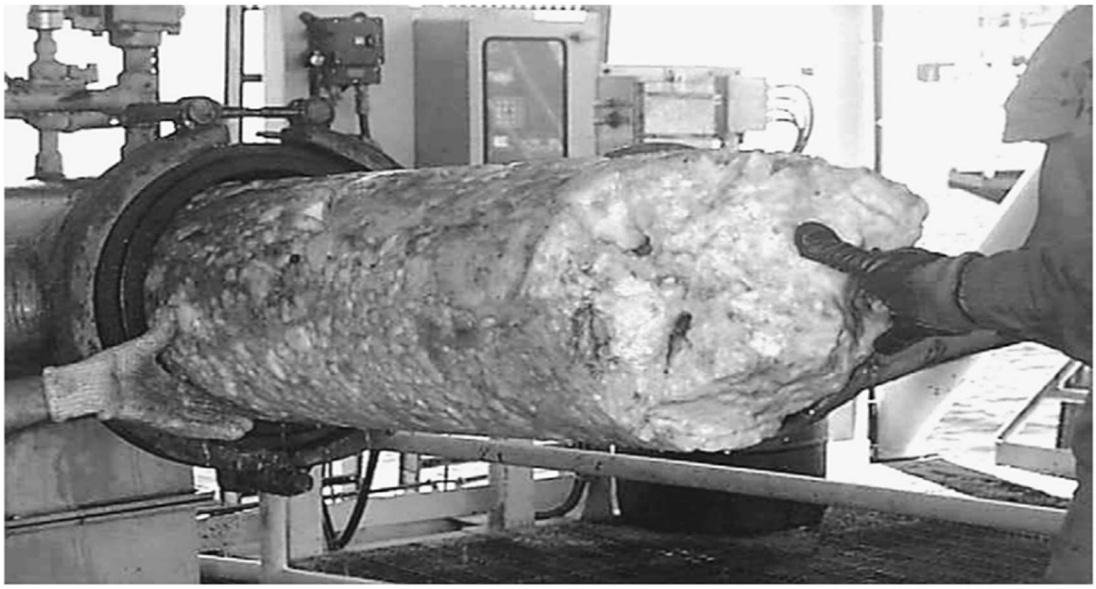


Figure 1. A solid gas-hydrate plug formed in a gas pipeline, 16 inches in diameter.

2. Natural gas hydrates - hydrates that form in nature

Natural gas hydrates are metastable minerals, the formation and dissociation of which depend on pressure and temperature, gas composition, reservoir water salinity, and the characteristics of the pore environment in which they form. Hydrate crystals in reservoir rocks can diffuse through the pore space without

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destroying the pores; however, in some cases, the rock is affected. Hydrates can occur as small nodules (up to 12 cm in size), as small lenses, or as layers up to several meters thick (Figure 2).

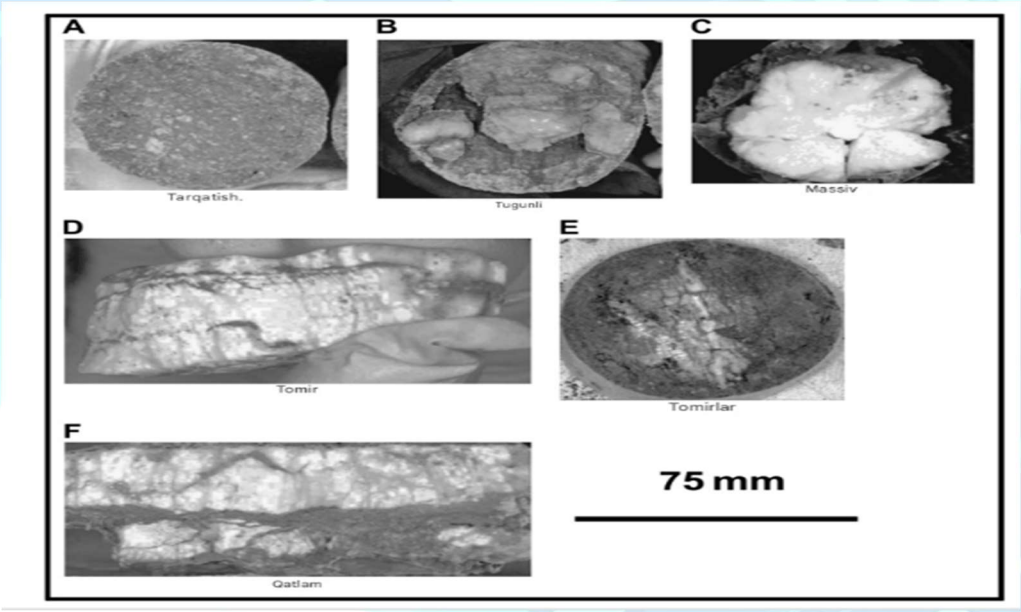


Figure 2. Natural gas hydrate cores Gas hydrates may have originated in space and helped form the planets of the solar system, as well as the Earth's hydrosphere and atmosphere. To release gas from a gas hydrate deposit, the entire mass of rock containing the gas hydrate must be heated.

The amount of energy required depends on the heat capacity of the hydrate, the heat capacity of the hydrate-saturated rock, the relative concentration of hydrate in the rock pores, and the degree of supercooling that caused the formation of the gas hydrate deposit. Hydrates have high acoustic conductivity and low electrical conductivity, which are used for effective methods of finding and evaluating gas hydrate deposits.

3. Methods for developing gas hydrate deposits

The thermodynamic interface of gas hydrate and free gas deposits does not have a lithological trap. Hydrate-saturated intervals are located in layers where thermodynamic equilibrium exists and free gas is present. Thus, conventional oil and gas methods can be used to develop gas hydrate. At the initial stage, the pore space saturation with hydrate was about 20%. Before the start of development, the maximum degree of supercooling in the reservoir did not exceed 2°C (in the upper part of the productive layer). The average degree of supercooling was 1°C. Low cooling contributed to the decomposition of hydrate, a significant decrease in the reservoir pressure of the field. The composition of the drilling mud, which contains calcium salts, prevented the formation of hydrates. Figure 2 shows the actual and calculated formation pressures during gas production, production and shutdown periods.

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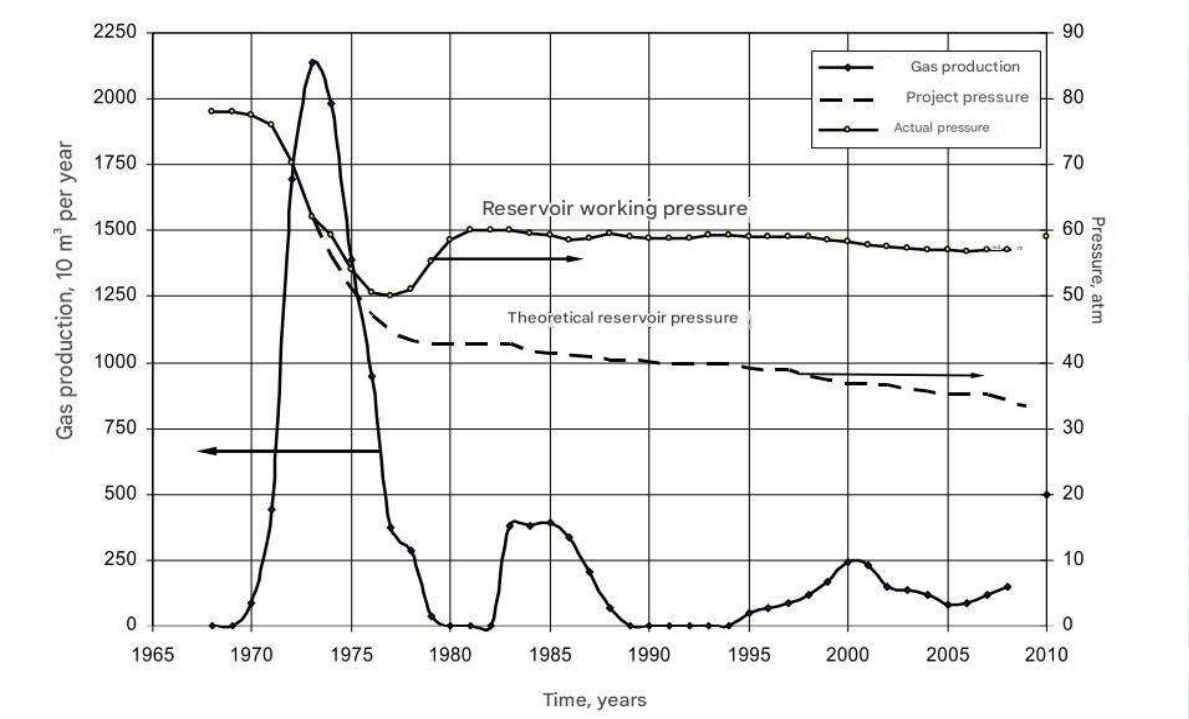


Figure 2. Reservoir pressure during gas hydrate development.

Gas production from the field amounted to 13.3 × 10⁹ m³, of which 6.9 × 10⁹ m³ was formed as a result of hydrate dissociation. A decrease in reservoir pressure was observed. The reservoir pressure, after 35 years of development, was reduced from 78 bar to 60 bar. In the absence of hydrate, the reservoir-voir pressure should have been 36 bar. In the early years of development, with high gas production rates, the reservoir pressure was reduced to 50 bar, which is 16 bar below equilibrium. In this case, the process of active hydrate decomposition began and lasted for many years. After a long shutdown of the field, the reservoir pressure increased to 60 bar; i.e., a return to the first equilibrium. Currently, gas production does not exceed 175 × 106 m³ per year, and the reservoir pressure is practically unchanged. The volume of gas produced from the field approximately corresponded to the volume of hydrate gas entering as a result of hydrate dissociation. The position of the gas-water interface did not change during gas production.

Conclusion

The energy stored in natural gas hydrates could serve as a very important non-conventional energy source to meet the growing energy needs for several decades. Natural gas hydrates are more evenly distributed on the planet than hydrocarbon sources. Gas production from gas hydrates would be open to many countries. Many existing technologies could be used to find and develop gas hydrates. However, significant research and development would be required before gas hydrates could be economically developed. The economic and environmental aspects of gas hydrate production need to be assessed. Both economics and

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environmental aspects depend on the technologies being developed. In addition, each gas hydrate is different, so different technologies may need to be used. Field experience has shown that the cost of producing gas hydrates was 15-20% higher than conventional methods.

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