

## The Study of Flammable Ice

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*Abstract: With global economic and politics development, many countries are facing energy crisis. The reserves of main fossil energy such as coal, oil and natural gas are greatly decreasing since the second industrial revolution. They produce waste gas and bring the greenhouse effect which pollutes our environment. Therefore, many countries are looking for new energy to replace them. Flammable ice is a kind of new energy to meet these needs. The global reserves of flammable ice are very huge which can be used for more than thousands of years. However, the mining technology is not complete. We discuss three plans and their feasibility and our country should put emphasis on the development of displacement method.*

*Keywords: flammable ice, displacement method, greenhouse effect, reserves*

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### 1. INTRODUCTION

Since entering the new century, the contradictions between limitation of the world's resources and limitless economic growth are increasing. Despite the progress of science and technology and productivity of human can widen prospect of available resources, the rapid growth of demand of the world's resources, the limitations of existing resources and uneven distributions all make the world resource competition intensified.

The world's energy resources are mainly fossil energy such as coal, oil, and natural gas and clean energy such as wind energy, hydro energy, solar energy and ocean energy. Although the reserves of global fossil energy resources are large, these resources are facing resource depletion with the large-scale development and utilization of industrial revolution for hundreds of years. Some realistic problems arise, such as serious pollution. Clean energy is not only abundant, but also low-carbon and environmentally sustainable. The potential for development is huge in the future.

Flammable ice is a solid compound of natural gas and water whose appearance is similar to ice. Flammable ice contains a lot of combustible gas such as methane, so it is easy to burn. Under the same conditions, the energy from the burning of combustible ice is several times more than coal and oil and gas. It does not produce any residue and waste gas after combustion, which avoids the problems of pollution that bother people. Scientists see flammable ice as "the energy belongs to the future".

## **2. THE DILEMMA OF EXTRACTION OF FLAMMABLE ICE**

The scope of distribution of flammable ice in the bottom of the sea roughly accounts for 10% of the total area of the sea, the equivalent of 4000 square kilometers. The flammable ice is the most valuable mineral resources in the bottom of the sea by far which is enough to be used for humans for one thousand years.

But in the heavy and complicated process of the combustible ice production, serious environmental disaster will happen once any errors appear, it will become the enemy of environmental protection. First of all, it is very difficult to collect gas in the sea water. The distribution of flammable ice is in large areas and the decomposition of methane is very difficult to gather in a certain region. It will decompose quickly once leave the seabed, therefore well accidents are easy to happen. More importantly, the greenhouse effect of methane is ten--twenty times worse than carbon dioxide. If it is not handled properly, the decomposition of methane gas is released into the atmosphere from seawater which will lead to more serious global warming problems. In addition, the mining in the undersea can also damage the stable equilibrium of the crust which can cause the turmoil of the edge of the continental shelf and underwater landslides, even lead to massive tidal waves and bring disastrous consequences. It is proved that this kind of natural gas released on a large scale in the past can led to the rapid climate change on earth to some extent. The massive tsunami in the Nordic eight thousand years ago was also probably due to the release of flammable ice.

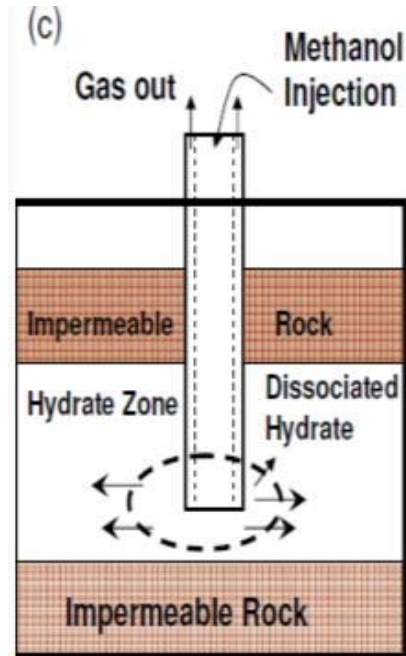
## **3. THE HARMFUL EFFECTS OF FLAMMABLE ICE**

Gas hydrate brings new energy future for human. It also puts forward serious challenges to survival of the environment of human at the same time. The greenhouse effect of the methane in gas hydrate is twenty times than carbon dioxide which causes abnormal climate and the rise of sea level. They are all threatening the survival of human. The amount of methane in natural gas hydrate in global ocean is approximately three thousand times of the total methane in the atmosphere of the earth. If the methane in gas hydrates in the bottom of the sea escape into the atmosphere, it will lead to unimaginable consequences. When conditions change, the methane gas can release from hydrates. The hydrates on the seabed sediments can also change the physical properties of the sediments, and greatly reduce the engineering mechanics properties of the seabed sediment to soften the seabed. Massive underwater landslide will happen and destroy the engineering facilities in the bottom of the sea, such as power transmission, communication cable, and offshore oil drilling platform. Natural flammable ice is solid, not like oil flowing out. If moving them from the bottom of the sea, the methane will be volatile in the process of transportation from the seabed to the surface. It can also cause huge harm to the atmosphere at the same time. In order to obtain this kind of clean energy, many countries in the world are studying the mining methods of natural combustible ice. Scientists believe that once the mining technology obtains breakthrough, flammable ice will immediately become the main energy in the twenty-first century.

#### 4. THE MINING SCHEME OF FLAMMABLE ICE

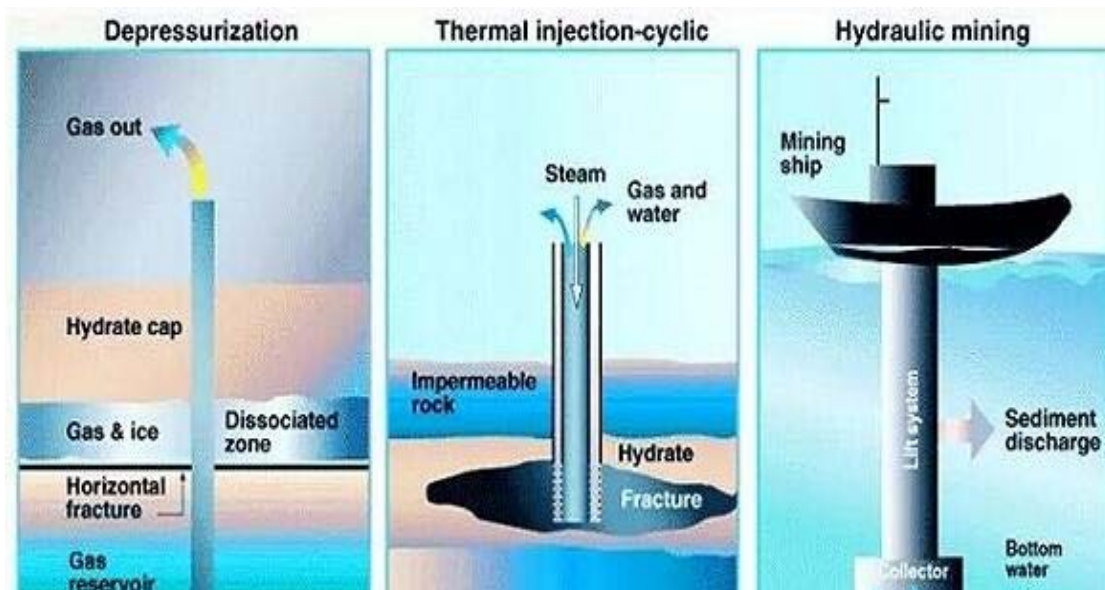
There are three main types of mining plans of flammable ice.

The first plan is pyrolysis method:



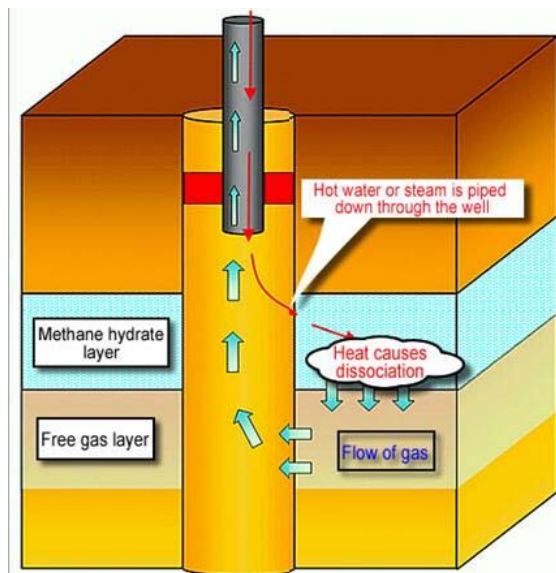
By making use of the characteristic of flammable ice that will decompose when heating can make the methane vapor decomposed from solid state. But this method is difficult to collect. The porous media on the seafloor is not concentrated in a certain area or a large block of rock. They spread evenly. The problem that is eager to solve is how to set up pipelines and collect it efficiently.

The second plan is Step-down method:



Some scientists have come up with the idea of burying nuclear waste into the ground and using the radiation effect to break it down. However, this method also has to solve the problems of laying pipelines and efficient collection.

The third plan is displacement method:



Study confirms that it is easy to liquefy carbon dioxide. And put them into 1.5 thousand meters below the ocean (not necessarily to the bottom of the sea) which can produce carbon dioxide hydrate. Because the proportion of carbon dioxide hydrate is bigger than water, it will sink to the bottom of the ocean. Because carbon dioxide is easier to form hydrates than methane, the carbon dioxide that was injected into the methane hydrate reservoir under the sea which could "squeeze out" methane molecules in methane hydrate, thus it can be replaced.

But if flammable ice leaks out in the process of mining, a large amount of methane gas will decompose and enter the atmosphere through seawater. The greenhouse effect of methane is 21 times larger than carbon dioxide, the global greenhouse effect will increase rapidly once the leak cannot be controlled. After the temperature of the atmosphere rises, the temperature and formation of the ocean will rise, too. These phenomena will cause the automatic decomposition of flammable ice and cause a vicious cycle. As a result, the extraction process must be controlled in order to effectively collect the release of methane gas.

The exploitation of flammable ice underwater involves complex technical problems, so it is still in the stage of development. It is estimated that it will take ten to thirty years for commercial exploitation. In fact, China, the United States, Canada, India, South Korea, Norway and Japan have begun their research programs of flammable ice. Japanese have built up seven exploratory wells and expect to put into commercial production in the year 2010. The United States also has rapid development in recent years. They hope to use them for commercial exploitation on the seabed or permafrost in the year 2015.

Obviously, flammable ice can not only bring new hope to human, but also have new difficulties. They can benefit human only the reasonable, scientific development and utilization of flammable ice.

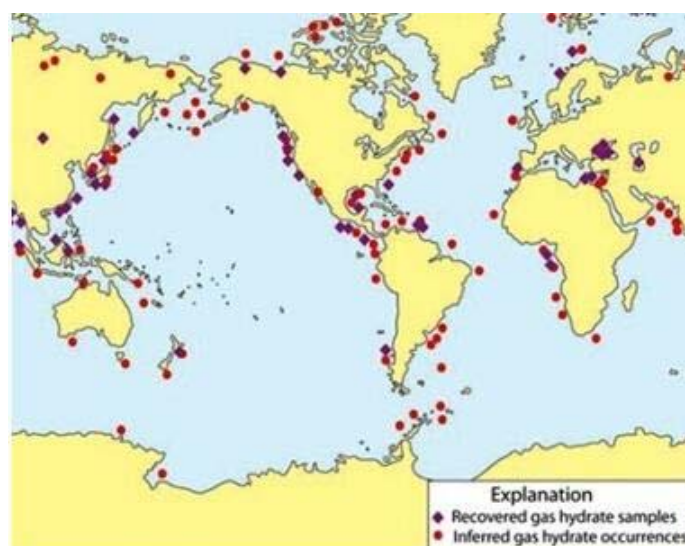
Because resources are not easy to develop, the use of flammable ice cannot be implemented in the short term.

## 5. GLOBAL RESERVES OF FLAMMABLE ICE

One cubic meter of flammable ice can be converted into 164 cubic meters of natural gas and 0.8 cubic meters of water. Scientists estimate that the range of flammable ice in the seafloor is about 40 million square kilometers which accounts for 10 percent of total ocean area. The amount of flammable ice on the sea floor is enough to be used for 1,000 years.

With the deepening of research and survey investigations, the amount of flammable ice that is found in the oceans of the world is gradually increasing. There were 57 areas in the year 1993 and 88 areas in the year 2001. It is estimated that Black ridge that off the southeastern coast of the United States has a capacity of 18 billion tons of flammable ice which could meet 105 years of gas consumption in the United States. The flammable ice resources in the sea of Japan and its surroundings are available for Japan for more than 100 years.

Experts estimate that the total oil reserves in the world are between 270 and 650 billion tons. The oil resources in the world will be depleted in 50 to 60 years at current consumption rates. The discovery of combustible ice has given new hope to human.



## 6. CONCLUSION

By analyzing the current situation and the dilemma of flammable ice, we know that the mining of flammable ice still needs for decades. Therefore, improving the mining technology is very important.

Our country has huge reserves of flammable ice. Therefore, putting emphasis on developing flammable ice can ease the energy crisis greatly.

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