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Methane Gas Hydrate

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Preface

Currently, natural gas is the fastest-growing primary energy source in the world. Natural gas is widely available and it is the cleanest-burning petroleum-based fuel. Natural gas can be produced from natural gas hydrates, or methane hydrates. The presence of gas hydrates in oceanic sediments was first postulated on the basis of seismic observations. Gas hydrates represent one of the world's largest untapped reservoirs of energy and, according to some estimates, have the potential to meet global energy needs for the next 1,000 years. They are also of considerable interest because of their potential role in global climate change. From an energy resource point of view, the enormous amounts of gas hydrates under the ocean and beneath Arctic permafrost represent an estimated more than 50% of all carbonaceous fuel reserves on Earth. The significance of methane hydrates lies mainly in the tremendous potential of this resource. Even a small percentage of the estimated global resource, if exploited, could meet the world's energy demands for centuries.

The industrial and social changes in which mankind was engaged during the twentieth century resulted in a rapidly increasing demand for hydrocarbon-based fuels. This increasing demand has been met by increasing the speed of exploration and exploitation of the vast resources of conventional oil and gas. These resources, however, are neither renewable nor inexhaustible, and we should expect to encounter severe depletion in the not-too-distant future. In this scenario, natural gas hydrates appear to be an exciting alternative and, if approached holistically, may become the main and a bountiful source of fuel for an energy-hungry world.

Gas hydrates are crystalline solid compounds, consisting of a gas molecule surrounded by a cage of water molecules. They are stable under the high pressure and low temperature typical of deepwater sediments of the world's oceans. Gas hydrate, or methane hydrate, is composed of natural gas molecules trapped inside ice. Per unit mass, gas hydrates contain twice as much carbon as all other fossil fuels (coal, natural gas, and oil) combined. The amount of methane trapped in marine sediments as a hydrate represents such an immense carbon reservoir that it must be considered a dominant factor in estimating unconventional gas energy resources. Significant safety and environmental concerns are also associated with the presence of natural gas hydrates, ranging from their possible impact on the safety of conventional drilling operations to the influence on Earth's periodic natural releases into the atmosphere of large volumes of hydrate-sourced methane or its derivative carbon dioxide.

Three processes have been proposed for dissociation of methane hydrates: thermal stimulation, depressurization, and inhibitor injection. The obvious production approaches involve depressurization, heating, and their combinations. The depressurization method involves lowering the pressure inside the well and encouraging the methane hydrate to dissociate. The chemical inhibition method seeks to displace the natural gas hydrate equilibrium condition beyond the hydrate stability zone's thermodynamic conditions through injection of a liquid inhibitor chemical adjacent to the hydrate. Of these three production processes, depressurization combined with the thermal stimulation process appears to be the most practical for zones where free gas is trapped beneath the methane hydrates.

Methane Gas Hydrate is written for the field engineer working in the natural gas industry. This book explains how, when, and where hydrates form, and provides the knowledge necessary to apply remedies in practical applications.

This book attempts to address the needs of energy researchers, chemical engineers, chemical engineering students, geology engineers, geology engineering students, geophysicists, gas engineers, energy resources specialists, engineers, and others interested in a practical tool for pursuing their interests in relation to energy. Each chapter starts with basic/fundamental explanations suitable for general readers and ends with in-depth scientific details suitable for expert readers. The expert readers will include chemists, chemical engineers, fuel engineers, geology engineers, geophysics engineers, geophysicists, gas engineers, biologists, fuel processors, policymakers, environmentalists, environmental engineers, automobile engineers, college students, and research faculty.

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