

## Improving the Effectiveness of Solidified Methane Storage: Developing Two Biosurfactants for Methane Hydrate Formation

**Authors :** Elaheh Sadeh, Abdolreza Farhadian, Matvei E. Semenov, Ulukbek Zh. Mirzakimov

**Abstract :** Recent advancements in solidified gas technology have demonstrated substantial potential for applications in carbon capture, storage, and natural gas transportation. The key factor limiting the industrial adoption of hydrates lies in the necessity for efficient and environmentally friendly promoters. This study aims to address this issue by synthesizing two biosurfactants - sodium oleate (SO) and hydroxylated sodium oleate (HSO) - as promoters for methane hydrate formation. The unique properties of these green, bio-based surfactants can potentially optimize solidified methane storage with wide-ranging applications in energy storage and transportation. The synthesis process of these promoters is simple and easily scalable for industrial production. The utilization of water as a solvent in the process helps to mitigate environmental impacts and simplifies the scale-up procedure. High-pressure autoclave experiments revealed a significant acceleration in methane hydrate formation kinetics with minute concentrations of the biosurfactants. Remarkably, just 5 ppm of SO and HSO facilitated a maximum water-to-hydrate conversion of 90%, equating to a storage capacity of 156 v/v in distilled water. Furthermore, SO and HSO demonstrated impressive biodegradability, exceeding 60% within 28 days. Toxicity assessments confirmed the biocompatibility of these biosurfactants, with cell viability above 70% for skin and lung cells at concentrations up to 180 and 90 µg/mL, respectively. These results indicate that SO and HSO could serve as an environmentally friendly alternative to synthetic surfactants, such as SDS, for methane storage. The findings of this study have far-reaching implications for various industries and applications. These biosurfactants' efficiency in methane hydrate formation may contribute to improved seawater desalination processes and more effective carbon capture techniques, ultimately reducing greenhouse gas emissions. Moreover, their application in gas storage could revolutionize the way natural gas is transported and stored. The synthesis of effective biosurfactants like SO and HSO opens up a world of possibilities in environmental sustainability, energy efficiency, and industrial innovation.

**Keywords :** methane storage, solidified methane, gas hydrate, biosurfactant

**Conference Title :** ICNGO 2025 : International Conference on Natural Gas and Oil

**Conference Location :** Dubai, United Arab Emirates

**Conference Dates :** January 30-31, 2025