Invited Lecture IL 07

Solids Formation Risk in Natural Gas, LNG and Liquid Hydrogen Production

Authors and affiliation

Eric F. May*[,1,2], Peter Metaxas[1], Paul Stanwix[1], Peter Falloon[1], Vincent Lim[1], Matthew Hopkins[1], Catherine Sampson[1], Arman Siahvashi[1], Zachary Aman[1].

Fluid Science & Resources Division, Department of Chemical Engineering, The University of Western Australia Crawley WA 6009, Australia

Future Energy Exports Cooperative Research Centre, 35 Stirling Hwy, Crawley WA 6009 Australia

*eric.may@uwa.edu.au

Key Word (3 words)

Hydrogen, LNG, Gas Hydrates,

Abstract (less than 300 words)

Natural gas and hydrogen are emerging as the fuels of primary importance for the 21st century. A common threat to the reliable production, trade and utilization of these fuels is the risk of solids formation. For example, the production of natural gas often involves transporting high-pressure multiphase mixtures through pipelines hundreds of kilometers long, with temperature changes likely to trigger gas hydrate formation. To increase the volumetric energy density economically viable levels, natural gas and hydrogen are often liquefied by cooling them to 110 K or 22 K, respectively. Solid blockages can form in these liquefaction processes if multiple impurities are not removed to part-per-million concentrations for LNG and even lower for LH2. Solids formation in any of these stages of the value chain can constitute a major technical and financial loss for the operators, yet the ability to quantitatively predict and/or monitor in real-time the risk of such an event represents a significant ongoing knowledge gap.

To address multiple aspects of this general problem we have developed several new apparatus with operating pressures as high as 30 MPa and operating temperatures as low as 80 K to acquire thousands of data points for both solid-fluid equilibrium and formation kinetics in key mixtures. These data have underpinned new predictive engineering models based on optimized equations of state for fluids and solids, as well as formation probabilities based on Classical Nucleation Theory. Online databases and free software packages, such as *ThermoFAST Web*, have been developed to implement and disseminate some of these results. Additionally a patented sensor for detecting solids freeze-out conditions in cryogenic liquefaction facilities has been demonstrated with samples from operating LNG plants. This talk will summarize the objectives and outcomes of this initiative to date and describe the challenges still to be addressed.