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Protecting environment and assuring efficient energy transfer using ionic liquids

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Gas hydrates are ice-like crystalline compounds that are formed when small gas molecules get trapped within the water molecules under high pressure and low-temperature conditions in oil and gas transmission lines. The formation of these hydrates is a major threat to oil and gas industry as they have a tendency to agglomerate and completely block the oil and gas transmission lines, which may lead to an explosion or cause unwanted operations shut down. Therefore, annually industry spends around 1 billion US dollars on hydrate prevention procedures which includes extensive use of chemical inhibitors. These chemical inhibitors are generally classified as thermodynamic hydrate inhibitors (THI) and kinetic hydrate inhibitors (KHI). The thermodynamic hydrate inhibitors function by shifting hydrate dissociation temperature to lower values and kinetic hydrate inhibitors function by delaying the hydrate formation time. The commercial THI like Methanol and Mono-ethylene glycol (MEG) perform well, but these inhibitors are required in large quantities (> 30 wt%) and cannot be easily disposed of into the environment. Therefore, there is a strong industrial need to design inhibitors that are environmentally friendly and are required in low dosage. Ionic liquids (ILs) well known as ionic fluids are a type of organic salts that have low melting points and tendency to stay in a liquid form at low or ambient temperature. Ionic liquids are extensively being used in different chemical processes due to their negligible vapor pressure and low viscosity. Recently, ionic liquid has been recognized as the dual functional inhibitors as they have the tendency to perform as kinetic hydrate inhibitor and thermodynamic hydrate inhibitor simultaneously. In this experimental-based work, the thermodynamic inhibition (TI) and kinetic inhibition (KI) effect of ionic liquids (ILs) 1-Methyl-1-

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Propyl-pyrrolidinium Chloride [PM-Py][Cl] and 1-Methyl-1-Propyl-pyrrolidinium Triflate [PM-Py][Triflate] have been investigated on a methane-rich gas mixture at different concentrations (1-5wt%) and pressure ranges (40-120 bars). The effect of the addition of synergists with ionic liquids has been also studied and the experimental results have been compared with the commercial thermodynamic inhibitor methanol and literature data. All the experimental work has been conducted using PSL system tecknik rocking cell assembly (RC-5). The ionic liquid [PMPy][Cl] was found to be more effective than the IL [PMPy] [Triflate].These experimental results, clearly show that the selected ionic liquids have a tendency to act as thermodynamic and kinetic inhibitors both simultaneously. In order to improve the kinetic inhibition effectiveness of the ionic liquids, the synergist polyethylene oxide (PEO) was added in equal ratio with the ionic liquids [PMPy][Triflate] and [PMPy][Cl]. The addition of PEO helped to enhance the kinetic inhibition effectiveness of these inhibitors significantly and delayed the hydrate induction time by 6 to 14 hours at the pressure range of 40-120 bars. A delay of 6 to 14 hours in hydrate induction time is highly beneficial for process operators as it allows them to take necessary action to avoid process disruptions as a result of hydrate formation. Acknowledgement This work was made possible by NPRP grant # 6-330-2-140 and GSRA # 2-1-0603-14012 from the Qatar National Research Fund (a member of Qatar Foundation). The statements made herein are solely the responsibility of the authors.