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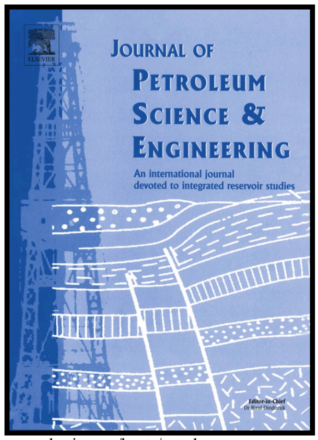

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Rapid formation of dry natural gas hydrate with high capacity and low decomposition rate using a new effective promoter

H. Rahimi Mofrad, H. Ganji*, K. Nazari, M. Kameli , A. Rezaie Rod, M. Kakavand

Research Institute of Petroleum Industry, Tehran 14665-137, IRAN
*Corresponding author. Tel: +982148252540; Fax: +982144739713. ganjih@ripi.ir

Abstract

In this research, the effects of sulfonated Lignin (SL) on formation rate, capacity and stability of natural gas hydrate have been investigated and the results compared with those of hydrate formation in pure water and Sodium dodecyl sulfate (SDS) aqueous solution. Experimental results verified that the reactor pressure is reduced by 63.8% after 15 hours when hydrate is formed in 500 ppm SL aqueous solution, while when using the same amount of SDS it is reduced no more than 57.8% after the same duration of time. It was also noticed that the formed hydrate when using SL had a lower decomposition rate than that of SDS aqueous solution. The reactor pressure increased 0.66 Mpa during dissociation of SL natural gas hydrate after 70 hours while in the case of SDS solution, at similar conditions this amount was 0.94 MPa. On the other hand, SL solution does not spume and so the formed hydrate is quite dense, brittle and dry which can be easily converted to powder while the hydrate formed in the SDS solution is foamy.

Keywords
Natural gas hydrate; Promoter; Formation rate; Decomposition rate; Storage capacity

1. Introduction

Natural gas hydrate (NGH) is composed of water and a certain number of natural gas molecules under favorable conditions of pressure and temperature. NGH can store large quantities of natural gas molecules in its structure (e.g. 180 volumes per each volume of hydrate at standard conditions) (Sloan and Koh, 2008). The storage capacity of NGH is less than that of liquefied natural gas (LNG) by 1/3 however it can be stored at much higher temperatures in compare with LNG (Khamehchi et al,2013). This caused NGH to be considered as a new mean for natural gas storage and transportation (Gudmundsson and Borrehaug, 1996; Khokhar et al., 1998; Gudmundsson and Mork , 2001; Makogon et al., 2007; Bergeron et al., 2010; Saw et al., 2012; Policicchio et al., 2013). Because of low solubility of light gases in water, gas hydrate formation rate is low. Furthermore, because of thermodynamic limitations, it will be difficult to reach the ideal NGH storage capacity (180V/V) and some cages remain empty. In literature, the effect of some additives on increase of NGH formation rate and its gas content has been addressed (Kalogerakis et al.,1993; Zhong and Rogers, 2000; Han et al., 2002; Karaaslan and Parlaktuna , 2002; Karaaslan et al., 2002; Sun et al., 2003; Ganandran and Amin , 2003; Link et al., 2003; Zhang et al., 2004; Mandal and Laik , 2008; Tajima et al., 2010; Mohammadi et al., 2011; Verrett et al., 2012; Ando