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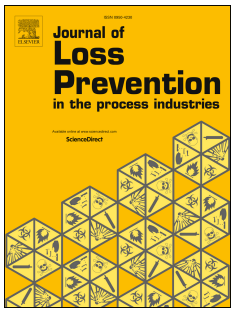

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Study on the natural gas pipeline safety monitoring technique and the time-frequency signal analysis method

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Abstract

Hydrate plugging and leakage in natural gas pipelines have been big issues for the industry with the globally increasing demand for natural gas. A natural gas pipeline safety monitoring technique is studied in this paper, which is based on acoustic excitation. In this technique hydrate plugging and leakage can be monitored online at multiple locations and distinguished by "energy-pattern" method based on the wavelet packet analysis. The position of a hydrate plugging or leakage can be achieved by correlation algorithm. The results of experiments and modeling work show that the technique can locate hydrate plugging or leakage at multiple positions with good accuracy and distinguish them effectively.

Key words: natural gas pipeline; hydrate plugging; leakage; monitoring; wavelet packet

1.Introduction

With the globally increasing demand for energy, natural gas, which is a clean and environmentally friendly fossil fuel, plays an increasingly important role all over the world. Among fossil fuels, natural gas is the one which emits the least carbon dioxide per unit energy (Esen and Oral, 2016; Macknick et al., 2013). The growth rate of annual global demand of natural gas is expected to be over 10 percent from 2007 to 2035 (Girgin and Krausmann, 2016; Furuoka, 2016). Pipelines are widely used for transportation or conveying most of the natural gas resources, consequently, the flow assurance is ever more important (Lasich et al., 2014). Hydrate blockage and leakage can lead to serious environmental pollution and high economic costs, which are of big issues for the industry. Detection and localization of such faults are necessary for smooth functioning of the industry and safety of the environment (Datta and Sarkar, 2016).

For the past few years, a series of methods and research work have been developed for natural gas pipeline hydrate and leakage detection respectively. Lung and Doige developed a time averaging transient testing technique for measuring the acoustic properties of piping systems and mufflers (Lung and Doige, 1983), but this method cannot deliver accurate work for locating and analyzing the internal characteristics of pipeline. Hasan reported a transient analysis solution to locate and characterize the plugs in gas wells (Hasan, et al., 1996), however, the localization accuracy depends on the dimensions of the deposit. Papadopoulou and Wang have reported an acoustic pipeline blockage and leakage detection method (Papadopoulou et al., 2008; Wang et al., 2009, 2012), respectively. However, these papers do not cover online hydrate monitoring and relevant experimental work, furthermore the water deposit in the experiments should not be regarded as hydrate. Yang has developed a hydrate early warning system (Yang et al., 2012), which is able to examine hydrate plugging offline. However, the system cannot monitor hydrate plugging online and is not suitable for