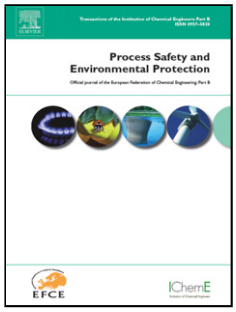

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Comprehensive risk assessment of deepwater drilling riser using fuzzy Petri net model

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Abstract: Drilling risers are the critical connection of subsea wellhead and the floating drilling unit. With exploration and development of oil and gas resources moving into deepwater, drilling riser operations have been characterized with high safety risk and occurrence rate of accidents causing high drilling downtime and drilling cost. In the present study, a Fuzzy Petri Net (FPN) methodology is proposed to evaluate the comprehensive risk of deepwater drilling risers. A risk index evaluation system was established based on analyses of drilling riser accidents and identification of risk factors, and the AHP-EM method was used to determine the weights of them. A 9-tuple set was defined to model drilling riser risks according to the FPN theories, and by using the fuzzy reasoning algorithm, risk values of risk factors at different levels and the integrated system were gained by iteration of state matrix. A specific case study of deepwater drilling risers of NANHAI-8 drilling unit in Liuhua oilfield in South China Sea is presented to illustrate the application of proposed approach, and some suggestions drawn from the investigation are presented to further mitigate the risk of drilling riser operations. The case study showed that FPN is a practical and reliable method in comprehensive risk evaluation of deepwater drilling riser system.

Keywords: Deepwater drilling riser; Risk assessment; Fuzzy petri net; Fuzzy reasoning algorithm; Combination weighting method

1. Introduction

Drilling riser system is the critical connection of subsea wellhead and drilling vessel as shown in Fig.1. With exploration and development of oil and gas moving into deepwater and ultra deepwater, drilling riser system components are more likely to suffer accidents. Complex environmental conditions, operational loads, variable operation modes, and human errors can all contribute to the occurrence of the accidents. Any accident of drilling riser system will lead to discharge of pollutants, drilling downtime, and even can lead to catastrophic consequences (Chang, 2008). From May 2003 to April 2004, several drilling riser accidents caused discharge of 6500 barrels of synthetic-based mud and a large amount of downtime (Fowler, 2004). Since 1983, such major drilling riser accidents, as unplanned disconnect of connector, break of drilling riser column, leakage of choke/kill lines, collapse of drilling riser main pipe, deformation caused by collision, burst of main pipe induced by wear, failure of the auxiliary equipments and grounding of the suspended riser column during typhoon evacuation can all be found throughout the references reviews (Erb et al., 1983; Holand, 1991, 1999, 2001; Kirton et al., 2004; Chang, 2008; Ju et al., 2011; Xu et al., 2013; Liu et al., 2013; Chang et al., 2014, 2018).