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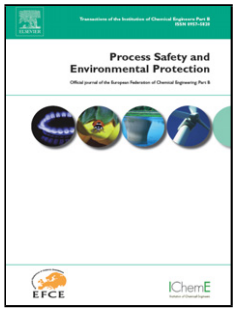

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Probability Prediction and Cost Benefit Analysis Based on System Dynamics

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Abstract: It is known that **optimizing** the investments on safety to reduce probabilities of blowout fire is very challenging due to the complexity of operational systems which involve varieties of potential contributors and ranges of safety measures. In this paper, a new method to evaluate blowout fire prevention and control measures is proposed in a cost effective manner. Firstly, a dynamic probability prediction model for blowout fire is proposed through the System Dynamics (SD) method. The dynamic probability of blowout fire on offshore drilling platform is predicted according to the proposed model. Secondly, Cost-Benefit analysis of the corresponding safety measures is carried out using SD simulation via Vensim software. Thirdly, a case study of blowout fire probability prediction and the Cost-Benefit Analysis of safety investments are demonstrated for some offshore drilling platform. The simulation results show that the predicted probability of blowout fire on offshore drilling platform increases from 2.41E-6 to 3.997E-6. The probability prediction formula of blowout fire is nonlinear fitted to obtain the intrinsic relationship between the probability of blowout fire and time. The case study shows that the built cost-benefit analysis model can be used to optimize the allocation of safety investments.

Key words: Dynamic Probability Prediction; Blowout Fire; System Dynamics; Cost Benefit Analysis; Safety Investment Allocation;

1. Introduction

Drilling operations usually operate in a dynamic environment in which technical, human and organizational errors may cause possible accidents like kicks and blowouts (Jyoti, 2015). The blowout fire of offshore drilling platform is caused by the coupling of these factors, in which there are uncertainties, non-linearity and high dynamics (Vandenbussche, 2012). This requires safety personnel to take dynamic risk analysis into account to predict possible accidents, thereby, to also reduce the probability of accidents. However, the traditional risk analysis methods cannot be used to predict the dynamic probability of blowout fire. So, in this paper, a dynamic probability model is proposed based on System Dynamic (SD) theory to handle both this complexity and changes in the system over time.

Historical accidents, such as the Piper Alpha (Cullen, 1990), Longford (Hopkins, 2000), Texas City (Chemical Safety Board, 2007) and Deepwater Horizon (Presidential Commission, 2011) have confirmed that substantial safety measures should be invested to protect people and the environment of offshore industry. The decision process of taking safety measures to reduce accident probability is complex, involving a number of actors and issues competing for the scarce available resources (Salvatore, 2016). Safety investments are viewed as a means to reduce the accident probability and incidence of injuries (Hinze, 2003). One of the main reasons why safety investment benefits are undervalued is that reducing financial loss as a result of incident avoidance through the safety measures is difficult to quantify (Reniers& Audenaert, 2009). A popular assumption holds that increased safety investment improves safety performance. However, close examination of previous studies on safety investments reveals that the relationship between the

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