

A model for simulating deepwater oil and gas blowouts – Part II: Comparison of numerical simulations with “Deepspill” field experiments

Un modèle pour simuler les éruptions en eau profonde de pétrole et de gaz – Partie II: Comparaison des simulations numériques avec des expériences en nature de déversement en profondeur

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ABSTRACT

A companion paper (Part I – Zheng *et al.*, 2003) presents the development and the module tests of a model, CDOG, developed to simulate the behavior of oil and gas accidentally released from deepwater. CDOG model incorporates the phase changes of gas, associated changes in thermodynamics and its impact on the hydrodynamics of the jet/plume. Hydrate formation, hydrate decomposition, gas dissolution, non-ideal behavior of the gas, possible gas separation from the main plume due to strong cross currents are integrated with the jet/plume hydrodynamics and thermodynamics. In this paper, CDOG model is used to numerically simulate the large-scale and unique field experiments conducted in Norway.

The field experiments consisted of two oil and methane gas releases and one methane gas only release from a deepwater location (844 m water depth). Comparisons between the simulations and observations are discussed in detail. The comparisons between the simulations and the observations are good.

RÉSUMÉ

Un article d’accompagnement (partie I Zheng *et al.*, 2003) présente le développement et les tests d’un modèle, CDOG, mis au point pour simuler le comportement de pétrole et de gaz accidentellement libérés en eau profonde. Le modèle CDOG tient compte des changements de phase du gaz, des changements associés de la thermodynamique et de leur impact sur l’hydrodynamique du jet/panache. La formation et décomposition d’hydrates, la dissolution de gaz, le comportement non-parfait du gaz, la séparation possible de gaz du panache principal dû à de forts courants en travers sont intégrés à l’hydrodynamique et la thermodynamique de jet/panache. Dans cet article, le modèle CDOG est mis en oeuvre pour simuler numériquement des expériences à grande échelle et uniques conduites sur le terrain en Norvège.

Les expériences sur le terrain ont consisté, d’une part, en un rejet d’huile et de méthane, et d’autre part, un rejet de méthane uniquement, en eau profonde (844 m de profondeur). Les comparaisons entre les simulations et les observations sont discutées en détail. Elles sont satisfaisantes.

Keywords: Blowout models; deepwater spills field experiments; oil spills; oil and gas spills; model verification; well head blow outs; underwater blowouts.

1 Introduction

Steadily increasing oil and gas exploration and production from deepwater locations (water depths in excess of 300 m) are found in several regions in the world: e.g. Gulf of Mexico, the North Sea, off shore West Africa, and off shore Brazil. According to Lane and Labelle (2000), the number of exploratory wells in the Gulf of Mexico (GOM) has increased by 70% from 1996 to 1998. They estimate the production from installations deeper than 800 m to be 69% of the total production by year 2007. The oil industry plans to extend the exploration and production from as deep as 3000 m water depth. As the production increases the potential for an oil/gas spill increases. Major concerns from a

deepwater oil/gas spill are fire, toxic hazard to the people working on the surface installations, and loss of buoyancy of ships and any floating installations. Therefore, it is important to know when, where, and how much gas will surface. Another environmental concern is whether oil will surface and if so, where, when, and what the oil slick thickness be. To meet these new challenges, spill response plans need to be upgraded. An important component of such a plan would be a model to simulate the behavior of oil and gasses, if accidentally released, in deepwater.

The major differences between a shallow water model and a deepwater model were discussed in detail in the companion paper (Part I – Zheng *et al.*, 2003). The companion paper describes the formulation of the mathematical model to simulate

Revision received March 20, 2002. Open for discussion till December 31, 2003.