Modeling for Gas and Hydrates Plumes from Deep Ocean

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The marine environment survey group in the environmental impact assessment Group of MH21 Research Consortium initiated the development of a model that could predict and assess the behaviors of methane that leaks from the seafloor into the seawater.

The only two models in the world that could comprehensively simulate the behavior of oil and gas releases from the deepwater are CDOG (Zheng, Yapa, and Chen, 2003; Yapa and Chen, 2004) and DEEPBLOW (Johansen, 2000). These two models handle the processes of methane or natural gases getting converted to hydrates under high pressure and then hydrates dissociating into free gas due to a combination of decreased pressure and increased temperatures at higher elevations. Of these two, CDOG formulation includes more detailed kinetics on gas hydrate formation.

Both models CDOG and DEEPBLOW were developed mainly with the focus of simulating the fate of oil when released from the deepwater. The gas was included in the model since it was known that the gas and hydrates in the mixture impacts on the behavior of oil plume. Neither model had the capability to take multiple gas bubble sizes into account in the simulations. Neither model accounts for gas bubble splitting or coalescence. Neither model takes gas hydrate dissolution into account in the simulations. In fact, DEEPBLOW does not even track the gases once they get separated from the main oil plume. Both models use only a single gas bubble size in their formulation.

In the present a model is developed to simulate the transport and fate of methane gases from deepwater. The model is developed with gas and hydrates as the focus. In this model processes such as gas hydrate formation and dissociation, gas dissolution, and plume dynamics are formulated using approaches similar to those in CDOG. However, the gas hydrate formation module has been significantly revised to allow possible dissolution from the gas core of a hydrate coated gas bubble. There have been significant changes to the above processes to improve the model. This model has many more processes that were not taken into account in CDOG. These are hydrate dissolution, hydrate crumbling and reformation, possibility of multiple gas bubble sizes, gas bubble splitting and coalescence. The model is also completely revised to allow the multiple sized gas bubble separation. This last aspect added a significant challenge to the modeling process.