Simulation of oil-gas releases including dispersant application with special focus on droplet size distributions

Experimental concept and some initial results

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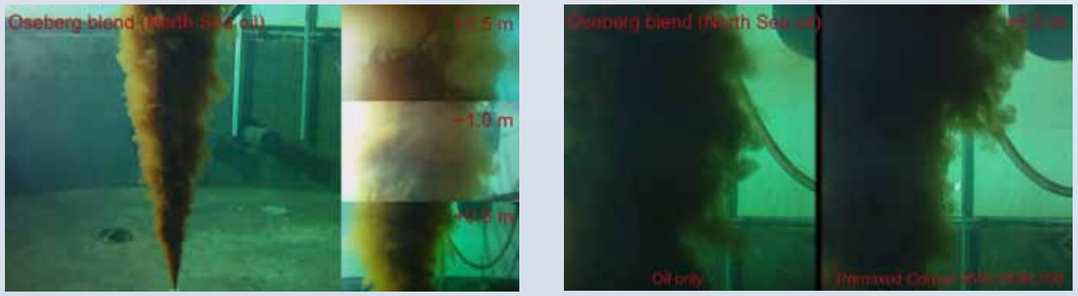


Figure 5: Left: Example of video from experiment. HD cameras are mounted at the nozzle and at various heights to study droplet formation and plume behaviour. Right: Comparison of droplet formation with "oil only" and with premixed dispersant. Water samples from these two experiments are shown in figure 6.

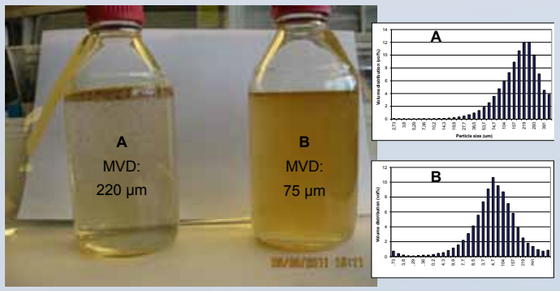
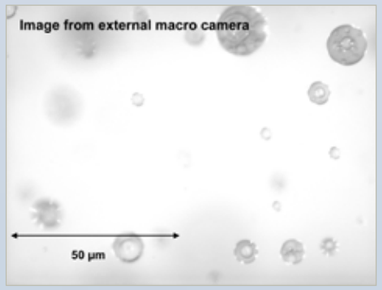


Figure 6:
Water samples are taken for chemical characterisation and calibration of in-situ UVF concentration. The figure shows two water samples from blow-out experiments with "oil alone"(A) and with premixed dispersants (B). Dispersant-to-oil Ratio (DOR) was 1:150 or 0.7%.

The reduction in droplet sizes due to dispersant treatment can clearly be seen, both visually and from the measured droplets size distributions. The droplets are reduced from a mean volume diameter (MVD) of 220 µm in bottle A to 75 µm in bottle B.



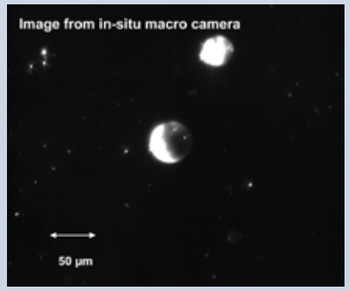


Figure 7:
Two different macro-camera techniques are used, as a supplement to the LIST instrument, to monitor larger droplets (see figure 3). The images are analysed with an automatic image analysis system to quantify droplet size distributions.

SUMMARY

The initial experiments in the Tower tank has so far been very promising and has already generated valuable datasets. Important features in the Tower tank design have been flexibility and versatility so it can be used to study many aspects of subsea releases of oil and gas. It is for example very suitable to study and optimize operational techniques for dispersant application since the reduction in droplet sizes can be studied directly.

ACKNOWLEDGMENT

The basic infrastructure for the Tower tank was established in 2005 and funded by Statoil ASA, Norway.

ABSTRACT

In case of a subsea blowout the size and distribution of oil droplets is believed to affect such factors as the time required for oil to rise to the surface, the location where it surfaces, dissolution in the water column, and entrainment of the smallest droplets beneath deepwater density layers.

A Tower tank is established at SINTEF to study droplet formation during subsea oil and gas blowouts. The tank is 6 meters high, 3 meters wide and holds 40m^3 of natural sea water. The tank is equipped with an advanced system for releasing oil and gas, and monitoring oil droplet size distributions and oil concentrations in the released plume. The droplet size distributions are measured with three independent methods (laser particle sizer, particle visual microscope and a macro camera with a blue-laser focusing plane).

STUDY OBJECTIVE FOR INITIAL STUDY

The focus areas for this initial work are to:

- simulate release of oil and gas from a hypothetical subsea blowout in order to increase our knowledge regarding the droplet size and distribution of released oil.
- study different application techniques for subsea dispersant application and their influence on droplet size and distribution.

EXPERIMENTAL DESCRIPTION

The new tower tank is equipped with a versatile system to control and monitor oil, gas and dispersants rates. Dispersants can either be injected into the oil prior to release (premixed) or injected into the oil & gas plume. An overview of the control system and the Tower tank system for handling waste oil and oil fumes are presented in figure 1.

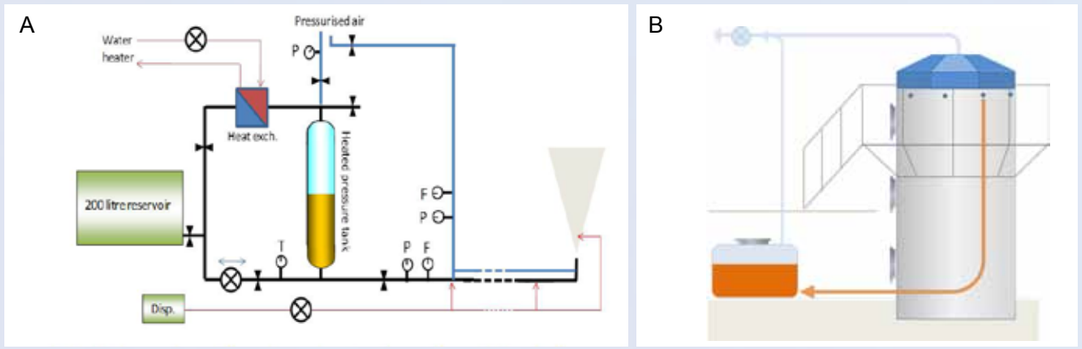


Figure 1: A: Overview of the set-up showing how oil, gas and dispersant can be released during the experiments (P: Pressure gauge, F: Flow controller) B: Principles for the scaffolding/railing around the tower,ventilated hood and overflow system to collect surface oil from the top of the tower.

MONITORING SYSTEMS IN TOWER TANK:

- LIST 100X Particle size analyser (2 - 500 µm)
- In-situ macro camera with a green laser focusing plane (5 - 2500 µm)
- External particle Visual Microscope, Mettler Toledo PVM V819 (5 -1200 µm)
- External UVF sensor, UviLux sensor with a flow-through cell
- Sampler to collect water and oil samples from the plume
- Video (HD cameras at four positions along the rising plume + low resolution for real time observation during operation.

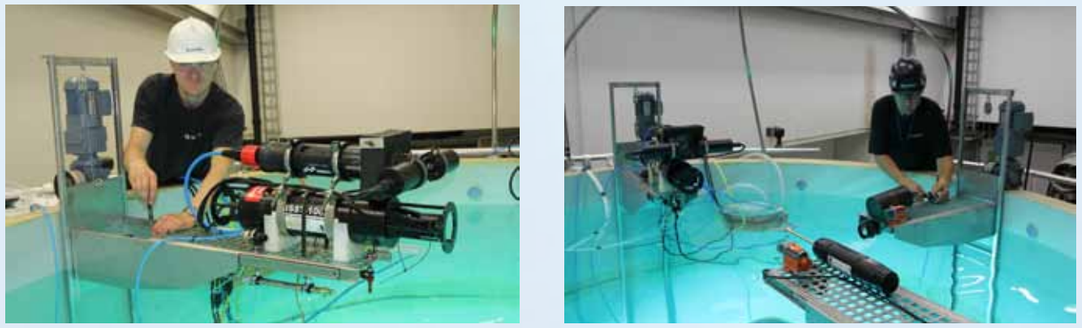


Figure 2: Pictures showing the main equipment used for monitoring of droplet sizes. Left: Mounting of laser scattering instrument (LIST100X) and the in-situ macro camera (close-up in figure 3). Right: Adjustment of camera equipment and the Vitrino 3D current profiler with all three instrument platforms in surface position.

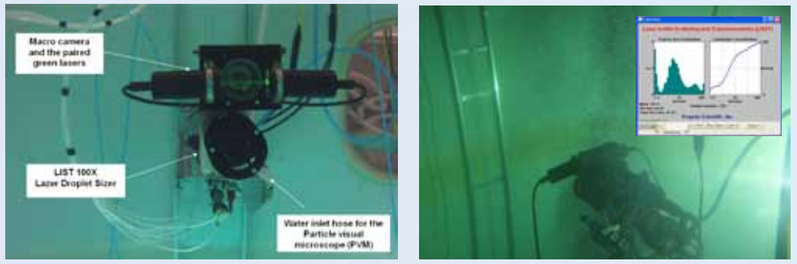


Figure 3: Left: Close-up of the equipment package for droplet size monitoring. Right: Monitoring of droplet sizes during an oil release experiment. Inserted is an example of real time output from the LISST 100X during an experiment.

Figure 4: Left: All three instrument platforms lowered and ready to initiate an experiment. The squared release platform can be seen in the middle on the bottom of the tank. Right: Top view of Tower tank after experiment showing surfaced oil inside the fume hood.