P26 Mitigation of Underwater Explosion Effects by Bubble Curtains: Experiments and Model

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Abstract:

Mine fields and UneXploded Ordnances (UXO) become a danger regarding maritime activities [1,2]. The safest solution to get rid of them would be to explode them in their locations. However, this method generates noise pollution and potentially damaging shock waves. Mitigation of shocks and noises is made possible by the use of a bubble curtain set around the explosive charge. Shock propagation in bubbly flows has been the subject of numerous investigations in the past decades and theoretical models of aerated liquids now reproduce shock features with good accuracy in the case of an uniform distribution of bubbles [3]. However, the modelling of the interaction between a shock wave and a bubble screen requires to consider an inhomogeneous bubbly liquid.

In the present study, the transmission of a shock wave propagating through a bubble curtain is investigated experimentally in a pool. A microporous pipe, connected to a compressed air supply system and a flowmeter, is placed on the bottom of the pool. A dual-tip fiber optical probe and an optoelectronic module are used to measure the void fraction, bubble rising velocity and bubble size distribution at different positions in the curtain. Shock waves are then generated upstream of the bubble curtain and recorded downstream with hydrophones.

As a result, void fraction profiles and bubble distributions are obtained for several positions in the bubble curtains. The profiles are finally injected in numerical model, which use classical bubble dynamic equations with addition of thermal and bubble fission effects [4], and outcomes are compared with the experimental results.

[1] OSPAR Quality Status Report 2010, http://qsr2010.ospar.org/en/ch09_09.html

[2] Francken, F., Dispersion of Critical Substances from Dumped Ammunition in Marine Sediments on Paardenmarktsite, Belgium, *Miremar NABU Conference*, Neumunster, Germany, 16-18th November, 2011.

[3] Kameda, M., Shimaura, N., Higashino, F., Matsumoto, Y., Shock waves in a uniform bubbly flow. *Physics of Fluids* 10, 2661-2668, 1998.

[4] Grandjean, H., Jacques N., Arrigoni, M., Zalewski, S., Damping of Underwater Wave Pressure by Bubble Curtain, *Safer seas*, Brest, May 12th, 2011.