Proceedings of Symposium on Ultrasonic Electronics, Vol. 30 (2009) pp. 171-172
18-20 November, 2009

# A study on reduction of flow-induced noise in water using open-cell foam

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## 1. Introduction

The low-frequency part of underwater acoustic signal is important for the characterization of passive acoustic signatures of underwater objects like ships or whales [1, 2]. For acquisition of good signatures, it is necessary to measure the signals in low ambient noise conditions. The ambient noise in the ocean at infrasonic- and low-frequency band is dominated by the flow-induced noise, which is a kind of self-noise caused by the presence of flow around the hydrophone [3, 4, 5].

For valid measurements in the environments with flow, it is necessary to reduce the noise level caused by the flow. In this paper, results of experimental approach are presented to reduce the low-frequency flow noise using open-cell foam in the ocean.

## 2. Results of at-sea experiment

The experiment was conducted at a shallow bay. The flow field of the site is controlled by tidal current, and that is appropriate condition to test the effect of flow on ambient noise.

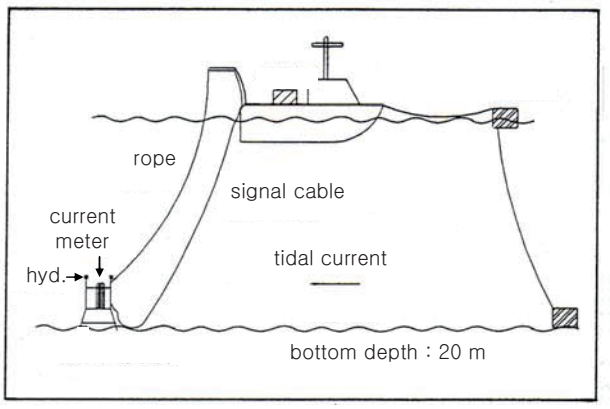


Fig. 1 Schematics of the experiment

**Fig. 1** represents the schematics of experiment. The hydrophone supporting structure with the height of 1.4 m is lowered at the bottom of the site. Four hydrophones are attached at the top of the structure.

The first hydrophone is installed with the protection guard removed and the others are screened with 10 ppi(pore per inch) open-cell foam around the guard. Thickness of the screen is 1, 2, and 3 cm respectively. The current meter is located at the middle of the structure for concurrent measurements of the flow speed with the ambient noise. The current data showed poor quality and is not represented.

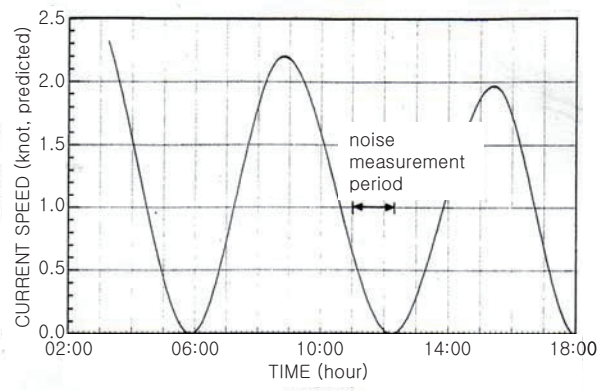


Fig. 2 Estimated speed of tidal current on the date of the experiment

**Fig. 2** represents the speed of tidal current predicted at the nearest tide station on the date of the experiment. Also, the period of ambient noise measurement is shown together in fig. 2. Although quantitative flow speed data is not available, it is possible to infer that the ambient noises were measured under the conditions of decreasing flow speed ranging from 0.7 knot to nearly zero.

**Fig. 3** shows amplitude variation of the ambient noise with time in 2 ~ 7 Hz band, which is measured at the bare hydrophone not screened with the open-cell foam. It could be seen from fig. 2 and fig. 3 that the measured ambient noises are closely related with the flow.

**Fig. 4** shows the spectrum levels of the ambient noises measured at the experiment. The solid line indicates the noise level measured with the bare hydrophone and shows the spectral slope of -10 dB/octave, which is typical of the flow-induced noise in water [1]. The dotted and

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dash-dotted lines represent the spectra measured with the hydrophones screened with the open-cell foam of 2 and 3 cm thick respectively. It could be seen that the flow noise reduction of more than 20 dB could be achieved when the 10 ppi foam of 3 cm thick is used. The peaks occurring at the multiples of 7 Hz are might be introduced by the vibrations of supporting structure.

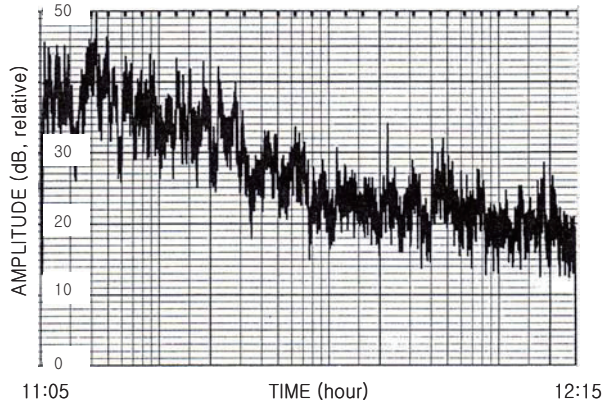


Fig. 3 Variation of the 2 ~7 Hz band ambient noise with time, measured with the hydrophone not screened with foam

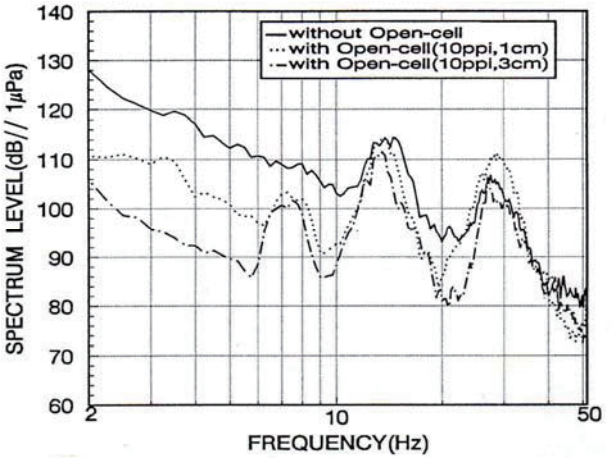


Fig. 4 Spectrum level of the ambient noise measured with and without the open-cell foam

## 3. Conclusion

Effects of screening the hydrophones with open-cell foams are investigated experimentally to reduce the low-frequency flow-induced noise in the ocean. The results show that the low-frequency flow noise could be reduced of more than 20 dB when the 10 ppi open-cell foam of 3 cm thick is used.

**Acknowledgment**
This work was supported by the KORDI under the contract number of PE98418.

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