ICSV14
Cairns • Australia
9-12 July, 2007

MEASUREMENT OF THE UNDERWATER SHIP NOISE BY MEANS OF THE SOUND INTENSITY METHOD

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Abstract

The measurements carried out close to surface sources by means of determination the acoustical pressure only especially in reverberation surrounding are not representative to the real physical conditions connected with sound field distribution. In this paper the results of wide range investigations of the sound generation by the ship in the shallow water are presented. These results will be compared with the results carried out in the far field (using only sound pressure measurements results). Due to directional feature of sound intensity characteristics one can also observe the changes of movements of elementary source. There are shown the results of calibrations of the underwater intensity probes and also spectrograms of underwater noise generating by the ships.

1. INTRODUCTION

Among acoustic waves generated by merchant vessels and ships could be distinguished those, which are closely connected with maintaining navigational parameters, that means with fixing or dynamic position of the ship.

The ship's noise is produced mostly by driving and auxiliary systems. The noise level depends mainly on resistance putting up by the environment (sea water) to the moving object, what usually is connected with forward speed or rapid change of acceleration in case of manoeuvre movements.

In the shallow sea when we usually carried out the measurements of underwater noise produced by moving objects the characteristics obtained by means the acoustical pressure only is not correct due to the near field phenomena. In this situation we applied the measuring method called the sound intensity one. Theoretical estimations of the sound energy level close to the source are not effective. For determination of the sound intensity vector we need to know both values the sound pressure and the acoustic velocity of vibrating particles of medium.

Because of the complexity of measuring procedure of the sound intensity usually we used a simply probe that consists of two identical sound pressure detectors – hydrophones. As is know the sound intensity is a product of sound pressure and particle velocity.

During direct measurement we obtain the sound pressure history and we need also to know the second function of mention above product. It can be determined by mean of well know Euler linearized equation.

2. CALIBRATION OF THE SOUND INTENSITY PROBE

Before start to carry out of the investigations of the distribution of sound intensity in shallow water when the moving hull is close to measuring probe we should carefully calibrate the measuring device. The first step of our investigation was calibration of the intensity probe. The scheme of the calibrating facility is shown in Figure 1. The applying setup consists of two main parts - transmitting part and receiving one.

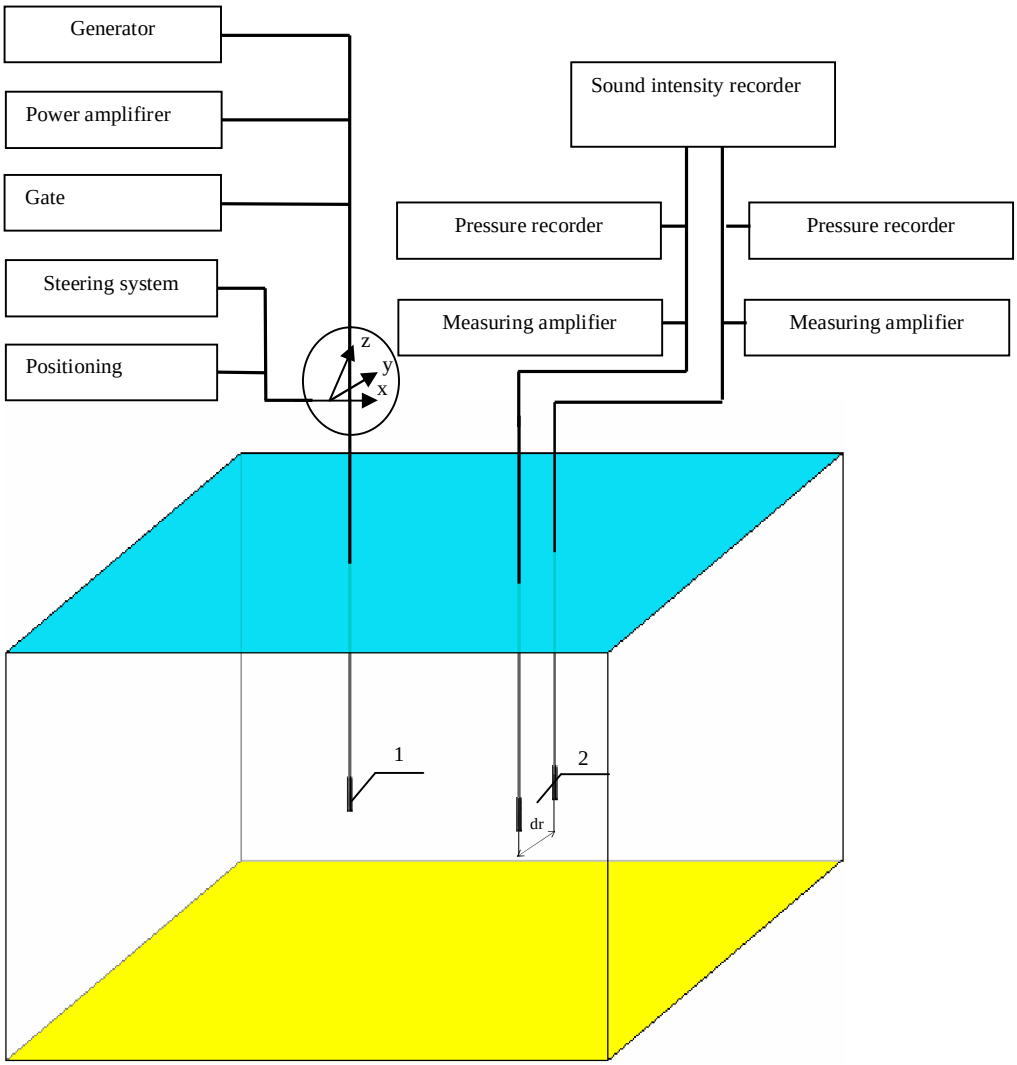

Figure 1. Scheme of the calibrating setup: 1-transmitter, 2-the intensity probe, dr-distance between hydrophones.

In the Figure 2 is shown the phase relation between signals from hydrophones because the phase matching between pressures time history is extremely important.

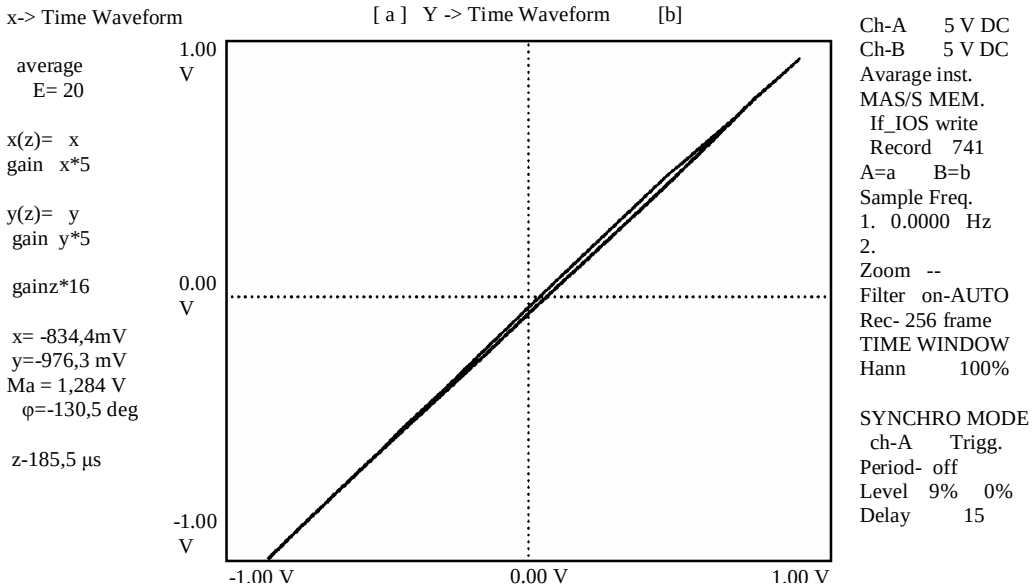

Figure 2. Differences between signals phase.

In Figure 3 and Figure 4 are shown results of examining of the sound intensity probe accuracy connected with the distance between hydrophones.

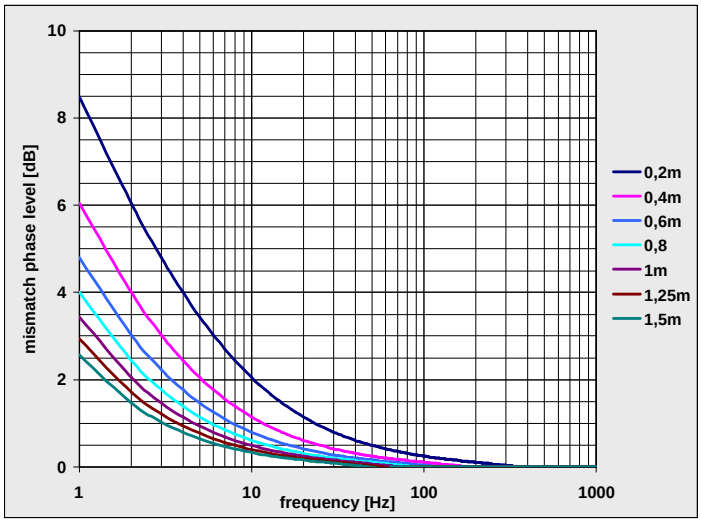

Figure 3.The mismatch phase level as a function of frequency for different distances between hydrophones.

After fulfil the procedure of calibration and determination of accuracy as a function of distance between hydrophones for interesting pass bands we can carried out a series of investigations in situ.

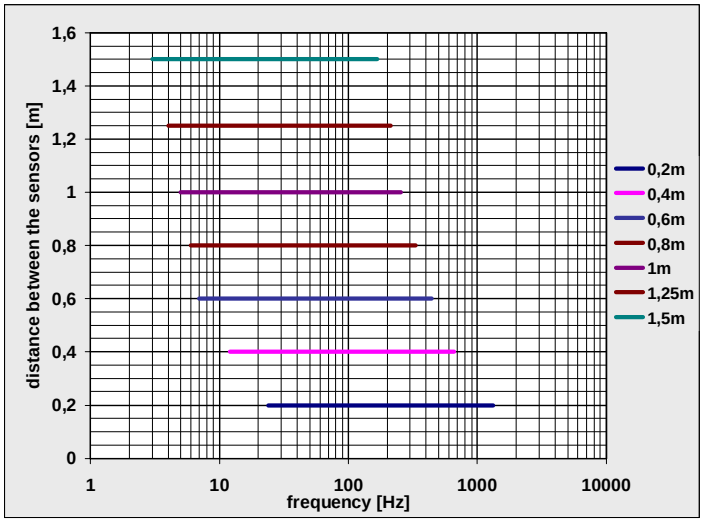

Figure 4. Accuracy of the sound intensity probe for chosen pass band of frequency.

3. INVESTIGATION METHODS AND FACILITY

The best location for measurement facility, used in evaluation of hydroacoustic characteristics of noise radiated by classical ships as well as submarines, is in places where the ambient noise is the smallest and the depth of the sea is high enough that the bottom could be treated as reflectionless. Of cause there are not too easy to found such kind of real conditions. As sensors of sound intensity are used a several probes mounted in such way that impact of environment motion, especially waved sea surface is minimalized. Signal from acoustics transducers are transmitted to the registering and analyzing laboratory. On the basis of these measurements, a set of characteristics that determine individual features of examined sources is obtained. In Figure 5 is shown the spectrogram of sound intensity characteristic for a surface ship.

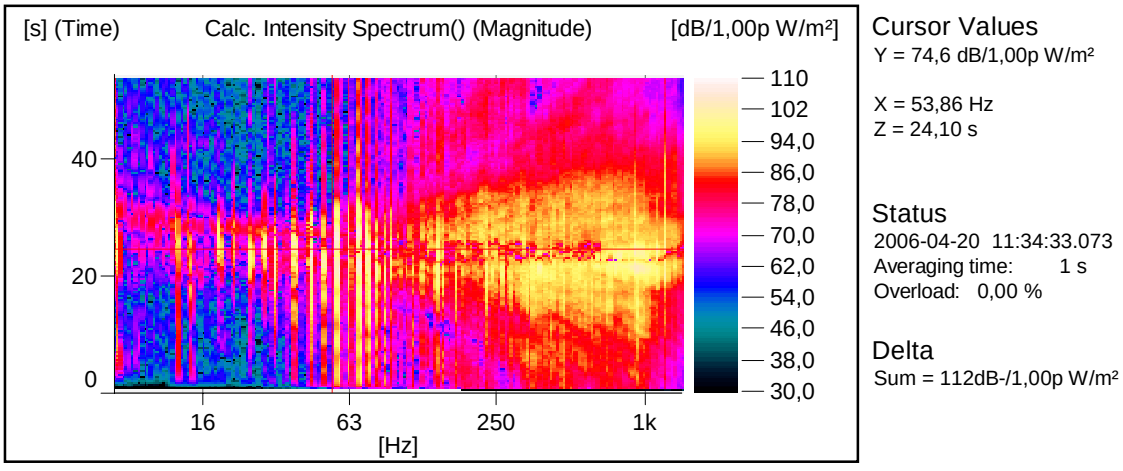

Figure 5.Typical spectrogram of the ship's sound intensity.

Because of vector feature of the sound intensity, we can observe the changes of movement directions of the source versus measuring array. The principles of these phenomena are shown in Figure 6.

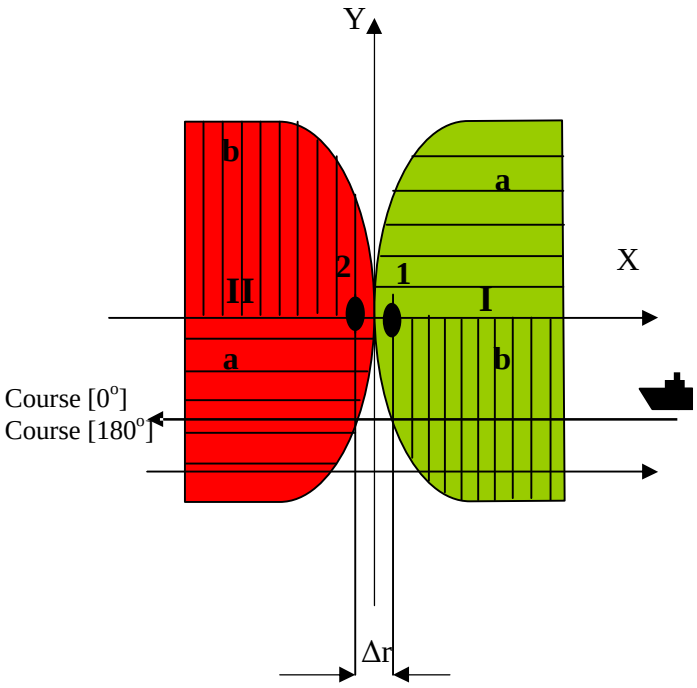

Figure 6. Principle of determination of the source course.

In the Figure 7 is shown characteristic of the sound intensity as a function of distance between source and receiving array.

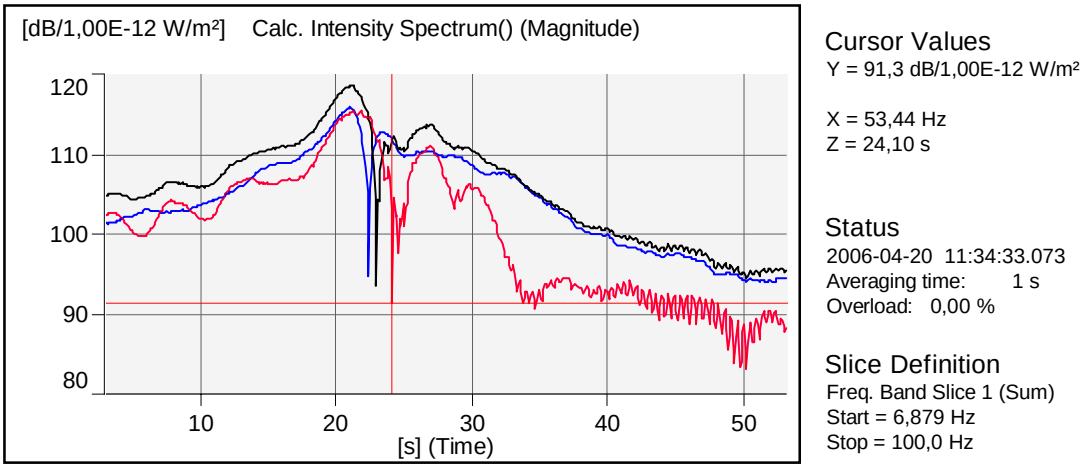

Figure 7. Sound intensity level as a function of distance (time) between moving source and receiver.

4. CONCLUSIONS

Applying the sound intensity measuring method we can to carried out the measurements in near field of a source of acoustic waves. It is very important in the case when we want to measure the ship's noise in the shallow sea. Otherwise on the base of intensity characteristics one can determine the direction of movement.

REFERENCES

[1] E. Kozaczka, Investigations of underwater disturbances generated by the ship propeller, *Archive of Acoustics* **13**, 2, 133-152 (1978)

[2] E.Kozaczka, G. Grelowska, Shipping noise, *Archive of Acoustics* **29**, 2, 169-176 (2004)