IDENTIFICATION OF SHIP'S MAIN NOISES IN THE HYDROACOUSTICS FIELD

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Paper presents the results of the structure of the hydroacoustics field of different classes' vessels measurements. Characteristics of underwater noises were described in the form of spectrograms and graphs worked out for different ship's speeds. These results are representative for hydroacoustic measurements carried out in the shallow sea.

INTRODUCTION

On measuring sea training grounds of the navy from the row of years measurements of fields of physical vessels of different classes are performed, of types by units about small for great displacements and about the different type of the main propulsion (diesel engines: little, on average and high-speed; gas turbines; electric motors). The acquaintance of the sound field and his disintegration are being used among others for the purposes of the passive defence, the identification and the ranking of vessels and for the preliminary diagnostic testing. Underwater noises propagated by the moving ship to the water centre are a sum of disorders coming from working mechanisms and ship's devices. Underwater noises contain the broad and folded information about „ sound field of the ship". The acquaintance of these noises and their spatial schedules enables the location to take the identification of individuals and them at the water centre, carrying out the preliminary assessment of the technical condition of the examined individual and are being used at military targets.

1. METHODS OF MEASUREMENTS

They took measurements on stationary and dynamic training grounds of physical fields from the ship. Measurements of hydroacoustic fields are performed for everyone set measuring arrangements for the ship full of the scope of the speed.

During measurements, ships flow through the sea measuring training ground of the minimum twice (cours180 ˚ and 0 ˚) with set by parameters of the work of the driving arrangement. Ships are getting set parameters at least 300 metres in front of the sea training ground and aren't changing them on the stretch of the minimum of 600 metres (300 metres behind buoys).

Gathered data, in the straight majority, contain results of measurements of underwater acoustic disorders, created by the moving ship, registered through hydrophones put one metre above the bottom. Hydrophones were measuring placed on different depths of the basin from 10 [m] to 50 [m], one by one what 10 [m]. The data set was subjected to analysis, for which chosen elements were described on enclosed pictures.

2. APPOINTED ACOUSTIC CHARACTERISTCS

Identification in the structure of underwater noises of the dominating source of the sound field which the level exceeds about 10 [dB] the level of alternative sources isn't creating the more considerable problem. For the presentation a spectrogram was chosen above underwater noises of the fast individual swimming with the speed 30 [kt].

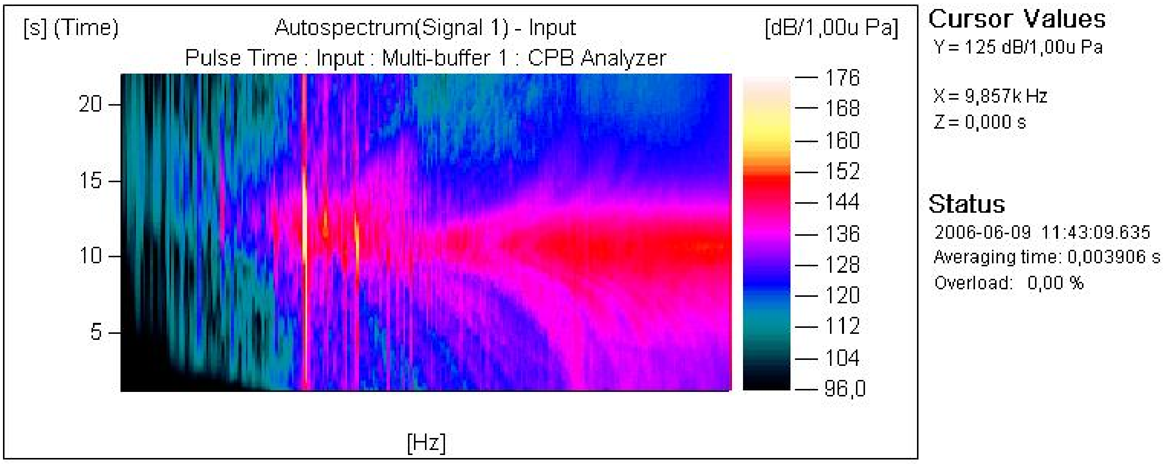

Fig.1. Spectrogram of underwater noise of the cutter at V >30 [kt]

The spectrogram was carried out for 22 [sec.] of registered underwater noises in the band to about 5600 [Hz] with resolution 1 / 12 octaves. On the spectrogram one can see the clearly characteristic component about the basic frequency about 35 [Hz]. With a view to determining the exact frequency of this characteristic component from the spectrogram a recorded spectrum was selected in 11 [sec.] of measurement.

Additionally with cursor third harmonic was marked f= 34.97 [Hz] with herl level L= 172 [dB re 1 μPa]. From the introduced apparition one can see, that the level of this component is much higher than levels of other characteristic storage payments of the spectre.. Knowing the driving arrangement and parameters of the work of this arrangement it is possible explicitly to state that these frequencies are associated with the rotation speed of the ship's propeller.

Much an identification of the dominating source of underwater noises is a more difficult issue in case of studying the damaged driving arrangement. In the presentation they used measurements, in which ship's propeller in the certain period of the rotation speed (speeds of ship) was a primary source of hydroacoustic noises.

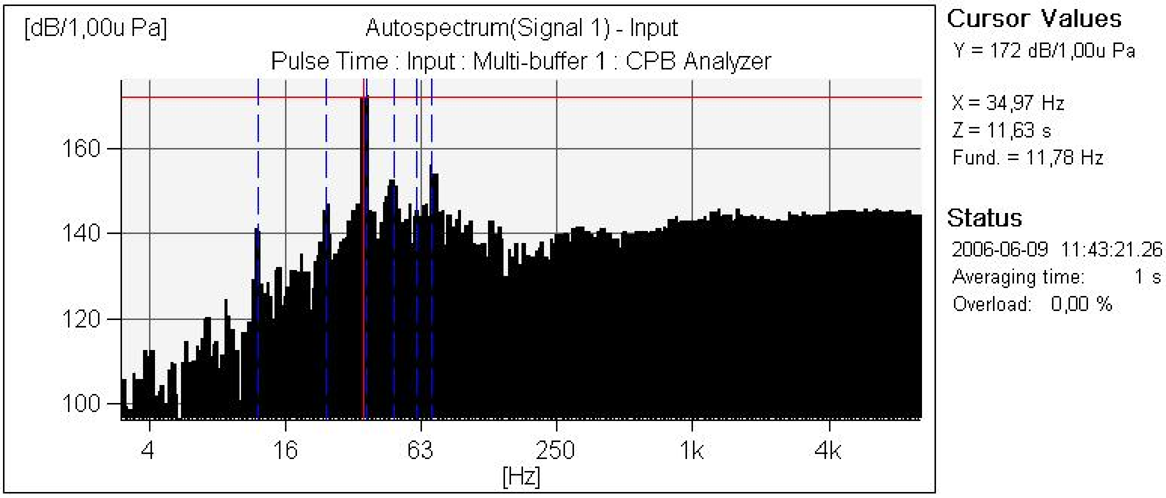

Fig.2. Spectrum of the hydroacoustics noise obtained from spectrogram presented on fig.1

Measurements of noises were recorded for the speed of the ship from 4 to 9 knots. Registered noise of ships were described in the form of the relation of the level of the hydroacoustic pressure in the function of the time of passing the ship by the sea training ground and frequencies. Representative spectrogram of whirrs of the ship made for the speed of ship v= 6.8 [kt] with the distinct components associated with the functioning of the excessively humming ship's screw propeller in the Fig. 3 was described. On the spectrogram they marked with number 1 basic frequency with next harmonic 2, 3. From spectrograms made for the speed of ship v= 4.2; 5.8; 6.8; 8.7 [kt] spectres which were introduced in fig.4 were selected.

Spectrum of noises carried out for the speed v=8.7 [kt] was registered at measuring large depths.

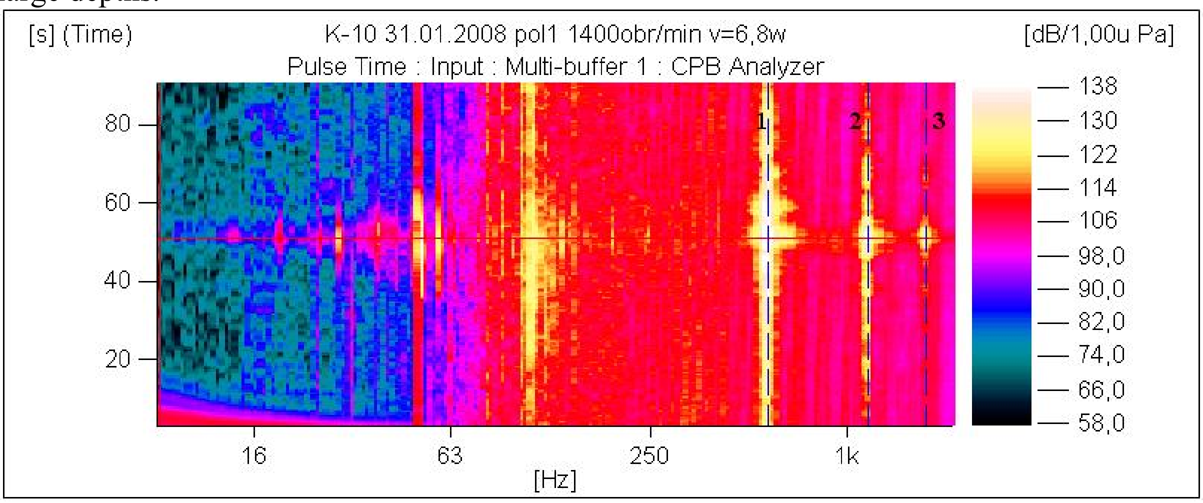

Fig.3. Spectrogram of the hydroacoustic noise where: 1 – the basic frequency associated with the ship's propeller; 2 – its II harmonic; 3 – its III harrmonic

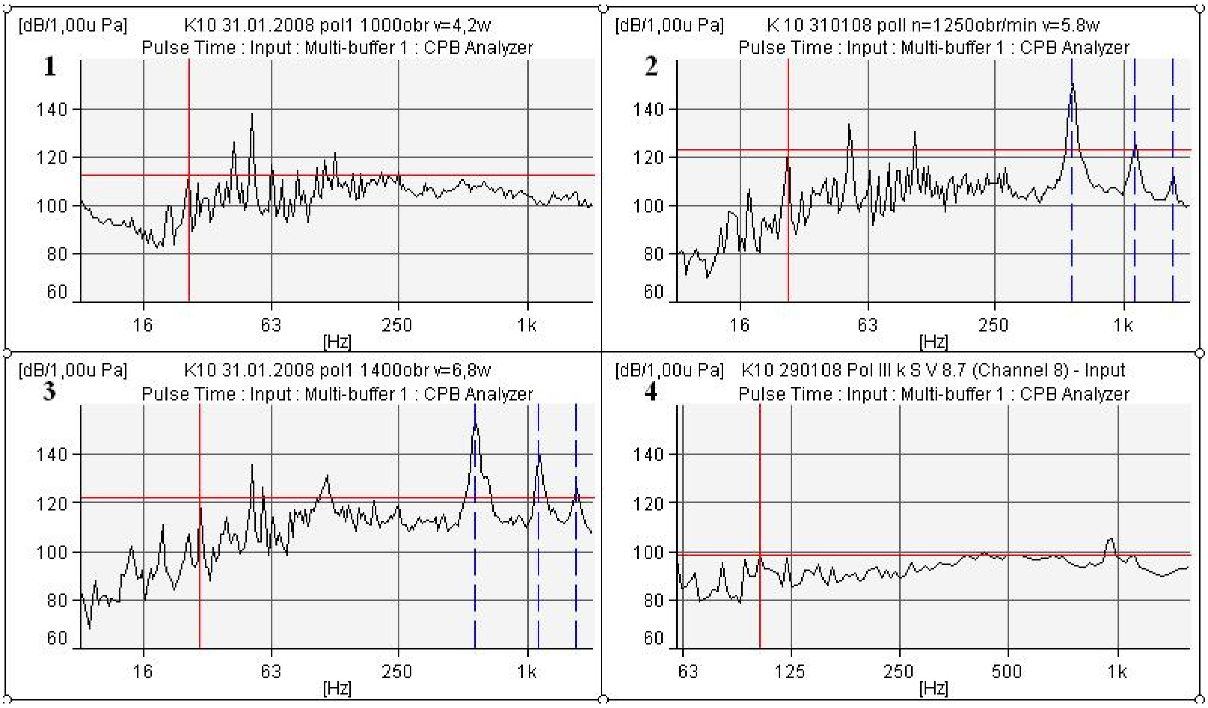

Fig.4. Spectrum of the hydroacoustics noise wqhere: 1. registered at the speed V= 4.2 [kt], 2. registered at the speed of V= 5.8 [kt], 3. registered at the speed of V= 6.8 [kt], 4. registered at the speed of V= 8.7 [kt]

In 4.1 pictures the characteristic components associated with the work of an engine are visible main, of generating set, with the rotary motion of the ship's propeller and the line of propeller shafts. The more further increase in the speed of the ship caused the appreciable increase of the level of the sound pressure. The basic frequency of these characteristic components was f= 561 [Hz] (fig.4.2.; 4.3). In the introduced apparition the lack is a fig. 4.4 distinct frequency basic ($f_{found.}$ = 561 [Hz]) and for her harmonic of the ship's propeller associated with the well-known work. Findings showed structures of hydroacoustic field, that of ship within the scope of the speed from 5 to 7 [kt] a growth of the noise level is appearing underwater from 10 [dB] to 15 [dB].

This occurrence is connected with hydrodynamic processes occurring on blades of the propeller.

In case of identifications of dominating sources of hydroacoustic waves generated by the ship equipped with two driving arrangements he is an issue compound. The presented ship is equipped with two driving arrangements and two ship's screws about the changeable jump.. Measurements hydroacoustic they made for the left and right driving arrangement and for two driving working simultaneously systems.. During measurements, the ship changed the speed by the change in the angle of inclination of blades of the ship's propeller. Noise of the ship were registered at the speed of by 4 knots up to 12 knots. Results from these measurements were presented in the form of the relation of the level of the hydroacoustic pressure in the function of the time of passing the ship by the sea training ground and frequencies. Analyses were performed using filters with resolution 1 / 24 octaves. Model results obtained from measurements of the right driving arrangement were presented in the Fig. 5.

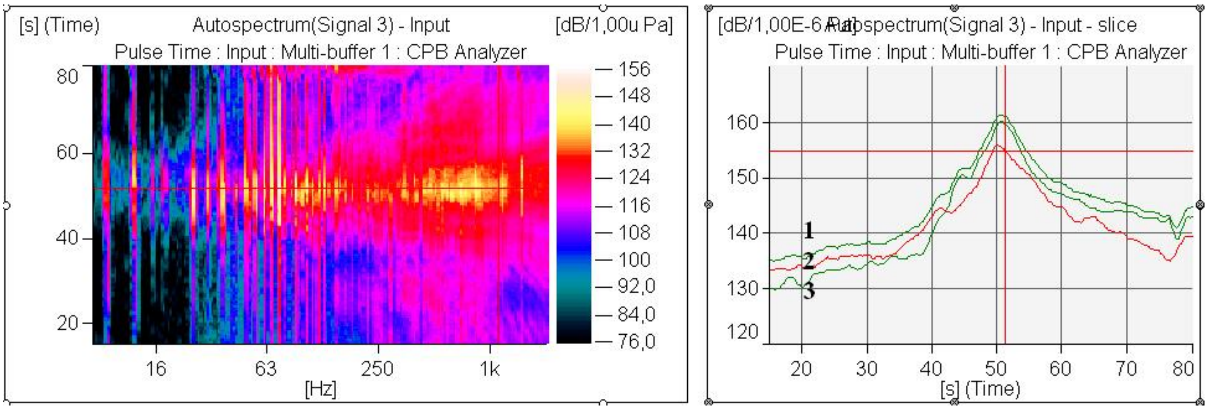

Fig.5. Noises of the right ship’s motor registered at the speed v= 9 [kt]. Hydroacoustics pressure level 1 – ship, 2 –ship's propeller, 3 – driving system

From the presented spectrogram spectres were selected in strips containing the waves associated with the noise level underwater of ship, with noise level cavitation of the propeller and the arrangement of the driving ship.. From received results of spectres relations of noise levels of the ship were carried out in the function of the speed of the ship. Relations carried out for the left driving arrangement were described to the Fig. 6.

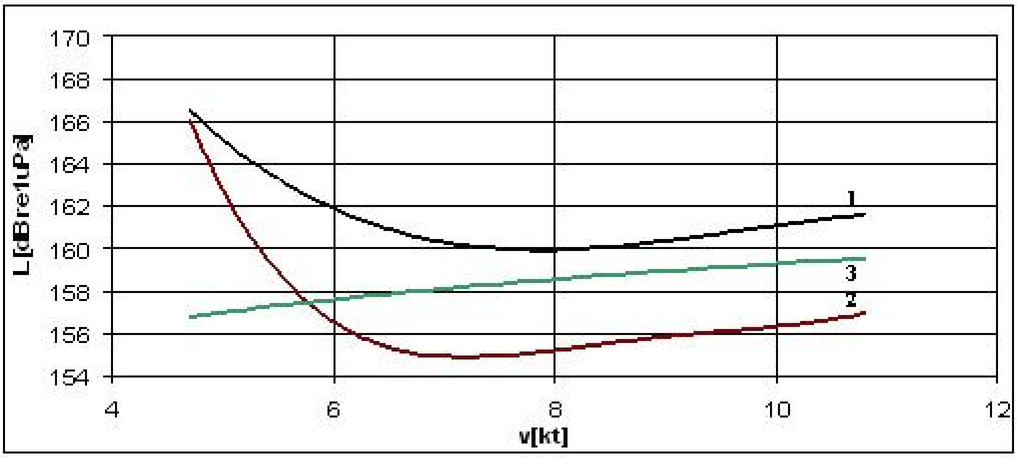

Fig.6. Dependences of noise levels in the function of the ship’s speed where: 1 – ship, 2 – cavitation of ship's propeller, 3 – driving system

To the purpose of the identification of a sound wave analysis of noises was performed while the most well-known worship of the ship was directly above the acoustic sensor. Spectre of noises of the ship flowing through the sea training ground with the speed v = 4.7 [ktn] they presented in Fig. 7. Performed analysis of underwater noises in the strip to 100 [Hz], with the resolution 0.25 [Hz], in the linear scale facilitated locating characteristic components of the spectre which are associated with the work of the driving arrangement. Additionally in the picture they marked harmonic (with blue lines) of basal frequency f_o = 6.118 [Hz] of work of this driving arrangement. In the analogous way an identification of characteristic components of the spectre was performed for remaining set the driving arrangement.

On account of the extensive amount of these materials in the report only a representative result of such analysis was presented.

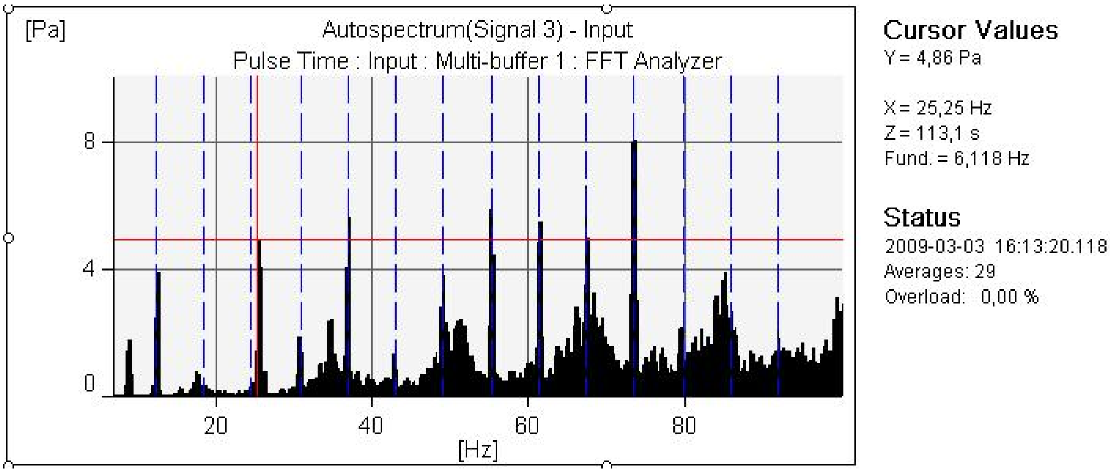

Fig.7. Example spectrum of ship's noise

3. CONCLUSIONS

In the paper there was shown that in the shallow sea an identification of hydroacoustic noises associated with working ship's driving systems is possible. Knowing dependencies between spectrum components allows to identify moving object and values of levels can be useful to evaluate the ship's technical conditions.

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