SETTING TIME PERIODS OF THE CONCENTRATION OF THE ACOUSTIC ENERGY GENERATED TO WATER BY SHIPS

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Generating the acoustic energy into the water environmental through the hull of the ship and the ship propeller usually remains in the frequency from the range of single hertz to a few or several kilohertz. In the range of the frequency that was analyzed there are discrete components that are connected with the work of ship's mechanisms as well as with broad-band "noise" that is relevant to phenomenon of cavitation that in some range of work of ship's propeller can mask discrete components connected for example with the work of the main engine. Fixing the ranges of frequencies in which the acoustic energy from ship's equipment are concentrated, can facilitate the remote diagnostics of the ship as well as its identification.

INTRODUCTION

The ships are not usually equipped with the devices for measurement of the acoustic emission into the water environment. Due to this matter ships have been tested periodically.
In the simple case the level of the acoustic emission in the range of the whole speed is specified. In the case of comprehensive estimation the composite characteristics of acoustic emission of signals are defined.
To make measurements more accurate and designate the part of concrete equipment or the group of equipment in the process of emission, the research was carried out on the two moving ships and their acoustic characteristics were compared in the range of similarities in the area of frequency in which the acoustic disorders are generated into the water environment.
To obtain possibility of reliable comparison of the acoustic characteristics of the ships in the purpose of separation the area of frequency in which with no doubt the disturbances from the concrete forces can be attributed, the two ships that differ in the construction of the hull and ship's propellers were tested.
In this case the initial research was carried out, and its results are presented in the following article.

1. THE METHOD OF THE RESEARCH

In the purpose of designation the concentration of the intervals of the energy that were generated into the water by ship's mechanisms, the spectrum analysis of vibrations generated by the two different ships. The units were navigated with different speed above the hydrophone that was situated in the ship's movement trajectory. Temporary values of the acoustic pressure were checked in and afterwards analysed.

2. SEPARATION OF THE ANALYSED RANGES

It was assumed that to separate the range of the frequency in which the basic vibration connected with the work of the main engine, hydrodynamic propeller pressure, work of shafts and cavitating ship's propeller dominated, it would be very profitable presenting them in the form of spectrograms of tested units.
In the picture no. 1 the spectrograms of the ships are definite respectively as second and first in the columns.
The following ranges of frequency during analysis of spectrograms were selected:

the frequency range from 3 to 2818 Hz the whole range of analysed frequencies,
the frequency range from 106 to 1029 Hz, was the range, in which dominated the vibration from working main and auxiliary mechanisms as well as cavitating ship's propeller
the frequency range from 3 do102 Hz connected with work of the shaft line, hydrodynamic pressure of the ship's propeller and work of aggregates of the action.

The method of the emissions of the analysed ranges is presented in the picture no. 2,
in the spectrogram of the ship, which was navigated at the speed of 3,5 [kt].
The levels of hydroacoustic pressure generated to water in the established ranges of analysis depended on the distance from hydrophone. They are presented in the picture no. 3.

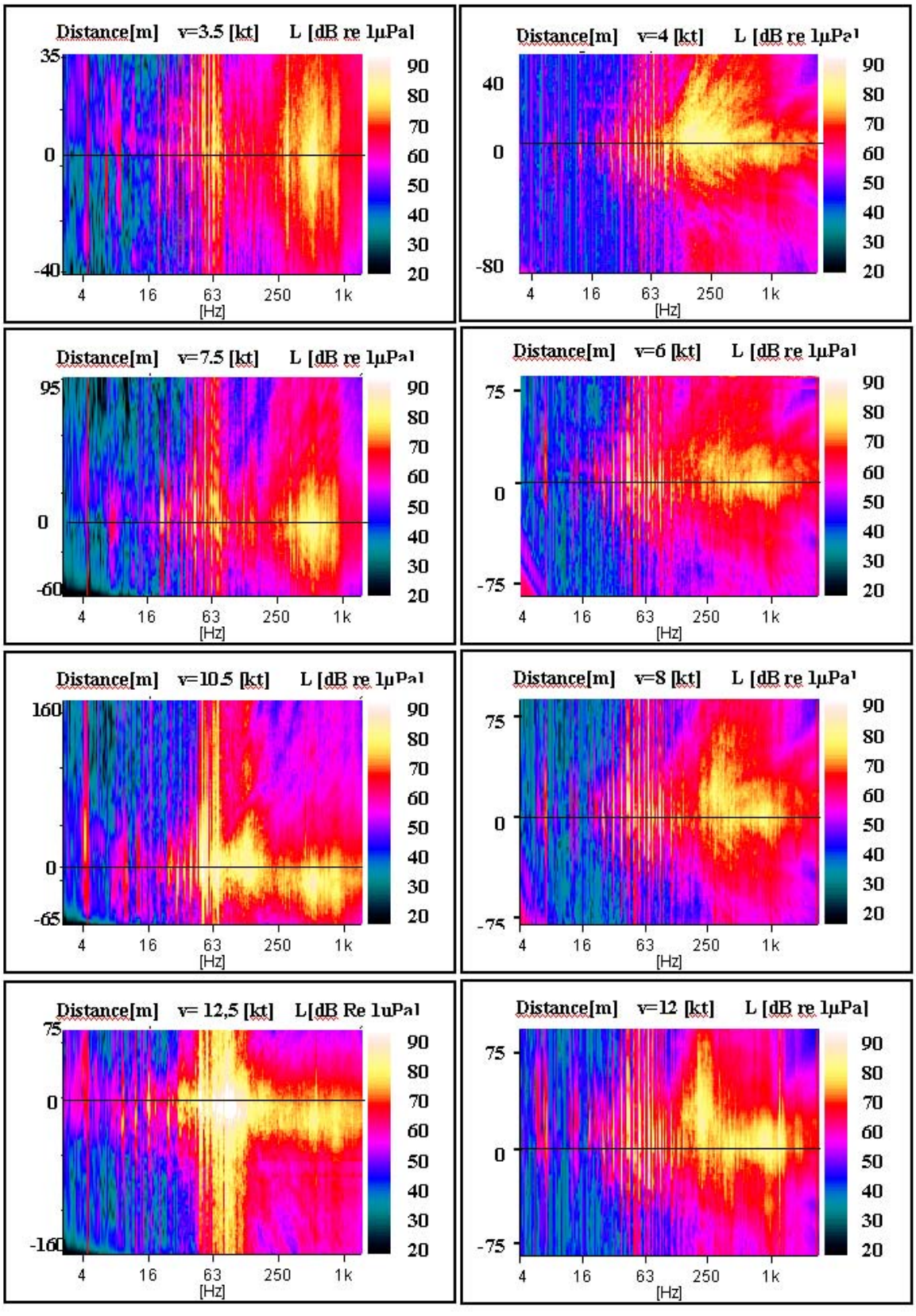
3. RESULTS

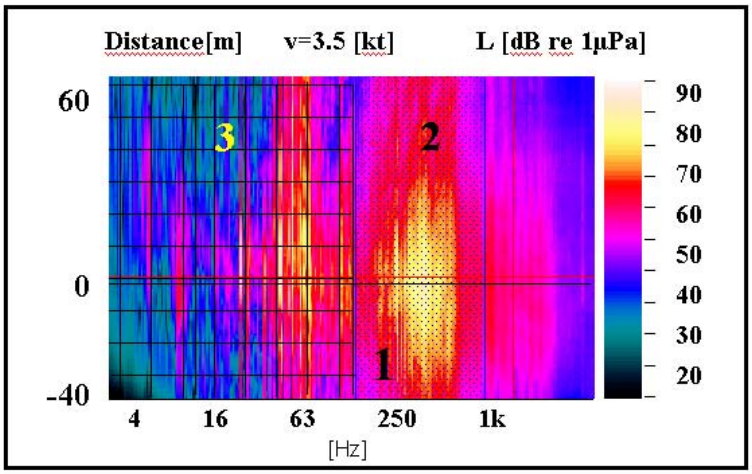
The results of the research of units no 1 and 2 are presented in the tables 4 and 5 as well as in the picture no 4. They present the influence of the value of the pressure in individual ranges of frequency at different speeds.

4. CONCLUSIONS

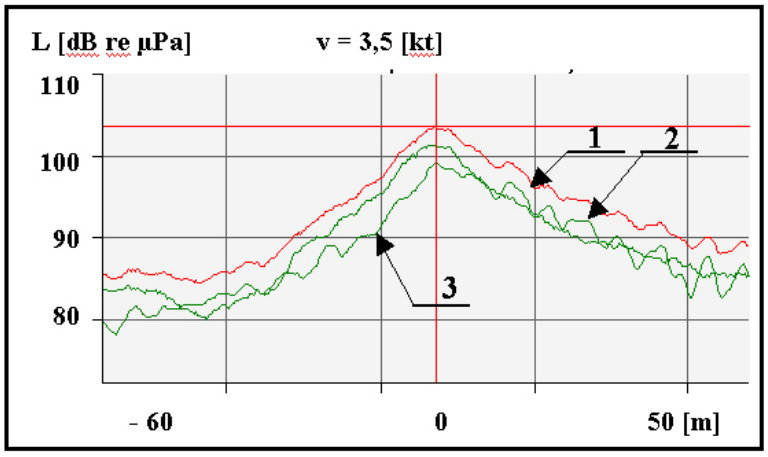
As it was expected the result of the conducted research of two ships differing with construction shows that they generate the different levels of under-water noise.
In comparision to the first unit, the second unit to the speed about 8 [kt] generates the lower level of hydroacustic pressure. The level of the underwater noise that is generated by the main and auxiliary mechanisms of the first unit is higher in the whole range of studied speeds.
Above the speed of 5 [kt] the level of underwater noise of four - blade ship's propeller is higher than three – blade what is caused by hydrodynamic phenomena of blades.
The concentration of energy of underwater noise of cavitating ship's propeller in the studied units appears in different ranges of frequency in comparable speeds.

The following stage of the research will be assigning the maximum of the distance from which the units possibly could be identified (in the range of frequency to 100 [Hz]) in respect of the level of the sea and the level of the acoustic background.

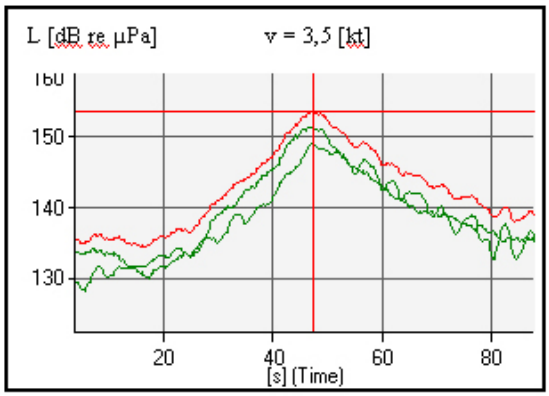

Distance[m] v=3.5 [kt] L [dB re 1µPa]
35
0
-40
4
16
63
250
1k
[Hz]
90
80
70
60
50
40
30
20
Distance[m] v=4 [kt] L [dB re 1µPa]
40
0
-80
Distance[m] v=7.5 [kt] L [dB re 1µPa]
95
0
-60
Distance[m] v=6 [kt] L [dB re 1µPa]
75
0
-75
Distance[m] v=10.5 [kt] L [dB re 1µPa]
160
0
-65
Distance[m] v=8 [kt] L [dB re 1µPa]
75
0
-75
Distance[m] v= 12,5 [kt] L[dB Re 1uPa]
75
0
-160
Distance[m] v=12 [kt] L [dB re 1µPa]
75
0
-75

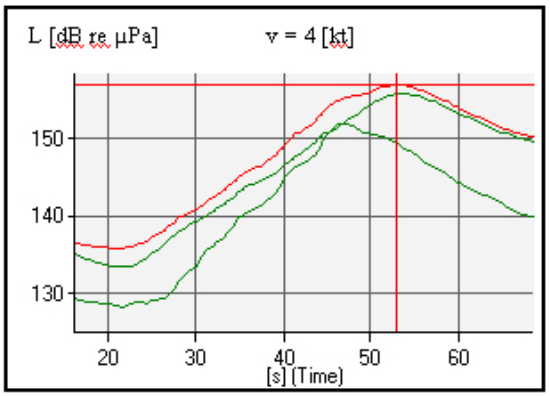


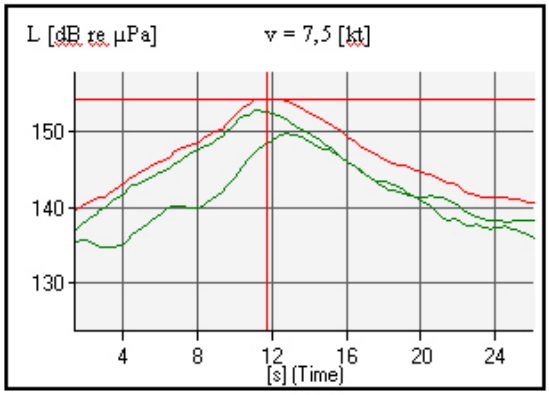
1. Range of frequency from 3 to 2818 [Hz],
2. Range of frequency from 106 to 1029 [Hz],
3. Range of frequency from 3 to 102 [Hz].

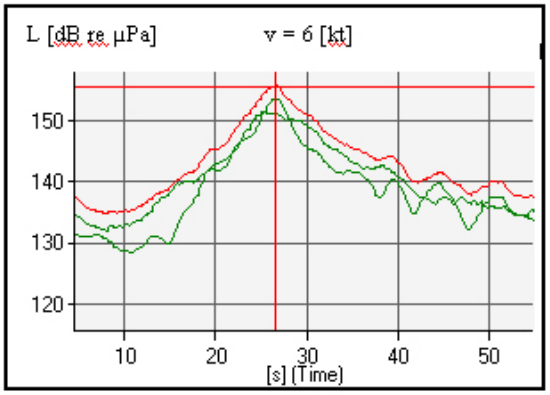


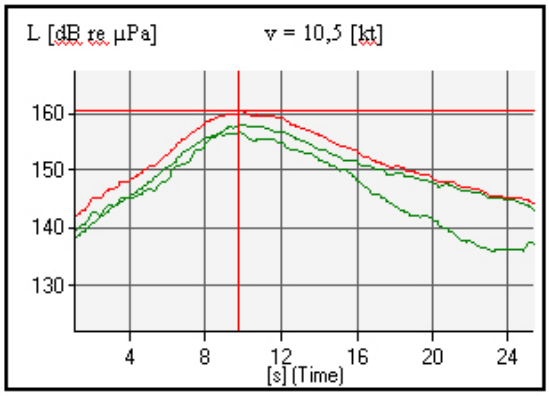
1. The level of underwater noise of the ship in the range of frequency from 3 to 2818 [Hz]
2. The level of underwater noise of ship's propeller in the range of frequency from 106 to 1029 [Hz],
3. The level of underwater noise of main and auxiliary mechanisms in the range of frequency from 3 to 102 [Hz].

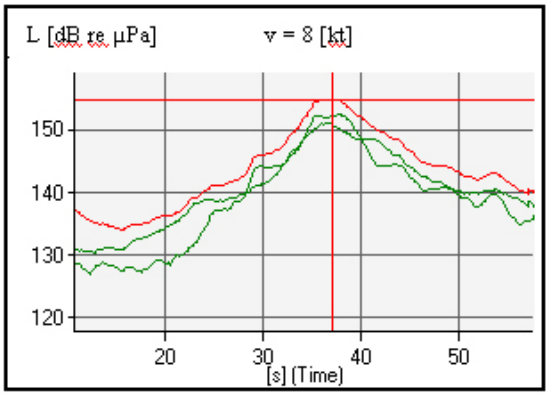

L [dB re µPa]
v = 3,5 [kt]
160
150
140
130
20
40
60
80
[s] (Time)

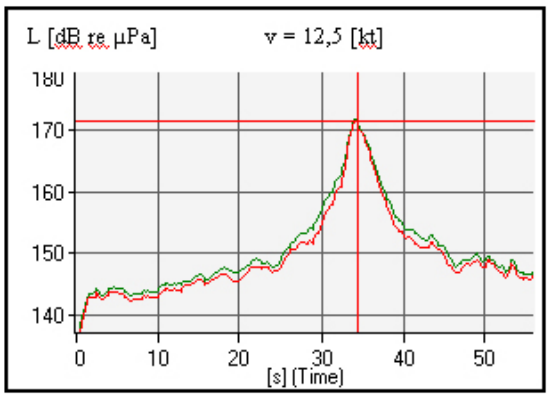

L [dB re µPa]
v = 4 [kt]
150
140
130
20
30
40
50
60
[s] (Time)

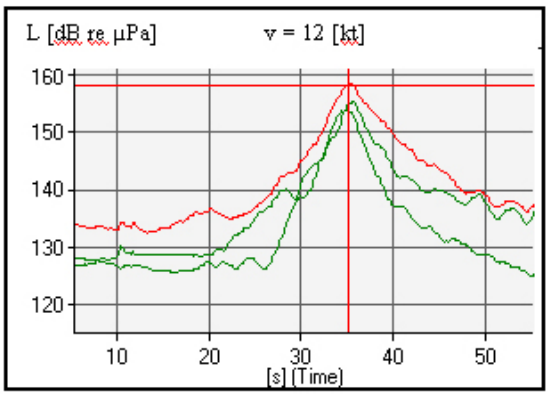

L [dB re µPa]
v = 7,5 [kt]
150
140
130
4
8
12
16
20
24
[s] (Time)


L [dB re µPa]
v = 6 [kt]
150
140
130
120
10
20
30
40
50
[s] (Time)


L [dB re µPa]
v = 10,5 [kt]
160
150
140
130
4
8
12
16
20
24
[s] (Time)


L [dB re µPa]
v = 8 [kt]
150
140
130
120
20
30
40
50
[s] (Time)


L [dB re µPa]
v = 12,5 [kt]
180
170
160
150
140
0
10
20
30
40
50
[s] (Time)


L [dB re µPa]
v = 12 [kt]
160
150
140
130
120
10
20
30
40
50
[s] (Time)

Tab.1

The source of the noise	**Ship 1**							
	v = 4 [kt]		**v = 6 [kt]**		**v = 8 [kt]**		**v = 12 [kt]**	
	L [dB]	f [Hz]	L [dB]	f [Hz]	L [dB]	f [Hz]	L [dB]	f [Hz]
The nosie of the mechanisms	152	3÷102	152	5÷115	153	3÷163	155	3÷100
The noisc of cavitation propeller	156	156÷1029	151	133÷1830	151	177÷1728	155	158÷1296
The nosie of the unit	157	3÷2818	154	3÷2818	155	3÷2818	158	3÷2818

Tab.2

The source of the noise	**Ship 2**							
	v = 3,5 [kt]		**v = 7,5 [kt]**		**v = 10,5 [kt]**		**v = 12,5 [kt]**	
	L [dB]	f [Hz]	L [dB]	f [Hz]	L [dB]	f [Hz]	L [dB]	f [Hz]
The nosie of the mechanisms	149	4÷91	149	5÷102	152	3÷77		
The noisc of cavitation propeller	151	266÷971	153	281÷971	156	80÷1728	171	158÷1296
The nosie of the unit	153	3÷2818	154	3÷2818	160	3÷2818	171	3÷2818

Pic.1 Spectrograms of the ships respectively in the second and first columns.
Pic.2 The division of the range of frequencies that are registered
Pic.3 The levels of the underwater noise of the ship in the selected range of frequency
Pic.4 The levels of acoustic pressure of the ships respectively in the second and the first column

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