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The Study of the Propulsion System of a Ship, the Choice of the Optimal Operating Mode Regarding the Efficiency of the Propeller

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ABSTRACT : In the paper, the study of an oil tanker type ship is carried out, on board which we performed the measurements that we used in the calculation. The propulsion factors for several operating regimes were analyzed. The operating regime of the vessel is determined, which has the maximum propeller efficiency. The results obtained for the propulsion factors at several operating regimes are presented, considering the race with load.

KEYWORDS: Deadweight, diesel engine, propulsion factors, ships, the power of the engine,

I. INTRODUCTION

Safety, pollution prevention and living and working conditions on board ships can be effectively improved by drastically reducing the number of substandard ships sailing in Community waters through the strict application of international conventions, codes and resolutions. [1] Ships must be built in accordance with good shipbuilding practices. [3] By naval propulsion installation is defined the complex formed by the main and auxiliary machines, which have the role of transforming the energy contained in the fuel into energy: thermal, mechanical, electrical and hydraulic. The purpose of the propulsion system on a ship is to convert fuel energy into useful thrust to propel the ship.[10] Transporting oil can have negative effects on the environment. Oil pollution is a real danger to the planet. Oil pollution can be prevented by strict compliance with the law in force. [11] The International Convention for the Prevention of Pollution from Ships (MARPOL) aims to prevent pollution from ships.[12]The standards for discharges of polluting substances are based on the Marpol Convention 73/78. [2],[12]

PROPULSION FACTORS CONSIDERING THE RACE WITH LOAD :

Current marine diesel engines are characterized by increasing power for the same design dimensions of engines. During the march, the studied ship was subjected to numerous tests and measurements. Increasing the power of a diesel engine can be done by increasing the amount of fuel injected into the combustion chamber of the engine.
The characteristics of the studied ship [7]
-engine power: 9480 [KW], 127 [rpm], with 6-cylinder.
-deadweight in the sea water is 37000tdw
- the tanker is equipped with a propeller.
D = 500 [mm] the cylinder bore
S = 2[m] the stroke of the piston
Vt = 0,428[m^3] - the total volume of the cylinder

The engine must cope with the variations in the power consumed by the propeller, due to the state of the sea, different loading situations, or operation in transient mode (maneuvers in port).

Table 1. Principalele Caracteristici ale Navei [4,6]

Parameter	U.M.	Value
Lmax - the length of the ship	[m]	179,960
L_{WL} – the length at the waterline	[m]	178,880
B – the maximum width	[m]	32,2
D - the construction height of the ship	[m]	16,5
T_j - the ship's draft	[m]	10,5
∇ - the volume of the hull	[m^3]	48744
D_W - deadweight-ul	[t]	37000
the number of the crew	members	31

Figure 1 shows the engine loading diagram.

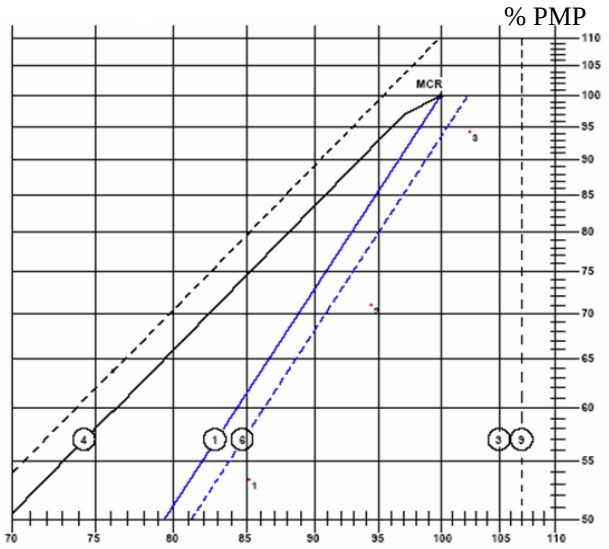

Figure. 1. Engine loading diagram

Table 2. The Power of the Propulsion Engine

Nr.crt.	n_m [rot/min]	v_m [Nd]	P_{MP} [kW]
1	94,38	12,00	4019
2	103,96	13,00	5150
3	113,54	14,00	6684
4	123,12	15,00	8572
5	132,70	16,00	11276

Table 2 shows the power of the propulsion engine for five operating modes analyzed.
The engine power (P_{MP}) for the operating modes analyzed is presented.
P_{MP} [kW] - the power of internal combustion engine;
n [rot/min] - internal combustion engine rotation,
c – constant;

It is necessary to understand the performance characteristics of the chosen propulsion system because they determine the overall operation and efficiency of the propulsion system. .[9] The total forward resistance of the studied ship is formed by a number of different components, by a variety of factors. These components interact with each other in a rather complex way.

Tabel 3. Resistance to forwarding of the ship

Nr. crt.	The speed v [Nd]	R_t [kN] (full load)
1	12	390,400
2	13	463,870
3	14	541,370
4	15	636,780
5	16	753,360

In table 3 are presented the results obtained for the forward resistance of the ship for five operating regimes analyzed. It is considered the race with the load. The factors that drive research and investigation into improving the overall efficiency of the propulsion of ships are both economic and environmental. [8]

Rt [kW] - is an important parameter that depends on the power of the propulsion system.

Figure 2 shows the dependence of the power of the main engine represented as a function of the ship's speed.[7]

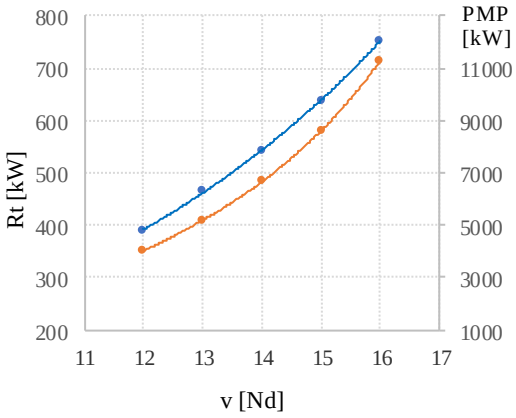

Figure. 2. Power of the propulsion engine

II. THE RESULTS OBTAINED

The results obtained after the calculation were listed in table 4.

Table 4. Figure 5. Parameters obtained for five operating regimes

Nr. Crt.	**Speed of the ship**	**The efficiency of the propeller**	**The towing power of the vessel**	**The power required to drive the propeller**
	v [Nd]	η_0	Prem [kW]	Pel [kW]
1.	12	0,6151	2409,861	3344,740
2.	13	0,6367	3101,991	4286,128
3.	14	0,6738	3898,730	5562,382
4.	15	0,6893	4913,394	7133,322
5.	16	0,6682	6200,454	9383,892

P_m - engine power at the coupling flange with the line of shafts

$P_m > P_{el} > P_{rem}$

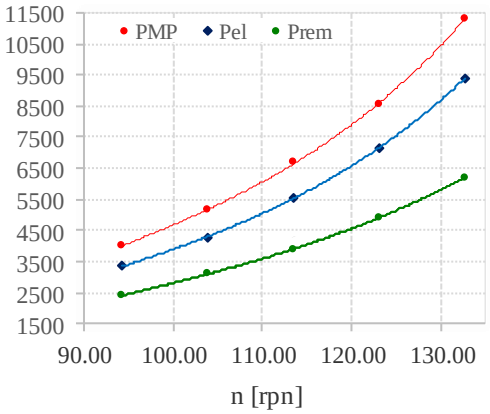

Figure 4. Dependence of the main parameters depending on the engine speed

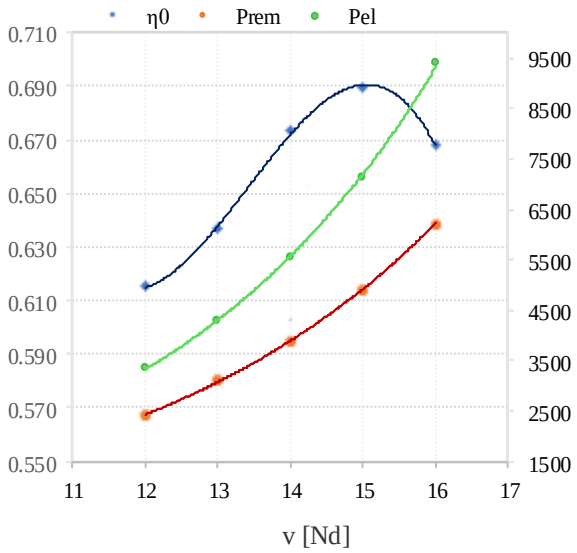

Figure 5. The parameters obtained Pel, Prem, η_0

Figure 5 shows the efficiency of the propeller for five operating modes analyzed.
It is represented as a function of the ship's speed v [Nd]. Figure 5 also shows Prem and Pel.

III. CONCLUSION

The maximum yield was obtained for the operating regime that has a speed of 15 Nd; Rt = 636,780 [kW]. At this operating mode, the power of the propulsion engine is 8572 [kW]. The power required to actuate the propeller is Pel =7133,322 [kW]. From the operating regimes analyzed, the regime at which the ship operates with maximum efficiency v=15 [Nd] was chosen.

The ship must operate according to an optimal operating regime for low fuel consumption.
The results obtained from the calculation are very close to the results of the basin samples.

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