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"Application of Integrated Propulsion Systems for Improving the Dynamical Performance of a Frigate"

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SUMMARY

This project consists of the engineering propulsion plant of a type of warship which is the frigate, by which all existing combined propulsion systems will be developed, which will be studied on which type of system will be most suitable for a modeled frigate, so it can perform well. As naval engineering students seek to familiarize themselves with the warships that every navy presents, first it's intended to focus on the propulsive part of this type of craft. Finally, it was concluded that the type of combined system to be installed in the frigate dimensioned is the CODOG type, which analysis will be presented in this work, also saying that it must supply a power of propulsion calculated by the analytical method Slender Body of resistance to advance, through computational means.

1. INTRODUCTION

The development of this project implies being able to know and investigate closely on the combined propulsion systems that are suitable for large vessels, one of them being frigates, it would be very important to know this subject for The maritime armies of the countries and especially Peru, also for us as students of the naval engineering career it is very important to know about the design, layout and operation of the frigates, especially those belonging to the Peruvian Navy, Which triggers a concern to know these vessels, and thus also motivates to participate in such projects in the naval field.

For the development of this project, it is to find the optimal combined propulsion system for a frigate designed model, the objective is to find the arrangement of the propulsion plant of this type of vessel, in order to propose the dimensions based on a design established, with the purpose of obtaining an optimum performance, and also of the development of the propulsive plant choosing the type of combined system that will make that its performance is the best one.

HISTORY

The old frigates were escort ships, combat and warning, of smaller size and artillery that the ships of line, but faster. They began their apogee during the eighteenth century, although the first appeared in the previous century.

During that century, the frigate used to displace between 200 and 300 tons, had no more than two decks, and as a rule, only one of them was artillery, with a total of pieces that rarely exceeded 30, although in some cases it reached 50.

At the end of the century and beginning of the nineteenth they increased their displacement to 800 and 1,200 tons, and in 1830 they surpassed 1,500, becoming the main units of almost all the navy. Having thus an artillery that used to carry from 11 to 48 guns in one or two batteries, they were manned by 200 or 300 men.

Being very important his participation in the fight against corsairs by its speed; To attack the enemy's traffic in case of war and in the largest and best prepared units to fight to the aid of line ships; At a time when there were no radars or radios to know where the danger might be.

Frigate Lupo of the Peruvian Navy

2. PROBLEM

A study about combined systems is proposed due to the fact that every war vessel must perform a high propulsion performance and that this is the most effective during the combat or to make its flight plan, the frigates of the navy Peruvian are Lupo type frigates that are old Italian designs, the problem is that the propulsion system should be optimized by applying the combined systems, thus presenting the problem of the lack of modernization in the aspect of propulsive plant due to the antiquity of the designs, Resulting in poor performance for what is currently required.

3. OBJECTIVES

General:

- Establish the type of combined system for a frigate, which ensure its optimal performance.

Specific:

- Establish the frigate dimensions based on a parametric study.
- Develop the frigate model using Maxsurf.
- Calculate the advance resistance of the frigate.
- Establish the type of the propulsión combined system.
- Define the arrangement of the system in the machine room.

4. DESCRIPTION OF THE SOLUTION

Based on the combined system analysis, which follows:

SYSTEM	ADAVANTAGES	DISADVANTAGES
CODOG	Easy transition between cruising speed and high speeds. Low level of vibration and noise at high speeds.	High weight on board by equipment. High price for a minimum time of operation.
CODAG	Better weight / power ratio and less space required than an equivalent diesel engine system.	Heavy and complex transmission systems.
COGAS	Constant operation. Excellent weight / power ratio.	Very high air / fuel ratio. Performance depending on the pressure ratio.
COSAG	One of the first combinations of propulsive systems.	It is not currently used for installation complications.

Through the following table, the components of all the mentioned combined systems are analyzed:

	PLANTS WITH DIESEL ENGINES	STEAM PLANTS	PLANTS WITH TAG
Weight/Power Ratio (lb/HP)	3	15	0.28
Installation Cost	$ 90/BHP	$ 170/BHP	$ 120/BHP
Specific fuel consumption (lbs / hr-SHP)	0.3-0.42	0.45-0.55	0.41-0.8
Specific fuel consumption (max speed)	0.34	0.55	0.41
Time required to put the plant in service Hrs.	4	8-10	0.1
Comments	Max. Power Limit 60000 SHP 20000 SHP	Max. Power Capacity 280000 SHP per Shaft	Light and Compact

Taking the following requirements for the selection for a warship in this hull a frigate:

- Its mission of surveillance, block, arrest and inspection of all types of ships makes it characteristic.
- They need to possess attack power and enough speed, as they are equipped in some way with attack or defensive missiles.

For the study, the four LUPO class Peruvian frigates in operation were: BAP Mariategui, BAP Aguirre, BAP Palacios and BAP Villaviciencio, which present the following combined propulsion system.

The four frigates mentioned above employ the same engineering plant which consists of:

COMPONENTS		POWER (HP)	SPEED (KNOTS)
TURBINE	2 FIAT-GENERAL ELECTRIC LM-2500	50000	34
DIESEL	2 GRANDI MOTORI TRIESTE BL-230-20M	7800	21

Based on this, the following combined system is defined, as well as the minimum amount of power at which it must operate, that power value was obtained from an analysis of resistance to the advance of the frigate hull that was modeled in Maxsurf, evaluating with the method Slender Body.

5. RESULTS

Inquiring about the propulsive equipment for the corresponding selection and fulfilling the power, the following is proposed:

Use a combined CODOG system to be the most appropriate for weight and speed reasons for frigates.

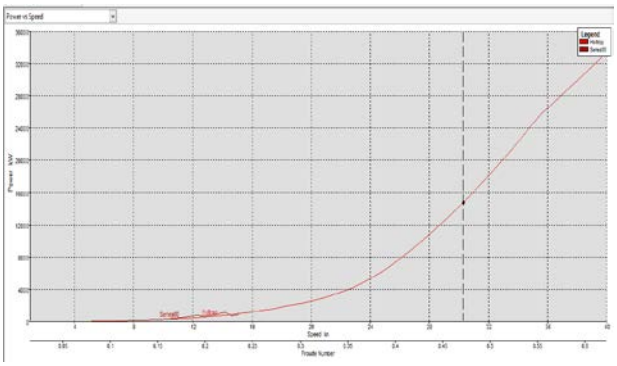
Frigate main characteristics:

LENGTH	115.00 m.
BREADTH	12.OO m.
DEPTH	8.50 m.

From the run in the MAXSURF the following strength and power values are obtained for the following speeds.

VELOCITY (KNOTS)	RESISTANCE (KN.)	POWER (HP)
10	46.6	314.51
20	260.6	3685.60
30	945.1	19723.10
40	1625	44841.31

In addition, the following speed vs. power graph analyzed by software will be shown below.

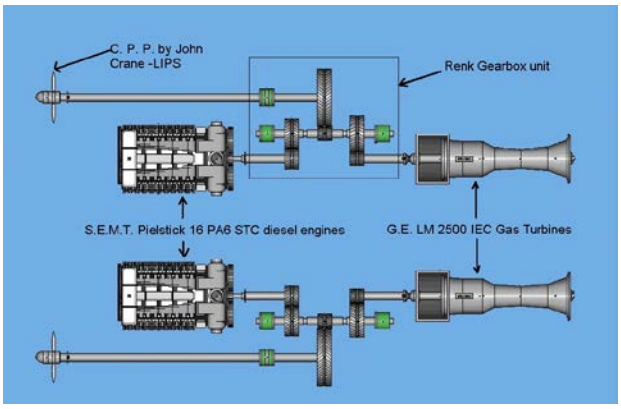


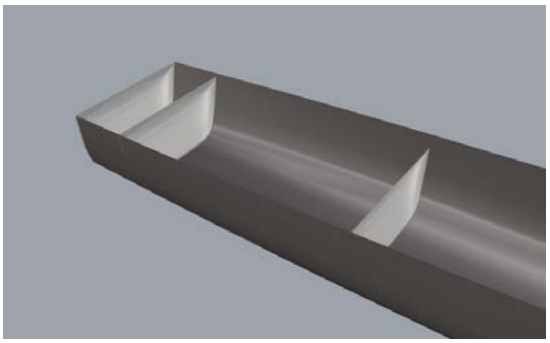
This graph represents the curve obtained by using the software maxsurf module resistance, which was analyzed by applying the analytical method of Slender Body, which gives us a good approximation of the power of propulsion that the boat needs.

Since it was decided to install a CODOG system, it should be defined at what speeds the DIESEL engine would be used and at what speeds the turbine would be used.

The practice supports the use of diesel engine at cruising speed, which for our frigate is 25 Knots, after that speed is necessary to use the turbine, and to leave aside the DIESEL.

Making an arrangement of the propulsion system, this will be the following:





6. CONCLUSIONS

1. In the design of frigates the need for speed and power are the main requirements that are met, even these are more important than the stability of the ship.

2. Unlike the traditional vessels (fishing boats, tugs, containers, etc.), the frigates include as part of their propulsive system a turbine, this is due to the speed requirements that must reach a number of rpm.

3. CODOG systems have the peculiarity of reaching their cruising speed using DIESEL engines, but if you want to achieve their maximum speed it is advisable to use the turbine for a subject of fuel consumption, rpm, and power. Under no circumstances do you work with the DIESEL engine and turbine at the same time.

4. The CODAG system comes in response to the need of most boats to use the DIESEL engine for all speed conditions. Which is one of the disadvantages of the combined CODOG system that reaches its maximum speed using only the turbine. However, the CODOG system is used because of its low maintenance costs and because it is lighter.

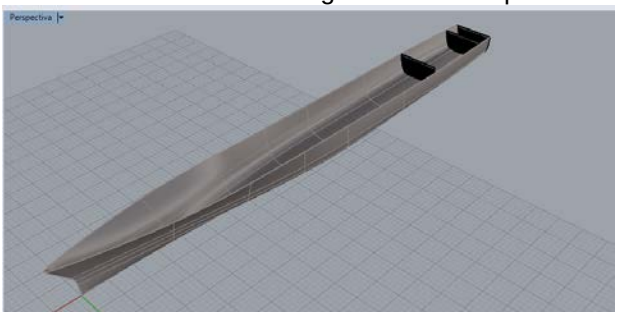
INFORMATION SOURCES

- https://www.ecured.cu/Fragata_(Barco)
- http://base.mforos.com/862753/3943205-las-fragatas-tipo-lupo/?pag=2
- http://maquina-de-combate.com/blog/?tag=fragata-lupo
- http://buquesarmadaperu.blogspot.pe/

ANNEXES

ANNEXE 1

The model hull with its engine room compartment.



ANNEXE 2

The hull in its analysis of resistance by waves, at a speed of 10 knots.