UNIVERSIDADE DA CORUÑA

Escola Politécnica Superior

Trabajo Fin de Grado
CURSO 2020/2021

ATUNERO CONGELADOR DE 2000 m^3

Grado en Ingeniería Naval y Oceánica

ALUMNA/O

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TUTORAS/ES

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FECHA

SEPTIEMBRE 2021

1 RPA

GRADO EN INGENIERÍA NAVAL Y OCEÁNICA

TRABAJO FIN DE GRADO

CURSO 2.020-2021

PROYECTO NÚMERO 2021-GENO-11

TIPO DE BUQUE: Atunero congelador de 2000 m^3

CLASIFICACIÓN, COTA Y REGLAMENTOS DE APLICACIÓN: DNV, Marpol,Torremolinos

CARACTERÍSTICAS DE LA CARGA: Atún que se procesará y se congelará en tanques.

VELOCIDAD Y AUTONOMÍA: 14 knots con autonomía para 37 días

SISTEMAS Y EQUIPOS DE CARGA / DESCARGA: Plumas en babor y estribor para la carga y descarga de la pesca

PROPULSIÓN: Motor diésel

TRIPULACIÓN Y PASAJE: 35 tripulantes

OTROS EQUIPOS E INSTALACIONES: constará de una panga para la realización del arte del cerco.

Ferrol, 15 septiembre 2021

ALUMNO/A: **Dª Gastón Manuel Mercado Roasso**

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Cuaderno 6

PREDICCIÓN DE LA POTENCIA PROPULSORA Y DISEÑO DE PROPULSOR Y TIMÓN

INDICE

2 TÍTULO Y RESUMEN

Título: Atunero congelador de 2000 m^3

El proyecto consistirá en el diseño general de un atunero congelador de 2000 m^3, con una velocidad de diseño de 14 nudos, de propulsión diésel y para navegar 37 días.

Los temas fundamentales a tratar serán: elección de la cifra de mérito y definición de alternativas, seleccionando la más favorable; el cálculo de pesos y centro de gravedad del buque; el diseño de las formas; los cálculos relacionados con la arquitectura naval; las situaciones de carga; predicción de potencia propulsora y diseño del propulsor y del timón; la disposición general; la cuaderna maestra; el francobordo y arqueo; definir la planta propulsora y sus equipos auxiliares; la planta eléctrica; los equipos y servicios auxiliares del buque; y finalmente, se calculará el presupuesto de la construcción del buque.

Título: atuneiro conxelador de 2000 m^3

O proxecto consistirá no deseño xeral dun atuneiro conxelador de 2000 m^3, cunha velocidade de 14 nudos, de propulsión diésel y para navegar 37 días.

Os temas fundamentais a tratar serán: elección da cifra de mérita e definición de alternativas, escollendo a máis favorable; o cálculo de peso e centro de gravedade do buque; o deseño das formas; os cálculos relacionados coa arquitectura naval; as situación de carga; predicción da potencia propulsora e deseño do propulsor e timón; a disposición xeral; a caderna maestra; o francobordo e arqueo; definir a planta propulsora e os seus equipos auxiliares; a planta eléctrica; os equipos e servizos auxiliares ao buque; e finalmente, calcularase o orzamento da construción do buque.

Title: 2000 m^3 freezer tuna vessel

The project will consist of the general design of a 2000 m^3 freezer tuna vessel, with a design speed of 14 knots, diesel propulsion and to sail 37 days.

The fundamental issues to be discussed will be: choice of the figure of merit and definition of alternatives, selecting the most favorable; weight calculation and center of gravity of the ship; forms design; calculations related to naval architecture; loading situations; thruster power prediction and thruster and rudder design; general arrangement; master frame; freeboard and tonnage; propulsion plant definition and its auxiliary equipment; power plant; ship´s auxiliary equipment and services; and finally, the budget for the construction of the ship will be calculated.

3 INTRODUCCIÓN

El buque proyecto con número 21-11 consiste en un atunero congelador con una capacidad total de cubas de 2000 m^3 con el objetivo de operar en la zona del mar del norte para la pesca del atún mediante redes de cerco. Las cubas irán dispuestas en la parte central del buque distribuidas 9 a babor y 9 a estribor y, mediante un sistema de refrigeración por tuberías, se congelará el atún en seco mediante salmuera. La habilitación será de 35 personas y la propulsión será tipo diésel, con una velocidad de diseño de 14 nudos, para dar una autonomía de 37 días. Dispondrá de embarcaciones auxiliares para la ayuda en la operación de pesca, como son la panga y tres botes rápidos.

Las características principales del buque son:

Lo.a(m)	85,75
Lpp(m)	71
B(m)	14,9
T(m)	7
Dcp(m)	7,16
Fn	0,273
CB	0,63
CM	0,989
CP	0,638
Δ(t)	5032
v(kn)	14

Tabla 1 "Características del buque"

En este cuaderno se procederá a calcular la potencia que requerirá el buque proyecto, obteniendo así el motor principal que se instalará. Para ello, se calculará la resistencia al avance con el fin conocer qué potencia es necesaria para superar dicha resistencia. Posteriormente, se realizará el diseño del timón y de la hélice que llevará el atunero, y se realizará un croquis de la parte del codaste, de manera que se cumplan los requisitos requeridos por el reglamento DNV.

4 CÁLCULO DE RESISTENCIA

La resistencia al avance de un buque es la fuerza que se opone al movimiento de este en el agua a una determinada velocidad y estará condicionada por las dimensiones y formas del buque. Se calculará para la velocidad establecida en las RPA, que será de 14 nudos. Para ello, se utilizará el programa NavCad, con el cual también se obtendrá la potencia propulsora, utilizando los datos obtenidos del cuaderno 3 “Diseño de Formas”, el perfil de buque proyecto para obtener algunas medidas y la curva de área seccionales.

- **Tabla de hidrostáticas obtenidas del cuaderno 3:**

TABLA HIDROSTÁTICAS		
Desplazamiento	5032	t
densidad	1,025	t/m3
Volumen	4909,454	m3
Calado	7	m
Eslora en la flotación	74,595	m
Manga	14,881	m
Área mojada	1692,223	m2
Max sect. Area	101,213	m2
Coeficiente prismático (Cp)	0,65	
Coeficiente de bloque (Cb)	0,632	
Max Sect. area coef. (Cm)	0,976	
KB	3,899	m
KG fluid	0	m
BMt	2,611	m
BML	64,467	m
GMt corrected	6,51	m
GML	68,365	m
KMt	6,51	m
KML	68,365	m

Tabla 2 "Tabla de hidrostáticas"

- **Datos obtenidos a partir del perfil, de la planta y de la vista transversal del buque proyecto:**

1. Nariz del bulbo medida desde el espejo de popa, 81.106 m
2. Altura del bulbo desde la línea de flotación, 3.48 m
3. Semiángulo de entrada, 27º
4. Área de la estampa, 0.75 m^2
5. Manga sumergida de la estampa, 6.3 m
6. Inmersión de la estampa, 0.165 m

Otros datos a tener en cuenta son el área del bulbo, que se obtendrá de la curva de áreas seccionales obtenida a través del programa MaxSurf, la parte de popa que tendrá una

forma de “U” y la parte de proa que será en forma de “V”. Con todos estos valores obtenemos la gráfica de Resistencia-Velodidad:

Vessel drag	Calc	ITTC-78 (CT)
Technique:		Prediction
Prediction:		Holtrop
Reference ship:		
Model LWL:	[m]	
Viscous		
Expansion:		Standard
Friction line:		ITTC-57
Hull form factor:	On	1,256
Speed corr:	On	
Spray drag corr:	Off	
Corr allowance:		ITTC-78 (v2008)
Roughness [mm]:	Off	
Catamaran		
Interference:	Off	
Added drag		
Appendage:	Calc	Percentage
Wind:	Off	
Seas:	Off	
Shallow/channel:	Off	
Towed:	Off	
Margin:	Calc	Hull + added drag [10...

Ilustración 1 "Datos de resistencia en NavCad"

General		
Length on WL:	74,600	m
Max beam on WL:	14,900	m
Max molded draft:	7,000	m
Displacement:	5032,00	t
Wetted surface:	1692,2	m2
Demi-hull spacing:		m
ITTC-78 (CT)		
LCB fwd TR:	36,726	m
LCF fwd TR:	31,101	m
Max section area:	101,2	m2
Waterplane area:	892,0	m2
Bulb section area:	13,5	m2
Bulb ctr below WL:	3,480	m
Bulb nose fwd TR:	81,106	m
Imm transom area:	0,8	m2
Transom beam WL:	6,300	m
Transom immersion:	0,165	m
Half entrance angle:	27,00	deg
Bow shape factor:	1,0	[WL flow]
Stern shape factor:	-1,0	[BTK flow]

Ilustración 2 "Características de resistencia en NavCad"

- **Método**: el método utilizado es el método Holtrop debido a que es el más utilizado en los buques pesqueros. Entre los diferentes métodos que tiene el programa para el cálculo de la resistencia, se encuentra este método, el cual es considerado como uno de los mejores. Además, se utiliza la línea de fricción ITTC-78.

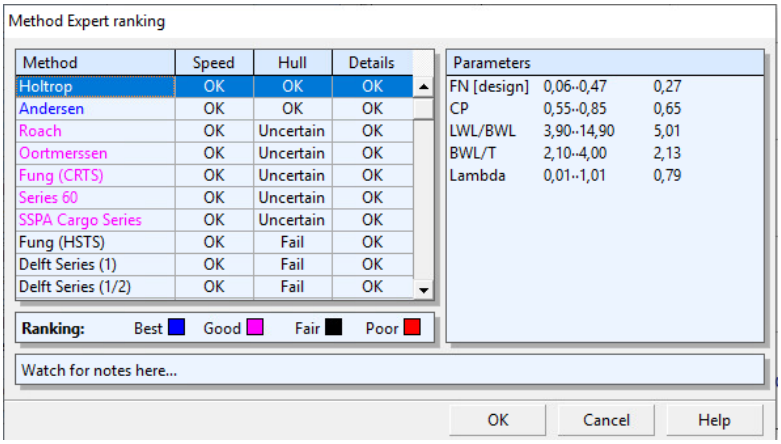


Ilustración 3 "Método Holtrop"

- **Apéndices**: en los apéndices se recogen los elementos del buque ajeno al casco, que favorecerán a incrementar la resistencia al avance. Como se tiene datos suficientes para definirlos con precisión, se estable un 5% del total.

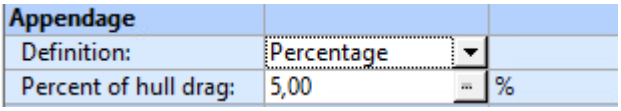


Ilustración 4 "Apéndices NavCad"

- **Margen**: el margen de mar establecido es del 10%

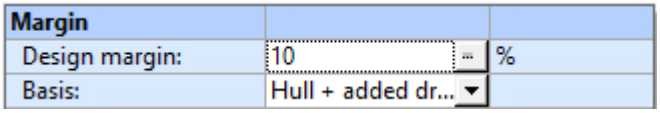


Ilustración 5 "Margen de mar NavCad"

- **Aerodinámica**: el área que se opone a la resistencia al avance será el área transversal del buque.

Edit: Environment

Wind		
Wind speed:	0,00	kt
Angle off bow:	0,00	deg
Gradient correction:	Off	
Exposed hull		
Transverse area:	95,8	m2
VCE above WL:	0,000	m
Profile area:	0,0	m2
Superstructure		
Superstructure shape:	Cargo ship	
Transverse area:	22,8	m2
VCE above WL:	0,000	m
Profile area:	0,0	m2
Seas		
Significant wave ht:	0,000	m
Modal wave period:	0,0	sec
Shallow/channel		
Water depth:	0,000	m
Type:	Shallow water	
Channel width:		m
Channel side slope:		deg
Hull girth:		m

Ilustración 6 "Aerodinámica NavCad"

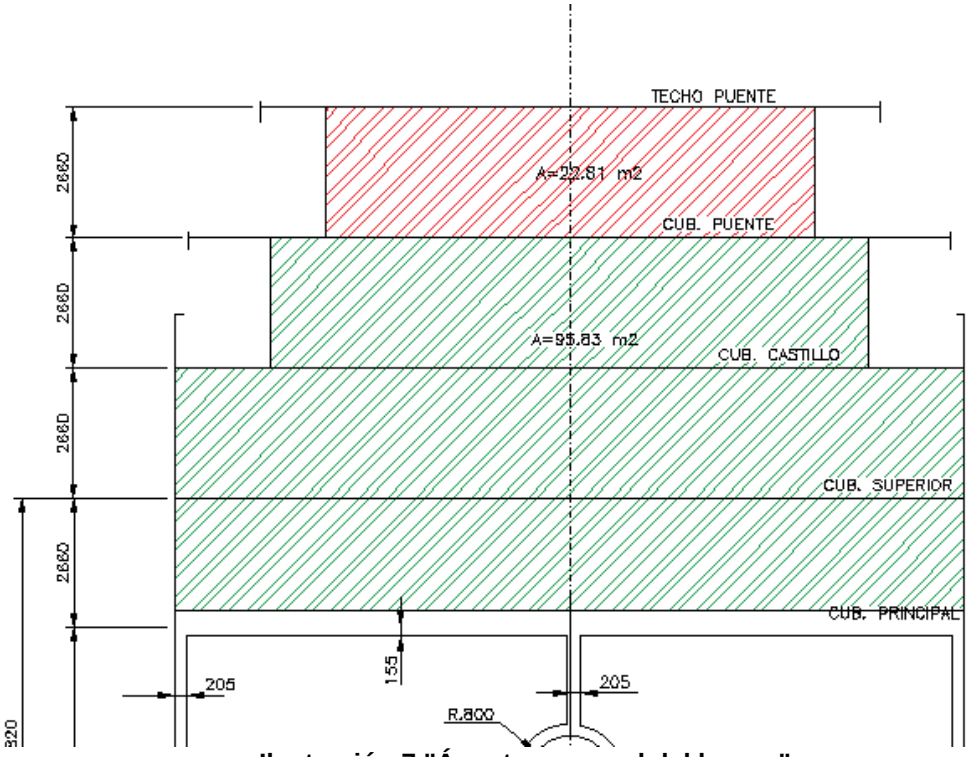


Ilustración 7 "Área transversal del buque"

Con esto, la gráfica obtenida es:

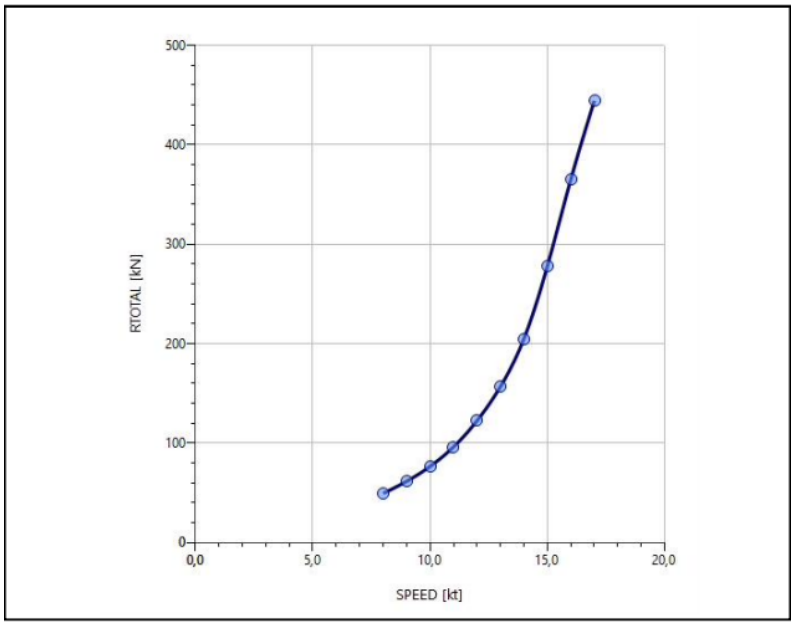


Ilustración 8 "Gráfica resistencia al avance"

En el Anexo I se muestran los resultados obtenidos.

5 ESTIMACIÓN DE LA POTENCIA PROPULSORA

En este apartado se estimará la potencia propulsora necesaria para vencer la resistencia anteriormente calculada. Para ello, se necesitará conocer el diámetro de la hélice, la inmersión de esta medida desde la línea de flotación y otros datos que se muestran a continuación, obteniendo así la gráfica Potencia-Velocidad:

Hull-propulsor	Calc	
Technique:		Prediction
Prediction:		Holtrop
Reference ship:		
Max prop diam:	[mm]	4600,0
Corrections		
Viscous scale corr:	Off	
Rudder location:		
Friction line:		
Hull form factor:		
Corr allowance:		
Roughness [mm]:	Off	
Ducted prop corr:	Off	
Tunnel stern corr:	Off	
Effective diam:	[m]	
Recess depth:	[m]	
System analysis		
Cavitation criteria:		Keller eqn
Analysis type:		Free run
CPP method:		Fixed RPM
Engine RPM:		750,0
Mass multiplier:		
RPM constraint:		
Limit [RPM/s]:		

Propulsor		
Count:	1	
Propulsor type:	Propeller series	
Propeller type:	CPP	
Propeller series:	B Series	
Propeller sizing:	By thrust	
Reference prop:		
Blade count:	4	
Expanded area ratio:	0,6000	
Propeller diameter:	4600,0	mm
Propeller mean pitch:	4600,0	mm
Hub immersion:	4700,0	mm
Engine/gear		
Drive line:	Direct drive	
Gear input:	No gearbox	
Engine data:	None defined	
Rated RPM:		RPM
Rated power:		kW
Primary fuel:	Defined	
Secondary fuel:	None	
Gear efficiency:	1,000	
Load correction:	Off	
Gear ratio:	1,000	
Shaft efficiency:	0,970	

Ilustración 9 "Datos y características de propulsión NavCad"

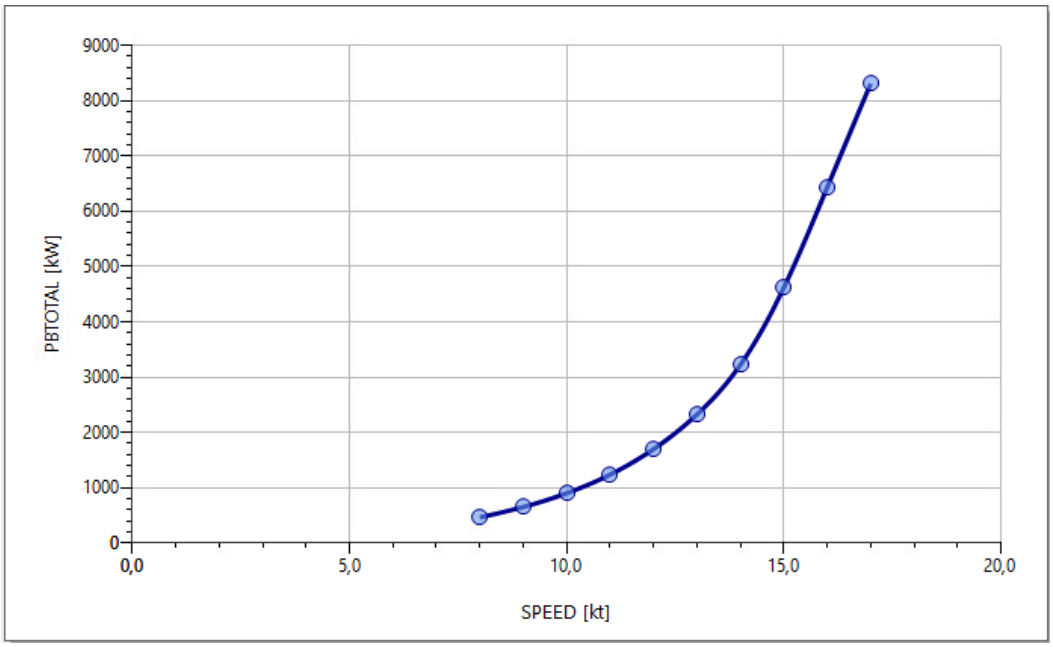


Ilustración 10 "Gráfica de potencia"

Se observa que para el valor de la velocidad fijada en las RPA, 14 nudos, la potencia total es de 3223.4 kW, con lo que, a partir de ella se escogerá el motor que impulsará la hélice de manera que este sea capaz de cumplir con los requisitos tanto de potencia como de dimensiones.

En el Anexo II se observan los resultados obtenidos.

6 ELECCIÓN DEL MOTOR PROPULSOR

La elección del motor propulsor dependerá de la potencia antes estimada, por lo que se ha optado por la elección de un motor diésel tipo MAN 8L32/44 CR cuyas características más específicas vienen dadas en el Anexo III.

- **Características principales:**

Output L32/44CR

Speed	rpm	750	720
mep	bar	27.1 / 25.3*	28.3 / 26.4*
		kW	kW
6L32/44CR		3,600	3,600
7L32/44CR		3,920*	3,920*
8L32/44CR		4,800	4,800
9L32/44CR		5,400	5,400
10L32/44CR		6,000	6,000

Dimensions L32/44CR

Cyl. No.		6	7	8	9	10
L	mm	6,312	6,924	7,454	7,984	8,603
L_1	mm	5,265	5,877	6,407	6,937	7,556
W	mm	2,174	2,359	2,359	2,359	2,359
H	mm	4,163	4,369	4,369	4,369	4,369
Dry Mass**	t	39.5	44.5	49.5	53.5	58.0

Minimum centerline distance for twin engine installation 2,500 mm
Speed 720 rpm for generator drive/constant speed operations only
* Different mep (7L, 14V)
**Including built-on lube oil automatic filter and electronic equipment
Fixed Pitch Propeller: 510 kW/cyl, 750 rpm

Ilustración 11 "Características del motor principal"

1. Potencia: 4800 kW
2. Velocidad: 720-750 rpm
3. Número de cilindros: 8
4. Peso: 49.5 t
5. Carrera del pistón: 440 mm
6. Diámetro del cilindro: 320 mm
7. Consumo: 177 g/kW*h
8. Ciclos: 4
9. Cilindrada: 35.4 dm^3

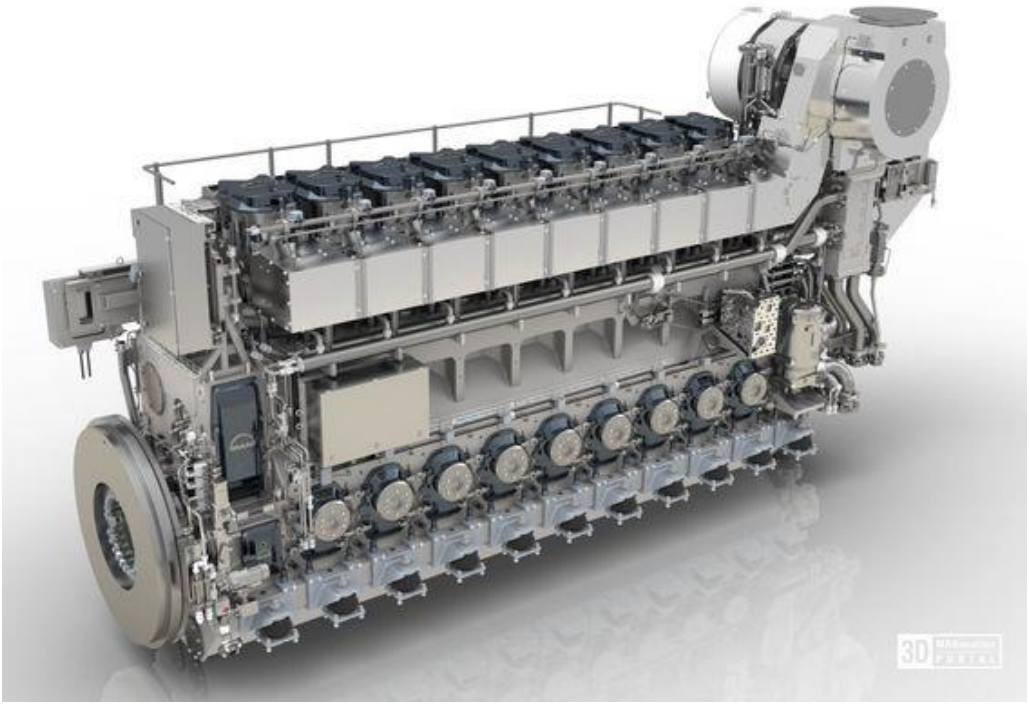
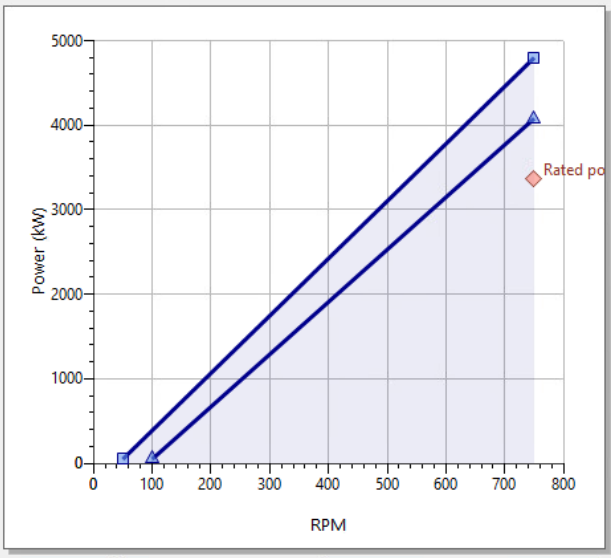


Ilustración 12 "Motor principal"

Se define la carga a la que se somete el motor:

Engine data

Properties		
Description:	Untitled Engin...	
Data source:	Defined	
Units		
Power:	[0.0]	kW
Vol fuel rate:	[0.00]	L/h
BSFC:	[0.000]	lbm/h...
BSEC:	[0]	BTU/h...
Fuel density:	[0.00]	kg/m3
Heating value:	[0]	J/g
Rating		
Rated power:	3360,0	kW
Rated RPM:	750	
Parasitic load:	0,0	kW
Defined fuel		
Density:	850,00	kg/m3
Heating value:	0	J/g
Carbon content:	0,0000	
Idle (unclutched)		
Power:	0,0	kW
RPM:	0	
Vol fuel rate:	0,00	L/h
BSFC:	0,000	lbm/hp·h
BSEC:	0	BTU/hp·h



	MAX POWER CURVE		FUEL RATE		
	RPM	POWER	VOLRATE	BSFC	BSEC
1	750	4800,0	0,00	0,000	0
2	50	50,0	0,00	0,000	0
3					
4					
5					
6					
7					
8					
9					
10					

	DEFINED LOAD CURVE		FUEL RATE		
	RPM	POWER	VOLRATE	BSFC	BSEC
1	750	4080	0,00	0,000	0
2	100	50,0	0,00	0,000	0
3					
4					
5					
6					
7					
8					
9					
10					

Ilustración 13 "Carga del motor"

Una vez esto, se realizará un dimensionamiento de la hélice ajustándose a los parámetros del motor escogido. Se hará una comparativa de una hélice de 4,5 y 6 palas para ver cual se adapta mejor para el buque proyecto.

Nº Palas	Gear Ratio	Expanded area	Propeller diameter	Propeller mean pitch	EFFO	EFFOA	MERIT
4	5,871	0,535	4600	3948,1	0,643	0,665	0,442
5	6,266	0,582	4600	4249,9	0,655	0,676	0,45
6	6,71	0,627	4600	4614,6	0,67	0,685	0,457

Tabla 3 "Tabla número de palas"

Se observa que el rendimiento EFOA es mayor para la hélice de 6 palas, pero se cogerá una hélice de 4 palas debido a que la diferencia es mínima y facilitará el diseño del codaste del buque.

El punto de diseño de la hélice queda:

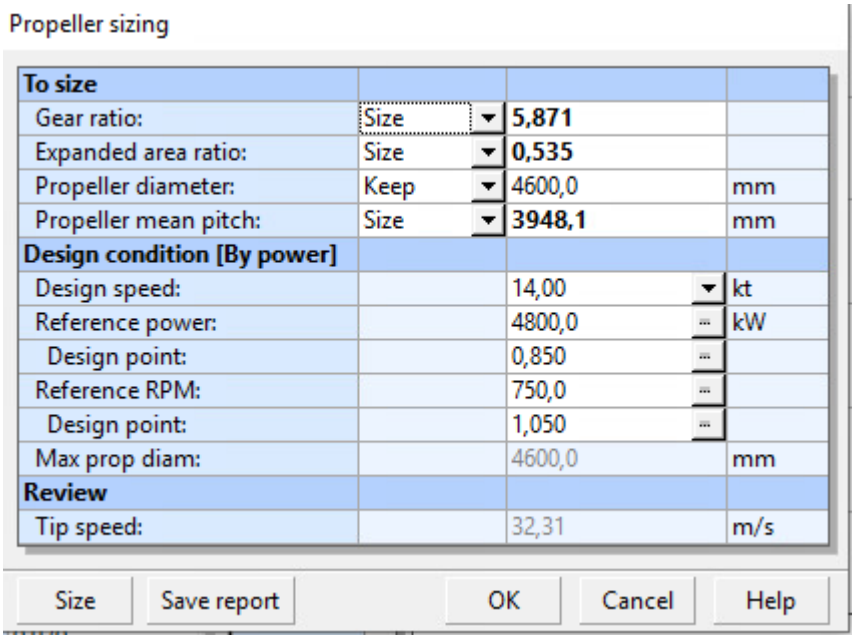


Ilustración 14 "Puntos de diseño hélice"

Gráfica hélice 4 palas:

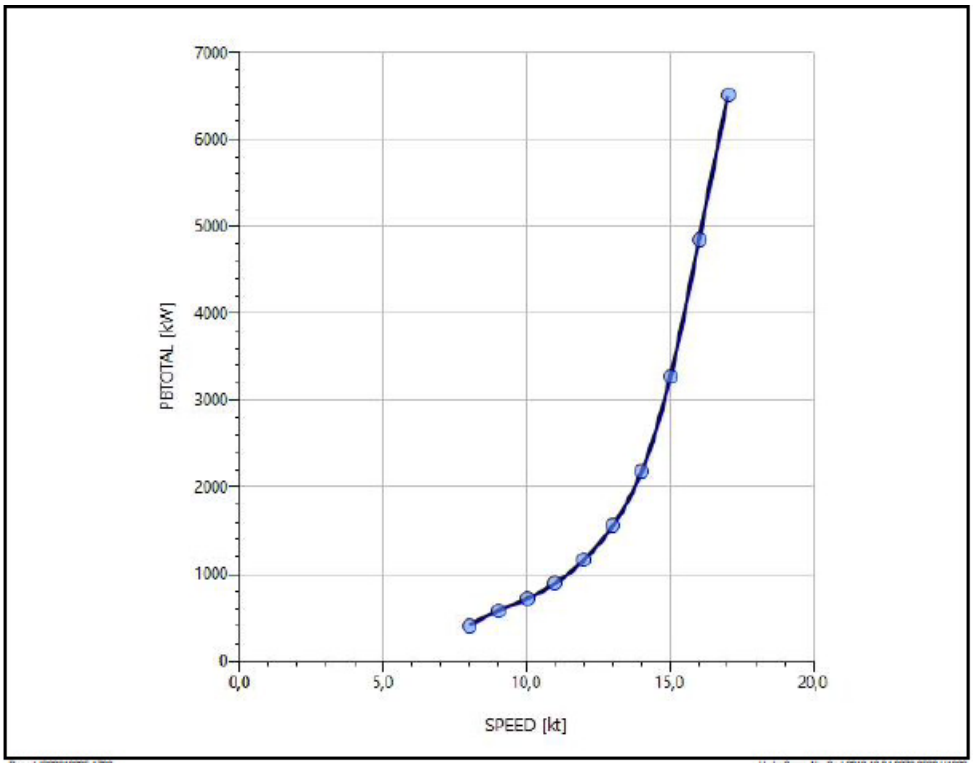


Ilustración 15 "Gráfica 4 palas"

Ver los resultados obtenidos en el Anexo IV.

7 DISEÑO DEL PROPULSOR

Se ha optado por una hélice de 4 palas, la cual se puede ver reflejada en la imagen como quedaría el codaste del buque. También, se tendrá que calcular las claras mínimas de la hélice para que no choque con el casco del buque. Para ello se utilizará el DNV dado que establece para buques de una línea de ejes las expresiones para el cálculo de las claras:

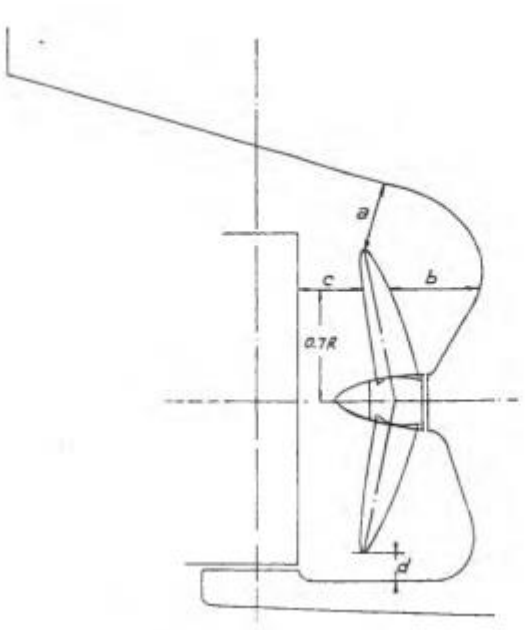


FIG. 8.4.1

Ilustración 16 "Claras mínimas DNV"

$$Clara\ a = (0.24 - 0.01 * Z) * D$$

$$Clara\ \mathrm{b} = (0.35 - 0.02 * Z) * D$$

$$Clara\ c = 0.1 * D$$

$$Clara\ d = 0.035 * D$$

Siendo D el diámetro del propulsor y Z el número de palas.

$$D = 4600mm\ ; Z = 4\ palas$$

Contorno POPA	
DNV	
Clara a	0,92
Clara b	1,242
Clara c	0,46
Clara d	0,161

Tabla 4 "Claras mínimas DNV"

8 DISEÑO DEL TIMÓN

Para buques pesqueros el tipo de timón más utilizado es el timón con pivote de talón, véase en la siguiente imagen:

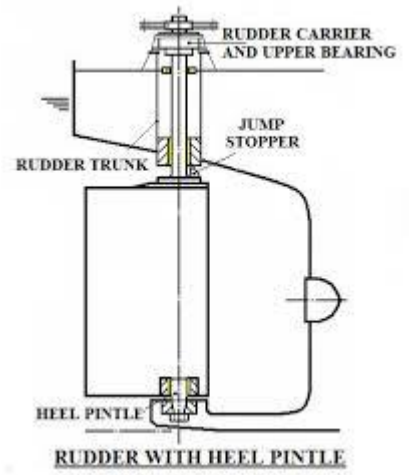


Ilustración 17 "Timón pivote de talón"

Por lo que, una vez escogido el diseño, se procederá al cálculo de las dimensiones para ajustarlo al codaste del buque proyecto y teniendo en cuenta las claras mínimas fijadas. Las características fundamentales son el área a la deriva (L_{pp} x T), el área del timón, que se estima entre un 2-3% del área a la deriva, tomando un 3%, la altura y su cuerda. El área del timón queda:

$$A_{DERIVA} = 71 * 7 = 497\ m^2$$

$$A_{TIMON} = 0.03 * 497 = 15\ m^2$$

Teniendo en cuenta el codaste del buque proyecto y el diámetro de la hélice a utilizar, 4600 mm, la altura del timón es de **5.8 mm**, por lo que, dado que es un timón rectangular, la cuerda de este vendrá dado por la siguiente fórmula:

$$Cuerda_{TIMON} = \frac{A_{TIMON}}{H_{TIMON}} = \frac{15}{5.8} = 2.6\ m$$

Con esto, se puede seleccionar el perfil que tendrá el timón para, posteriormente, calcular la fuerza sobre la pala y el par torsor. El perfil más utilizado es el tipo NACA y será el escogido para el timón del buque proyecto.

Profile Type	K_2	
	Ahead condition	*Astern condition*
NACA-00 series Göttingen 	1.10	0.80

Ilustración 18 "Perfil del timón NACA"

8.1 Cálculo de la fuerza y del par torsor sobre la pala del timón

Una vez esto, se procede a calcular la fuerza que se ejerce sobre la pala y el par torsor.

La distancia desde el canto de ataque al centro de presión se estima con la siguiente expresión, con un ángulo de 35º indicado por el SOLAS:

$$D = (0.2 + 0.3 * sen\alpha) * I$$

$$I = cuerda\ del\ timón = 2.6\ m$$

Por lo que:

$$D = (0.2 + 0.3 * sen35º) * 2.6 = 0.967\ m$$

Las distancias del centro de presión al eje son:

$$d_{avante} = 0.967 - 0.65 = 0.32\ m$$

$$d_{ciar} = (2.6 - 0.967) - 0.65 = 0.983\ m$$

Utilizando la fórmula de Joëssel para el cálculo de la fuerza:

$$F_{avante} = \frac{41.35 * A_{timón} * v^2 * sen\alpha}{0.2 + 0.3 * sen\alpha} = \frac{41.35 * 15 * (16 * 0.5144)^2 * sen35º}{0.2 + 0.3 * sen35º}$$

$$F_{avante} = 64.78\ t$$

Para la fuerza ciando, se toma 2/3 de la velocidad.

$$F_{avante} = \frac{41.35 * A_{timón} * v^2 * sen\alpha}{0.2 + 0.3 * sen\alpha} = \frac{41.35 * 15 * \left((\frac{2}{3})16 * 0.5144\right)^2 * sen35º}{0.2 + 0.3 * sen35º}$$

$$F_{ciar} = 28.78\ t$$

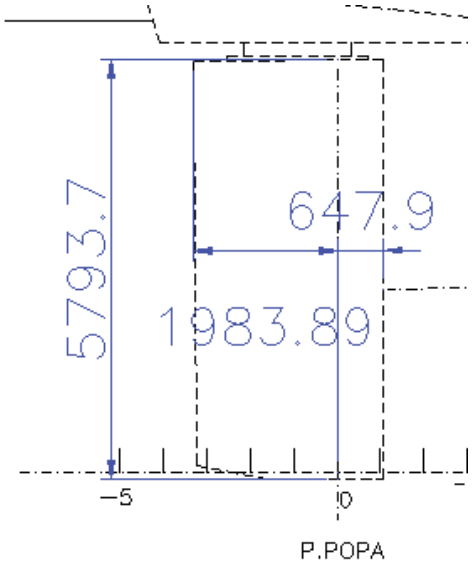


Ilustración 19 "Medidas del timón"

El par torsor queda:

$$Par\ torsor = F * d$$

$$Par\ torsor_{avante} = F_{avante} * d_{avante} = 64.78 * 0.32 = 20.73\ t * m$$

$$Par\ torsor_{ciar} = F_{ciar} * d_{ciar} = 28.78 * 0.983 = 28.29\ t * m$$

El par torsor para el diseño del servo, se calcula multiplicando el mayor valor de momento torsor por un factor de seguridad, 1.3:

$$\boldsymbol{Q_{torsor} = 28.29 * 1.3 = 36.77\ t * m}$$

9 CROQUIS CODASTE

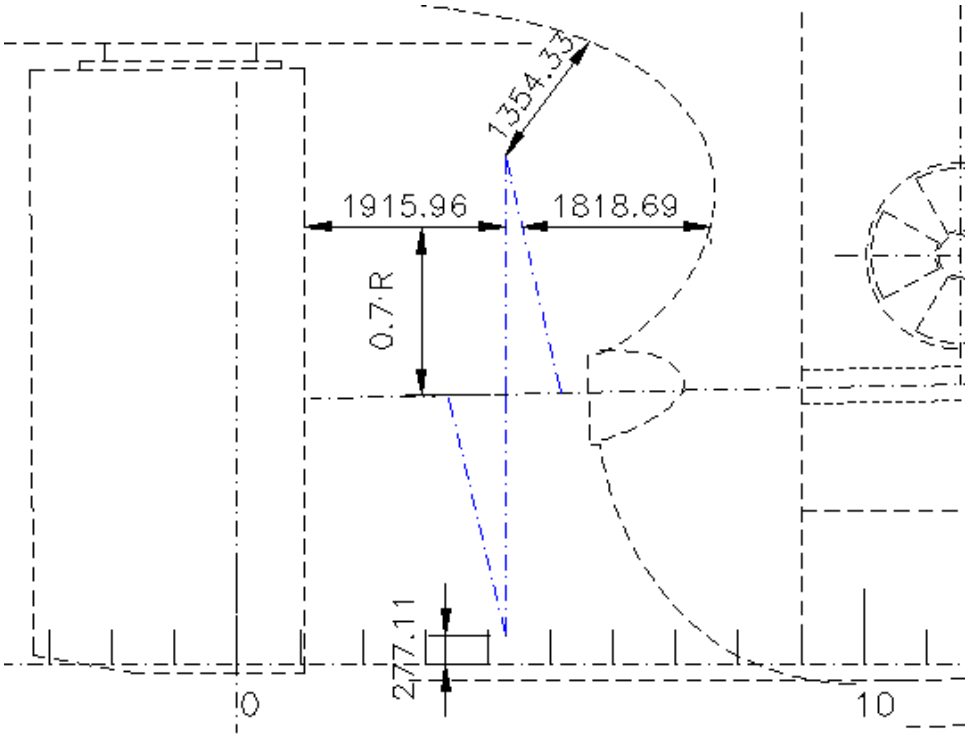


Ilustración 20 "Croquis del codaste"

Contorno POPA		
DNV		REAL
Clara a	0,92	1,132
Clara b	1,242	1,279
Clara c	0,46	0,516
Clara d	0,161	0,46

Tabla 5 "Contornos de popa"

Se comprueba que se ha diseño el codaste de manera que cumpla con todas las claras mínimas exigidas por el DNV.

10 ANEXO I: RESULTADOS DE RESISTENCIA

Resistance

24 feb 2021 04:48
HydroComp NavCad 2018

Project ID
Description
File name **buque proyecto.hcnc**

Analysis parameters

Vessel drag		**ITTC-78 (CT)**
Technique:	**[Calc]**	**Prediction**
Prediction:		**Holtrop**
Reference ship:		
Model LWL:		
Expansion:		**Standard**
Friction line:		**ITTC-57**
Hull form factor:	**[On]**	**1,256**
Speed corr:	**[On]**	
Spray drag corr:	**[Off]**	
Corr allowance:		**ITTC-78 (v2008)**
Roughness [mm]:	**[Off]**	

Added drag		
Appendage:	**[Calc]**	**Percentage**
Wind:	**[Off]**	
Seas:	**[Off]**	
Shallow/channel:	**[Off]**	
Towed:	**[Off]**	
Margin:	**[Calc]**	**Hull + added drag [10%]**

Water properties	
Water type:	**Salt**
Density:	**1026,00 kg/m3**
Viscosity:	**1,18920e-6 m2/s**

Prediction method check [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T	Lambda
Value	**0,27**	**0,65**	**5,01**	**2,13**	**0,79**
Range	**0,06··0,47**	**0,55··0,85**	**3,90··14,90**	**2,10··4,00**	**0,01··1,01**

Prediction results

	SPEED COEFS		ITTC-78 COEFS						
SPEED [kt]	FN	FV	RN	CF	[CV/CF]	CR	dCF	CA	CT
8,00	**0,152**	**0,319**	**2,58e8**	**0,001824**	**1,253**	**0,000001**	**0,000000**	**0,000622**	**0,002909**
9,00	**0,171**	**0,359**	**2,90e8**	**0,001795**	**1,251**	**0,000001**	**0,000000**	**0,000618**	**0,002865**
10,00	**0,190**	**0,399**	**3,23e8**	**0,001770**	**1,247**	**0,000064**	**0,000000**	**0,000614**	**0,002886**
11,00	**0,209**	**0,438**	**3,55e8**	**0,001748**	**1,242**	**0,000217**	**0,000000**	**0,000609**	**0,002997**
12,00	**0,228**	**0,478**	**3,87e8**	**0,001728**	**1,236**	**0,000467**	**0,000000**	**0,000604**	**0,003206**
13,00	**0,247**	**0,518**	**4,20e8**	**0,001710**	**1,227**	**0,000802**	**0,000000**	**0,000599**	**0,003499**
+ 14,00 +	**0,266**	**0,558**	**4,52e8**	**0,001693**	**1,216**	**0,001290**	**0,000000**	**0,000594**	**0,003942**
15,00	**0,285**	**0,598**	**4,84e8**	**0,001678**	**1,202**	**0,002051**	**0,000000**	**0,000589**	**0,004658**
16,00	**0,304**	**0,638**	**5,16e8**	**0,001664**	**1,187**	**0,002816**	**0,000000**	**0,000584**	**0,005377**
17,00	**0,323**	**0,678**	**5,49e8**	**0,001651**	**1,171**	**0,003279**	**0,000000**	**0,000579**	**0,005793**

	RESISTANCE								
SPEED [kt]	RBARE [kN]	RAPP [kN]	RWIND [kN]	RSEAS [kN]	RCHAN [kN]	RTOWED [kN]	RMARGIN [kN]	RTOTAL [kN]	
8,00	**42,78**	**2,14**	**0,00**	**0,00**	**0,00**	**0,00**	**4,49**	**49,41**	
9,00	**53,32**	**2,67**	**0,00**	**0,00**	**0,00**	**0,00**	**5,60**	**61,58**	
10,00	**66,31**	**3,32**	**0,00**	**0,00**	**0,00**	**0,00**	**6,96**	**76,58**	
11,00	**83,32**	**4,17**	**0,00**	**0,00**	**0,00**	**0,00**	**8,75**	**96,23**	
12,00	**106,08**	**5,30**	**0,00**	**0,00**	**0,00**	**0,00**	**11,14**	**122,52**	
13,00	**135,85**	**6,79**	**0,00**	**0,00**	**0,00**	**0,00**	**14,26**	**156,90**	
+ 14,00 +	**177,51**	**8,88**	**0,00**	**0,00**	**0,00**	**0,00**	**18,64**	**205,03**	
15,00	**240,80**	**12,04**	**0,00**	**0,00**	**0,00**	**0,00**	**25,28**	**278,13**	
16,00	**316,25**	**15,81**	**0,00**	**0,00**	**0,00**	**0,00**	**33,21**	**365,27**	
17,00	**384,62**	**19,23**	**0,00**	**0,00**	**0,00**	**0,00**	**40,38**	**444,23**	

	EFFECTIVE POWER		OTHER			
SPEED [kt]	PEBARE [kW]	PETOTAL [kW]	CTLR	CTLT	RBARE/W	
8,00	**176,0**	**203,3**	**0,00001**	**0,03744**	**0,00087**	
9,00	**246,9**	**285,1**	**0,00001**	**0,03687**	**0,00108**	
10,00	**341,1**	**394,0**	**0,00083**	**0,03714**	**0,00134**	
11,00	**471,5**	**544,6**	**0,00279**	**0,03857**	**0,00169**	
12,00	**654,8**	**756,3**	**0,00601**	**0,04126**	**0,00215**	
13,00	**908,5**	**1049,3**	**0,01033**	**0,04503**	**0,00275**	
+ 14,00 +	**1278,5**	**1476,7**	**0,01660**	**0,05073**	**0,00360**	
15,00	**1858,2**	**2146,2**	**0,02640**	**0,05995**	**0,00488**	
16,00	**2603,1**	**3006,6**	**0,03625**	**0,06920**	**0,00641**	
17,00	**3363,7**	**3885,1**	**0,04220**	**0,07455**	**0,00779**	

11 ANEXO II: RESULTADOS DE PROPULSIÓN

Propulsion

24 feb 2021 06:27
HydroComp NavCad 2018

Project ID
Description
File name **buque proyecto.hcnc**

Analysis parameters

Hull-propulsor interaction		**System analysis**	
Technique:	**[Calc] Prediction**	Cavitation criteria:	**Keller eqn**
Prediction:	**Holtrop**	Analysis type:	**Free run**
Reference ship:		CPP method:	**Fixed RPM**
Max prop diam:	**4600,0 mm**	Engine RPM:	
Corrections		Mass multiplier:	
Viscous scale corr:	**[Off]**	RPM constraint:	
Rudder location:		Limit [RPM/s]:	
Friction line:		**Water properties**	
Hull form factor:		Water type:	**Salt**
Corr allowance:		Density:	**1026,00 kg/m3**
Roughness [mm]:		Viscosity:	**1,18920e-6 m2/s**
Ducted prop corr:	**[Off]**		
Tunnel stern corr:	**[Off]**		

Prediction method check [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T
Value	**0,27**	**0,65**	**5,01**	**2,13**
Range	**0,06··0,80**	**0,55··0,85**	**3,90··14,90**	**2,10··4,00**

Prediction results [System]

	HULL-PROPULSOR				ENGINE			FUEL PER ENGINE	
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBENG [kW]	LOADENG [% rated]	VOLRATE [L/h]	MASSRATE [t/h]
8,00	**203,3**	**0,2259**	**0,1822**	**1,0063**	**103**	**464,6**	**0,0**	**---**	**---**
9,00	**285,1**	**0,2257**	**0,1822**	**1,0063**	**116**	**653,8**	**0,0**	**---**	**---**
10,00	**394,0**	**0,2254**	**0,1822**	**1,0063**	**129**	**902,5**	**0,0**	**---**	**---**
11,00	**544,6**	**0,2253**	**0,1822**	**1,0063**	**143**	**1238,4**	**0,0**	**---**	**---**
12,00	**756,3**	**0,2251**	**0,1822**	**1,0063**	**158**	**1699,3**	**0,0**	**---**	**---**
13,00	**1049,3**	**0,2249**	**0,1822**	**1,0063**	**174**	**2325,5**	**0,0**	**---**	**---**
+ 14,00 +	**1476,7**	**0,2248**	**0,1822**	**1,0063**	**192**	**3223,4**	**0,0**	**---**	**---**
15,00	**2146,2**	**0,2247**	**0,1822**	**1,0063**	**213**	**4618,9**	**0,0**	**---**	**---**
16,00	**3006,6**	**0,2246**	**0,1822**	**1,0063**	**235**	**6432,6**	**0,0**	**---**	**---**
17,00	**3885,1**	**0,2245**	**0,1822**	**1,0063**	**254**	**8305,7**	**0,0**	**---**	**---**

	EFFICIENCY			THRUST	
SPEED [kt]	EFFO	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
8,00	**0,4244**	**0,4376**	**0,25076**	**60,41**	**49,41**
9,00	**0,4230**	**0,4361**	**0,24795**	**75,30**	**61,58**
10,00	**0,4236**	**0,4366**	**0,24914**	**93,65**	**76,58**
11,00	**0,4268**	**0,4397**	**0,25573**	**117,67**	**96,23**
12,00	**0,4321**	**0,4451**	**0,26773**	**149,82**	**122,52**
13,00	**0,4381**	**0,4512**	**0,28354**	**191,86**	**156,90**
+ 14,00 +	**0,4449**	**0,4581**	**0,30555**	**250,71**	**205,03**
15,00	**0,4513**	**0,4647**	**0,3369**	**340,10**	**278,13**
16,00	**0,4541**	**0,4674**	**0,36409**	**446,65**	**365,27**
17,00	**0,4545**	**0,4678**	**0,37819**	**543,21**	**444,23**

	POWER DELIVERY								
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP	CPPITCH [mm]
8,00	**103**	**41,98**	**41,98**	**450,7**	**464,6**	**464,6**	**464,6**	**437,1**	**2070,4**
9,00	**116**	**52,64**	**52,64**	**634,2**	**653,8**	**653,8**	**653,8**	**349,4**	**2070,4**
10,00	**129**	**65,29**	**65,29**	**875,4**	**902,5**	**902,5**	**902,5**	**281,3**	**2070,4**
11,00	**143**	**80,89**	**80,89**	**1201,3**	**1238,4**	**1238,4**	**1238,4**	**225,5**	**2070,4**
12,00	**158**	**100,48**	**100,48**	**1648,4**	**1699,3**	**1699,3**	**1699,3**	**179,3**	**2070,4**
13,00	**174**	**124,80**	**124,80**	**2255,8**	**2325,5**	**2325,5**	**2325,5**	**141,9**	**2070,4**
+ 14,00 +	**192**	**156,78**	**156,78**	**3126,7**	**3223,4**	**3223,4**	**3223,4**	**110,3**	**2070,4**
15,00	**213**	**202,18**	**202,18**	**4480,4**	**4618,9**	**4618,9**	**4618,9**	**82,4**	**2070,4**
16,00	**235**	**255,26**	**255,26**	**6239,7**	**6432,6**	**6432,6**	**6432,6**	**63,1**	**2070,4**
17,00	**254**	**304,57**	**304,57**	**8056,5**	**8305,7**	**8305,7**	**8305,7**	**52,0**	**2070,4**

Propulsion

24 feb 2021 06:27

HydroComp NavCad 2018

Project ID

Description

File name **buque proyecto.hcnc**

Prediction results [Propulsor]

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
8,00	**28,22**	**4,58**	**0,92**	**24,85**	**0,249**	**6,06**	**2,0**	**2,0**	**2133,6**
9,00	**22,28**	**3,64**	**0,73**	**27,89**	**0,261**	**7,55**	**2,0**	**2,0**	**2135,7**
10,00	**18,04**	**2,94**	**0,59**	**31,03**	**0,275**	**9,39**	**2,0**	**2,0**	**2134,8**
11,00	**14,90**	**2,39**	**0,48**	**34,37**	**0,295**	**11,80**	**2,0**	**2,0**	**2129,9**
12,00	**12,51**	**1,96**	**0,39**	**37,97**	**0,320**	**15,02**	**2,0**	**2,0**	**2120,9**
13,00	**10,66**	**1,62**	**0,32**	**41,83**	**0,354**	**19,24**	**2,0**	**2,0**	**2109,0**
+ 14,00 +	**9,19**	**1,33**	**0,27**	**46,16**	**0,402**	**25,14**	**2,0**	**2,0**	**2092,4**
15,00	**8,00**	**1,07**	**0,22**	**51,29**	**0,473**	**34,11**	**2,0**	**2,0**	**2068,6**
16,00	**7,03**	**0,88**	**0,18**	**56,57 !**	**0,559**	**44,79**	**2,0**	**2,0**	**2047,7**
17,00	**6,23**	**0,75**	**0,15**	**61,22 !!**	**0,637**	**54,48**	**2,8**	**2,8**	**2036,8**

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KT/J2	KQ/J3	CTH	CP	RNPROP	
8,00	**0,4028**	**0,0445**	**0,00672**	**0,27417**	**0,10282**	**0,69818**	**1,6348**	**2,37e7**	
9,00	**0,4039**	**0,0440**	**0,00669**	**0,26984**	**0,10152**	**0,68714**	**1,6143**	**2,66e7**	
10,00	**0,4034**	**0,0442**	**0,00670**	**0,27167**	**0,10207**	**0,69181**	**1,623**	**2,96e7**	
11,00	**0,4007**	**0,0453**	**0,00677**	**0,28199**	**0,10516**	**0,71809**	**1,6721**	**3,28e7**	
12,00	**0,3958**	**0,0472**	**0,00689**	**0,30155**	**0,11107**	**0,76788**	**1,7661**	**3,62e7**	
13,00	**0,3893**	**0,0498**	**0,00705**	**0,32893**	**0,11949**	**0,8376**	**1,8999**	**3,99e7**	
+ 14,00 +	**0,3800**	**0,0535**	**0,00727**	**0,37047**	**0,13253**	**0,94339**	**2,1074**	**4,39e7**	
15,00	**0,3665**	**0,0588**	**0,00760**	**0,43764**	**0,15433**	**1,1144**	**2,4539**	**4,88e7**	
16,00	**0,3544**	**0,0634**	**0,00788**	**0,50501**	**0,17702**	**1,286**	**2,8147**	**5,38e7**	
17,00	**0,3481**	**0,0659**	**0,00803**	**0,5439**	**0,19048**	**1,385**	**3,0287**	**5,82e7**	

12 ANEXO III: CARACTERÍSTICAS DEL MOTOR

32/44CR Engine

High Power. High Efficiency.

Engineering the Future – since 1758.

MAN Diesel & Turbo

MAN Diesel & Turbo

Delivering Powerful Efficiency

MAN Diesel & Turbo is the world's leading designer and manufacturer of low and medium speed engines, with our engines covering an estimated 50% of the power needed for all world trade. We develop two-stroke and four-stroke engines, auxiliary engines, turbochargers and propulsion packages that are manufactured both within the MAN Diesel & Turbo Group and at our licensees.

More than ever, our development focus is the environmental performance of our engines. The goal is to achieve uncompromising harmony between ecology and economy. Using our unrivaled grasp of large engine technology, we aim to make our engines progressively cleaner, more powerful and more efficient.

MAN Diesel & Turbo's 32/44 Common Rail engine family is certified to meet EPA emission requirements, allowing our US customers to take advantage of the high power output and high efficiency our engines offer. With several locations throughout the US, our team members know the market and are ready to offer local service personalized to meet each customer's needs. Each customer can be assured that their engine is specifically designed to meet stringent emissions standards without compromising on performance.

32/44CR: Engineered to Set Benchmarks

High Power Meets Low Consumption

The 32/44CR engine represents the newest technologies in the area of medium speed operated industrial sized diesel engines. By the use of electronic injection, high efficiency turbochargers, electronic hardware and variable valve timing, the 32/44CR is a combination of the most advanced large engine technologies available.

More Output at Lower Fuel Consumption

The development of the 32/44CR has benefited from many years of experience of industrial-sized diesel engine architecture along with knowledge from detailed research and developed plans. As a result, the output of the engine was substantially increased while simultaneously decreasing the fuel consumption.

Two Configurations Available

- **32/44CR– 600 kW/Cylinder:** Applicable for electric propulsion and mechanical propulsion with CPP
- **32/44CR– 510 kW/Cylinder:** Applicable for mechanical propulsion with FPP and dredger (mechanical drive). These configurations are specially adapted to the stated applications and differ in the engine configuration

Electronics

The 32/44CR is equipped with the newest generation of MAN Diesel & Turbo's engine management system. $SaCoS_{one}$ breaks down all functions of modern engine management into one complete system. Through integration on the engine, it forms one unit with the drive assembly. $SaCoS_{one}$ offers

- Integrated self-diagnosis functions
- Maximum reliability and availability
- Simple use and diagnosis
- Quick exchange of modules (plug in)
- Trouble-free and time-saving operation

Industries and Markets

Whatever vessel type you operate, MAN's 32/44CR engine provides high power output while optimizing efficiency. The engine is suited for a wide range of marine applications, including fishing, ATBs, anchor handlers, construction vessels, dredgers and drillships.

Fishing Industry

Modern fishing vessels require cost-efficient propulsion systems as well as tough and robust technical solutions for operation in harsh environments. The 32/44CR provides efficient propulsion and power for factory and hotel loads. It also has the option for PTI/PTO for hybrid operation. The engine is approved for single engine diesel-mechanical propulsion and offers low fuel consumption to reduce OPEX.

Articulated Tug Barges

The unique design of an ATB requires an engine that optimizes speed and power without sacrificing efficiency. The 32/44CR is well-suited to these demands, providing the power needed to drive both the bow thruster and propulsion. Its ease of operation and low maintenance requirements work well with the smaller crew size of an ATB. Today's ATBs require greater speed, safety and power – all of which are provided by the 32/44CR.

Offshore Service Vessels

The 32/44CR offers a range of benefits for offshore vessels, including construction vessels, anchor handlers and supply vessels. A four-engine plant provides redundancy with power ranging from 19,000 –32,000 HP (14,400–24,000 kW). The patented boost injection technology is specifically designed to improve the load response of the engine. Vessels with the 32/44CR boast a higher charter rate due to lower fuel consumption. The engine also operates well in Arctic conditions and has fewer cylinders to service compared to conventionally-fueled engines.

Drillships

Dynamic positioning needs on drillships require an engine designed to meet those requirements. The 32/44CR features excellent transient response and load pick-up, ideal for the active heave compensation needed for drillships. The engine easily adapts to low-load operation and offers a high degree of reliability and efficiency.

Dredgers

Today's dredgers require engines that balance cost, weight and power needs with increasingly strict emissions requirements. The 32/44CR optimizes dredger efficiency while producing the power needed for dredger pump operations. It offers low emissions and life-cycle costs, reducing the overall cost of ownership during the vessel's lifetime.

Selective Catalytic Reduction

Efficiency Without Compromise

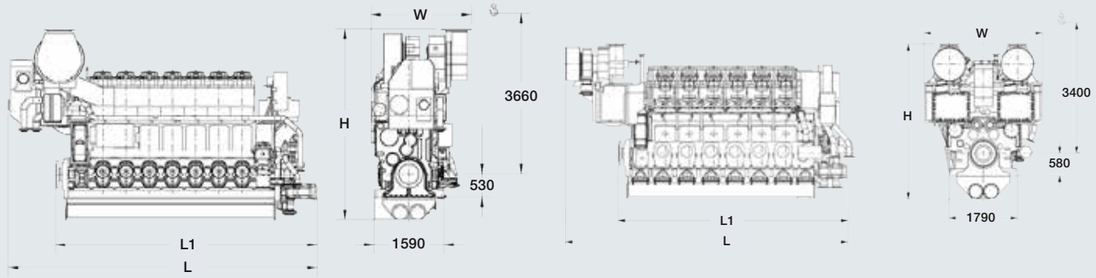
As concerns for the environment and emissions continue to grow, MAN's 32/44CR answers a very real problem for vessel operators: how to achieve high power output while reducing emissions and improving efficiency. In order to achieve the lowest possible emissions, the engine is paired with Selective Catalytic Reduction (SCR) technology. SCR is the most tested and approved system for achieving NO_x reduction rates of up to 90%. By inducing chemical reactions in the engine's exhaust gases, harmful substances are transformed into ecologically benign products. The technology was first tested on a retrofit in 2012 and has since been redesigned to better suit the needs of marine vessels.

MAN's SCR system keeps urea consumption low, using technology to fine tune the amount of urea the engine needs. Extensive advance research and analysis informs the initial amounts of urea fed into the system, while an integrated NO_x analyzer is able to tweak amounts and concentrations based on the engine's needs. The system minimizes ammonia slip throughout the cycle and prevents aging effects thanks to the constant NO_x monitoring and subsequent urea adjustment.

In 2015 the 32/44 Common Rail engine family received US EPA Tier 2 certification for Category 3 engines, building the foundation for the introduction of MAN's EPA Tier 3 for Category 3 product in 2016. The certification allows US customers to benefit from the high power output and low fuel consumption of MAN's medium-speed common-rail engines.

Technical Data

Definitions, Output, Dimensions & Weight



Engine data for 32/44CR

General

- Engine cycle: Four-stroke
- Turbocharging system: Constant pressure
- No. of cylinders, In-line engine: 6, 7, 8, 9, 10
- No. of cylinders, V-engine: 12, 14, 16, 18, 20
- Bore: 320 mm
- Stroke: 440 mm
- Displacement per cylinder: 35.4 l

Cylinder output (MCR)

- At 750/720* rpm: 600 kW

7L, 14V reduced output (TC under development)

Power-to-weight ratio (MCR)

- In-line engine: 10.4–11.8 kg/kW, 7.6–8.7 kg/bhp
- V-engine: 9.3–10.4 kg/kW, 6.8–7.6 kg/bhp

Cooling

- Cylinder cooling: Cooling water
- Charge-air cooling (two-stage): Fresh water
- Fuel injector cooling: Cooling water

Starting method

- In-line and V-engine: air (turbine) starter

General performance definition for diesel engines as per ISO 30461/1-2002

ISO reference conditions

- Air temperature: 298 K (25°C)
- Air pressure: 1 bar
- Fresh water temperature upstream of charge-air cooler: 298 K (25°C)
- Relative humidity: 30%

No power reduction required

- Air temperature: ≤ 318 K (45°C)
- Air pressure: ≥ 100 kPa (1 bar)
- Cooling water temperature upstream of charge-air cooler (LT-stage) ≤ 311 K (38°C)

US EPA requirements

The engine detailed herein will comply with the emission limits referred to as US EPA Tier 2 for Category 3.

MCR = maximum continuous rating
** For generator drive only*

Output L32/44CR

Speed	rpm	750	720
mep	bar	27.1 / 25.3*	28.3 / 26.4*
		kW	kW
6L32/44CR		3,600	3,600
7L32/44CR		*3,920**	*3,920**
8L32/44CR		4,800	4,800
9L32/44CR		5,400	5,400
10L32/44CR		6,000	6,000

Dimensions L32/44CR

Cyl. No.		6	7	8	9	10
L	mm	6,312	6,924	7,454	7,984	8,603
L_1	mm	5,265	5,877	6,407	6,937	7,556
W	mm	2,174	2,359	2,359	2,359	2,359
H	mm	4,163	4,369	4,369	4,369	4,369
Dry Mass**	t	39.5	44.5	49.5	53.5	58.0

Minimum centerline distance for twin engine installation 2,500 mm
Speed 720 rpm for generator drive/constant speed operations only
* Different mep (7L, 14V)
**Including built-on lube oil automatic filter and electronic equipment
Fixed Pitch Propeller: 510 kW/cyl, 750 rpm

Output V32/44CR

Speed	rpm	750	720
mep	bar	27.1 / 25.3*	28.3 / 26.4*
		kW	kW
12V32/44CR		7,200	7,200
14V32/44CR		*7,840**	*7,840**
16V32/44CR		9,600	9,600
18V32/44CR		10,800	10,800
20V32/44CR		12,000	12,000

Dimensions V32/44CR

Cyl. No.		12	14	16	18	20
L	mm	7,195	7,970	8,600	9,230	9,860
L_1	mm	5,795	6,425	7,055	7,685	8,315
W	mm	3,100	3,100	3,100	3,100	3,100
H	mm	4,039	4,262	4,262	4,262	4,262
Dry Mass**	t	70	79	87	96	104

Minimum centerline distance for twin engine installation 4,000 mm
Speed 720 rpm for generator drive/constant speed operations only
* Different mep (7L, 14V)
**Including built-on lube oil automatic filter and electronic equipment
Fixed Pitch Propeller: 510 kW/cyl, 750 rpm

MAN PrimeServ

Service Where You Need It

Whatever sector you operate in, your expectations for your vessel are the same: thousands of hours of smooth operation with no disruptions. MAN Diesel & Turbo offers worldwide, round-the-clock service, 365 days a year under its MAN PrimeServ brand. Service centers on all continents, including several in the United States, provide local comprehensive and continuous support. We only use genuine spare parts, safeguarding the longevity of your engine.

The PrimeServ Academy in Fort Lauderdale provides world class training for our engines and turbochargers, including the 32/44CR. It's equipped with a real 32/44CR engine, all types of radial and axial turbochargers and fully functional $SaCoS_{one}$ simulators for hands-on training. These tools will familiarize you with operating and maintaining machinery for practical, on-the-job situations. All trainings are carried out by our experienced instructors to ensure our Academy is the ideal place for efficient learning.

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13 ANEXO IV: RESULTADOS OBTENIDOS DEL NÚMERO DE PALAS

Propulsion

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HydroComp NavCad 2018

Project ID
Description
File name **buque proyecto.hcnc**

Analysis parameters

Hull-propulsor interaction	
Technique:	**[Calc] Prediction**
Prediction:	**Holtrop**
Reference ship:	
Max prop diam:	**4600,0 mm**
Corrections	
Viscous scale corr:	**[Off]**
Rudder location:	
Friction line:	
Hull form factor:	
Corr allowance:	
Roughness [mm]:	
Ducted prop corr:	**[Off]**
Tunnel stern corr:	**[Off]**

System analysis	
Cavitation criteria:	**Keller eqn**
Analysis type:	**Free run**
CPP method:	**Fixed RPM**
Engine RPM:	
Mass multiplier:	
RPM constraint:	
Limit [RPM/s]:	
Water properties	
Water type:	**Salt**
Density:	**1026,00 kg/m3**
Viscosity:	**1,18920e-6 m2/s**

Prediction method check [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T
Value	**0,27**	**0,65**	**5,01**	**2,13**
Range	**0,06··0,80**	**0,55··0,85**	**3,90··14,90**	**2,10··4,00**

Prediction results [System]

	HULL-PROPULSOR				ENGINE			FUEL PER ENGINE	
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBENG [kW]	LOADENG [% rated]	VOLRATE [L/h]	MASSRATE [t/h]
8,00	**203,3**	**0,2259**	**0,1822**	**1,0149**	**662**	**413,8**	**12,3**	**---**	**---**
9,00	**285,1**	**0,2257**	**0,1822**	**1,0149**	**743**	**581,9**	**17,3**	**---**	**---**
10,00	**394,0**	**0,2254**	**0,1822**	**1,0149**	**750**	**717,1**	**21,3**	**---**	**---**
11,00	**544,6**	**0,2253**	**0,1822**	**1,0149**	**750**	**900,1**	**26,8**	**---**	**---**
12,00	**756,3**	**0,2251**	**0,1822**	**1,0149**	**750**	**1168,7**	**34,8**	**---**	**---**
13,00	**1049,3**	**0,2249**	**0,1822**	**1,0149**	**750**	**1561,0**	**46,5**	**---**	**---**
+ 14,00 +	**1476,7**	**0,2248**	**0,1822**	**1,0149**	**750**	**2180,2**	**64,9**	**---**	**---**
15,00	**2146,2**	**0,2247**	**0,1822**	**1,0149**	**750**	**3271,6**	**97,4**	**---**	**---**
16,00	**3006,6**	**0,2246**	**0,1822**	**1,0149**	**750**	**4845,4**	**144,2**	**---**	**---**
17,00	**3885,1**	**0,2245**	**0,1822**	**1,0149**	**750**	**6504,0**	**193,6**	**---**	**---**

	EFFICIENCY			THRUST	
SPEED [kt]	EFFO	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
8,00	**0,4871**	**0,5066**	**0,28781**	**60,42**	**49,41**
9,00	**0,4859**	**0,5051**	**0,28479**	**75,30**	**61,58**
10,00	**0,5450**	**0,5664**	**0,32052**	**93,65**	**76,58**
11,00	**0,6002**	**0,6237**	**0,35967**	**117,67**	**96,23**
12,00	**0,6422**	**0,6672**	**0,39793**	**149,82**	**122,52**
13,00	**0,6672**	**0,6930**	**0,43178**	**191,86**	**156,90**
+ 14,00 +	**0,6724**	**0,6983**	**0,46178**	**250,71**	**205,03**
15,00	**0,6513**	**0,6763**	**0,48619**	**340,09**	**278,13**
16,00	**0,6162**	**0,6397**	**0,49408**	**446,65**	**365,27**
17,00	**0,5932**	**0,6158**	**0,49367**	**543,21**	**444,23**

	POWER DELIVERY								
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP	CPPITCH [mm]
8,00	**100**	**37,88**	**5,70**	**389,3**	**401,4**	**401,4**	**413,8**	**490,8**	**2070,4**
9,00	**112**	**47,48**	**7,15**	**547,5**	**564,4**	**564,4**	**581,9**	**392,6**	**2070,3**
10,00	**113**	**57,93**	**8,72**	**674,7**	**695,6**	**695,6**	**717,1**	**354,0**	**2354,6**
11,00	**113**	**72,71**	**10,94**	**846,9**	**873,1**	**873,1**	**900,1**	**310,3**	**2697,4**
12,00	**113**	**94,41**	**14,21**	**1099,6**	**1133,6**	**1133,6**	**1168,7**	**260,7**	**3086,2**
13,00	**113**	**126,10**	**18,98**	**1468,7**	**1514,2**	**1514,2**	**1561,0**	**211,4**	**3532,8**
+ 14,00 +	**113**	**176,12**	**26,51**	**2051,3**	**2114,8**	**2114,8**	**2180,2**	**163,0**	**4082,0**
15,00	**113**	**264,29**	**39,78**	**3078,2**	**3173,5**	**3173,5**	**3271,6**	**116,4**	**4830,7**
16,00	**113**	**391,42**	**58,91**	**4559,0**	**4700,0**	**4700,0**	**4845,4**	**83,8**	**5726,3**
17,00	**113**	**525,41**	**79,08**	**6119,6**	**6308,9**	**6308,9**	**6504,0**	**66,4**	**6606,3**

Propulsion

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Project ID

Description

File name **buque proyecto.hcnc**

Prediction results [Propulsor]

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
8,00	**28,22**	**4,91**	**0,98**	**23,99**	**0,249**	**8,00**	**2,0**	**2,0**	**2210,1**
9,00	**22,28**	**3,90**	**0,78**	**26,92**	**0,261**	**9,97**	**2,0**	**2,0**	**2212,4**
10,00	**18,04**	**3,82**	**0,76**	**27,19**	**0,275**	**12,40**	**2,0**	**2,0**	**2436,5**
11,00	**14,90**	**3,82**	**0,75**	**27,19**	**0,295**	**15,59**	**2,0**	**2,0**	**2692,5**
12,00	**12,51**	**3,82**	**0,74**	**27,19**	**0,320**	**19,84**	**2,0**	**2,0**	**2961,9**
13,00	**10,66**	**3,82**	**0,74**	**27,19**	**0,354**	**25,41**	**2,0**	**2,0**	**3245,1**
+ 14,00 +	**9,19**	**3,82**	**0,73**	**27,19**	**0,402**	**33,21**	**2,2**	**2,2**	**3552,4**
15,00	**8,00**	**3,82**	**0,72**	**27,19**	**0,473**	**45,05**	**6,2**	**6,2**	**3902,3**
16,00	**7,03**	**3,82**	**0,71**	**27,19**	**0,559**	**59,16 !**	**15,0**	**15,0**	**4261,1**
17,00	**6,23**	**3,82**	**0,70**	**27,19**	**0,637**	**71,95 !!**	**27,7 !!**	**27,7**	**4586,5**

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KT/J2	KQ/J3	CTH	CP	RNPROP	
8,00	**0,4172**	**0,0477**	**0,00651**	**0,27418**	**0,089582**	**0,69819**	**1,4123**	**1,73e7**	
9,00	**0,4184**	**0,0472**	**0,00648**	**0,26984**	**0,088393**	**0,68715**	**1,3936**	**1,95e7**	
10,00	**0,4604**	**0,0576**	**0,00774**	**0,27167**	**0,079341**	**0,69181**	**1,2509**	**1,97e7**	
11,00	**0,5066**	**0,0724**	**0,00972**	**0,28199**	**0,07477**	**0,71809**	**1,1788**	**1,98e7**	
12,00	**0,5528**	**0,0921**	**0,01262**	**0,30155**	**0,074731**	**0,76788**	**1,1782**	**1,99e7**	
13,00	**0,5990**	**0,1180**	**0,01686**	**0,32893**	**0,078463**	**0,83761**	**1,237**	**2,00e7**	
+ 14,00 +	**0,6451**	**0,1542**	**0,02355**	**0,37047**	**0,087695**	**0,9434**	**1,3826**	**2,01e7**	
15,00	**0,6913**	**0,2092**	**0,03534**	**0,43764**	**0,10694**	**1,1144**	**1,686**	**2,02e7**	
16,00	**0,7375**	**0,2747**	**0,05233**	**0,50501**	**0,13045**	**1,286**	**2,0566**	**2,03e7**	
17,00	**0,7837**	**0,3341**	**0,07025**	**0,5439**	**0,14592**	**1,385**	**2,3005**	**2,04e7**	

Propulsion

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Project ID
Description
File name **buque proyecto.hcnc**

Hull data

General		
Configuration:		**Monohull**
Chine type:		**Round/multiple**
Length on WL:		**74,600 m**
Max beam on WL:	[LWL/BWL 5,007]	**14,900 m**
Max molded draft:	[BWL/T 2,129]	**7,000 m**
Displacement:	[CB 0,630]	**5032,00 t**
Wetted surface:	[CS 2,798]	**1692,2 m2**

ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,492]	**36,726 m**
LCF fwd TR:	[XCF/LWL 0,417]	**31,101 m**
Max section area:	[CX 0,970]	**101,2 m2**
Waterplane area:	[CWP 0,802]	**892,0 m2**
Bulb section area:		**13,5 m2**
Bulb ctr below WL:		**3,480 m**
Bulb nose fwd TR:		**81,106 m**
Imm transom area:	[ATR/AX 0,007]	**0,8 m2**
Transom beam WL:	[BTR/BWL 0,423]	**6,300 m**
Transom immersion:	[TTR/T 0,024]	**0,165 m**
Half entrance angle:		**27,00 deg**
Bow shape factor:	[WL flow]	**1,0**
Stern shape factor:	[BTK flow]	**-1,0**

Planing		
Proj chine length:		***0,000 m***
Proj bottom area:		***0,0 m2***
LCG fwd TR:	*[XCG/LP 0,000]*	***0,000 m***
VCG below WL:		***0,000 m***
Aft station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Fwd station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Propulsor type:		***Propeller***
Max prop diameter:		***4600,0 mm***
Shaft angle to WL:		***0,00 deg***
Position fwd TR:		***0,000 m***
Position below WL:		***0,000 m***
Transom lift device:		***Flap***
Device count:		***0***
Span:		***0,000 m***
Chord length:		***0,000 m***
Deflection angle:		***0,00 deg***
Tow point fwd TR:		***0,000 m***
Tow point below WL:		***0,000 m***

Propulsor data

Propulsor			
Count:		**1**	
Propulsor type:		**Propeller series**	
Propeller type:		**CPP**	
Propeller series:		**B Series**	
Propeller sizing:		**By power**	
Reference prop:			
Blade count:		**4**	
Expanded area ratio:		**0,4543**	**[Size]**
Propeller diameter:		**4600,0 mm**	**[Keep]**
Propeller mean pitch:	[P/D 0,9080]	**4176,9 mm**	**[Size]**
Hub immersion:		**4700,0 mm**	

Engine/gear		
Drive line:	**Standard**	
Gear input:	**Single engine**	
Engine data:	**Untitled Engine Obje...**	
Rated RPM:	**750 RPM**	
Rated power:	**3360,0 kW**	
Primary fuel:	**Defined**	
Secondary fuel:	**None**	
Gear efficiency:	**0,970**	
Load correction:	**Off**	
Gear ratio:	**6,644**	**[Size]**
Shaft efficiency:	**0,970**	

Propeller options	
Oblique angle corr:	**Off**
Shaft angle to WL:	**0,00 deg**
Added rise of run:	**0,00 deg**
Propeller cup:	**0,0 mm**
KTKQ corrections:	**Standard**
Scale correction:	**Full ITTC**
KT multiplier:	**1,000**
KQ multiplier:	**1,000**
Blade T/C [0.7R]:	**Standard**
Roughness:	**Standard**
Cav breakdown:	**Off**

Design condition [By power]	
Max prop diam:	**4600,0 mm**
Design speed:	**14,00 kt**
Reference power:	**3360,0 kW**
Design point:	**0,850**
Reference RPM:	**750,0 RPM**
Design point:	**1,050**

Propulsion

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File name **buque proyecto.hcnc**

Symbols and values

SPEED =	Vessel speed
PETOTAL =	Total vessel effective power
WFT =	Taylor wake fraction coefficient
THD =	Thrust deduction coefficient
EFFR =	Relative-rotative efficiency
RPMENG =	Engine RPM
PBENG =	Brake power per engine
VOLRATE =	Volumetric fuel rate total Primary
LOADENG =	Engine load as a percentage of engine rated power
RPMPROP =	Propulsor RPM
QPROP =	Propulsor open water torque
QENG =	Engine torque
PDPROP =	Delivered power per propulsor
PSPROP =	Shaft power per propulsor
PSTOTAL =	Total vessel shaft power
PBTOTAL =	Total vessel brake power
TRANSP =	Transport factor
EFFO =	Propulsor open-water efficiency
EFFG =	Gear efficiency (load corrected)
EFFOA =	Overall propulsion efficiency [=PETOTAL/PSTOTAL]
MERIT =	Propulsor merit coefficient
THRPROP =	Open-water thrust per propulsor
DELTHR =	Total vessel delivered thrust
J =	Propulsor advance coefficient
KT =	Propulsor thrust coefficient [horizontal, if in oblique flow]
KQ =	Propulsor torque coefficient
KT/J2 =	Propulsor thrust loading ratio
KQ/J3 =	Propulsor torque loading ratio
CTH =	Horizontal component of bare-hull resistance coefficient
CP =	Propulsor thrust loading coefficient
RNPROP =	Propeller Reynolds number at 0.7R
SIGMAV =	Cavitation number of propeller by vessel speed
SIGMAN =	Cavitation number of propeller by RPM
SIGMA07R =	Cavitation number of blade section at 0.7R
TIPSPEED =	Propeller circumferential tip speed
MINBAR =	Minimum expanded blade area ratio recommended by selected cavitation criteria
PRESS =	Average propeller loading pressure
CAVAVG =	Average predicted back cavitation percentage
CAVMAX =	Peak predicted back cavitation percentage [if in oblique flow]
PITCHFC =	Minimum recommended pitch to avoid face cavitation
+ =	Design speed indicator
* =	Exceeds recommended parameter limit
! =	Exceeds recommended cavitation criteria [warning]
!! =	Substantially exceeds recommended cavitation criteria [critical]
!!! =	Thrust breakdown is indicated [severe]
--- =	Insignificant or not applicable

Propulsion

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Project ID
Description
File name **buque proyecto.hcnc**

Analysis parameters

Hull-propulsor interaction	
Technique:	**[Calc] Prediction**
Prediction:	**Holtrop**
Reference ship:	
Max prop diam:	**4600,0 mm**
Corrections	
Viscous scale corr:	**[Off]**
Rudder location:	
Friction line:	
Hull form factor:	
Corr allowance:	
Roughness [mm]:	
Ducted prop corr:	**[Off]**
Tunnel stern corr:	**[Off]**

System analysis	
Cavitation criteria:	**Keller eqn**
Analysis type:	**Free run**
CPP method:	**Fixed RPM**
Engine RPM:	
Mass multiplier:	
RPM constraint:	
Limit [RPM/s]:	
Water properties	
Water type:	**Salt**
Density:	**1026,00 kg/m3**
Viscosity:	**1,18920e-6 m2/s**

Prediction method check [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T
Value	**0,27**	**0,65**	**5,01**	**2,13**
Range	**0,06··0,80**	**0,55··0,85**	**3,90··14,90**	**2,10··4,00**

Prediction results [System]

	HULL-PROPULSOR				ENGINE			FUEL PER ENGINE	
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBENG [kW]	LOADENG [% rated]	VOLRATE [L/h]	MASSRATE [t/h]
8,00	**203,3**	**0,2259**	**0,1822**	**1,0073**	**636**	**458,4**	**9,5**	**---**	**---**
9,00	**285,1**	**0,2257**	**0,1822**	**1,0073**	**714**	**645,1**	**13,4**	**---**	**---**
10,00	**394,0**	**0,2254**	**0,1822**	**1,0073**	**750**	**823,0**	**17,1**	**---**	**---**
11,00	**544,6**	**0,2253**	**0,1822**	**1,0073**	**750**	**1006,6**	**21,0**	**---**	**---**
12,00	**756,3**	**0,2251**	**0,1822**	**1,0073**	**750**	**1273,9**	**26,5**	**---**	**---**
13,00	**1049,3**	**0,2249**	**0,1822**	**1,0073**	**750**	**1658,5**	**34,6**	**---**	**---**
+ 14,00 +	**1476,7**	**0,2248**	**0,1822**	**1,0073**	**750**	**2253,7**	**47,0**	**---**	**---**
15,00	**2146,2**	**0,2247**	**0,1822**	**1,0073**	**750**	**3278,6**	**68,3**	**---**	**---**
16,00	**3006,6**	**0,2246**	**0,1822**	**1,0073**	**750**	**4738,6**	**98,7**	**---**	**---**
17,00	**3885,1**	**0,2245**	**0,1822**	**1,0073**	**750**	**6343,1**	**132,1**	**---**	**---**

	EFFICIENCY			THRUST	
SPEED [kt]	EFFO	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
8,00	**0,4430**	**0,4573**	**0,26175**	**60,41**	**49,41**
9,00	**0,4415**	**0,4556**	**0,25881**	**75,30**	**61,58**
10,00	**0,4784**	**0,4935**	**0,28135**	**93,65**	**76,58**
11,00	**0,5407**	**0,5577**	**0,324**	**117,67**	**96,23**
12,00	**0,5936**	**0,6121**	**0,36781**	**149,82**	**122,52**
13,00	**0,6327**	**0,6523**	**0,40943**	**191,86**	**156,90**
+ 14,00 +	**0,6553**	**0,6755**	**0,45004**	**250,71**	**205,03**
15,00	**0,6548**	**0,6749**	**0,48878**	**340,09**	**278,13**
16,00	**0,6347**	**0,6541**	**0,50899**	**446,65**	**365,27**
17,00	**0,6128**	**0,6314**	**0,50998**	**543,21**	**444,23**

	POWER DELIVERY								
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP	CPPITCH [mm]
8,00	**102**	**40,86**	**6,52**	**431,3**	**444,6**	**444,6**	**458,4**	**443,1**	**2070,4**
9,00	**114**	**51,24**	**8,18**	**607,0**	**625,7**	**625,7**	**645,1**	**354,2**	**2070,3**
10,00	**120**	**62,23**	**9,93**	**774,3**	**798,3**	**798,3**	**823,0**	**308,5**	**2225,6**
11,00	**120**	**76,11**	**12,15**	**947,1**	**976,4**	**976,4**	**1006,6**	**277,4**	**2530,0**
12,00	**120**	**96,32**	**15,37**	**1198,6**	**1235,6**	**1235,6**	**1273,9**	**239,1**	**2870,8**
13,00	**120**	**125,40**	**20,01**	**1560,5**	**1608,7**	**1608,7**	**1658,5**	**199,0**	**3256,1**
+ 14,00 +	**120**	**170,41**	**27,20**	**2120,6**	**2186,1**	**2186,1**	**2253,7**	**157,7**	**3719,7**
15,00	**120**	**247,91**	**39,57**	**3084,9**	**3180,3**	**3180,3**	**3278,6**	**116,1**	**4331,3**
16,00	**120**	**358,30**	**57,19**	**4458,6**	**4596,5**	**4596,5**	**4738,6**	**85,7**	**5039,7**
17,00	**120**	**479,62**	**76,55**	**5968,2**	**6152,8**	**6152,8**	**6343,1**	**68,0**	**5724,0**

Propulsion

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Project ID

Description

File name **buque proyecto.hcnc**

Prediction results [Propulsor]

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
8,00	**28,22**	**4,73**	**0,94**	**24,45**	**0,254**	**6,25**	**2,0**	**2,0**	**2168,0**
9,00	**22,28**	**3,75**	**0,75**	**27,45**	**0,268**	**7,79**	**2,0**	**2,0**	**2169,8**
10,00	**18,04**	**3,40**	**0,68**	**28,83**	**0,284**	**9,69**	**2,0**	**2,0**	**2297,6**
11,00	**14,90**	**3,40**	**0,67**	**28,83**	**0,306**	**12,17**	**2,0**	**2,0**	**2539,0**
12,00	**12,51**	**3,40**	**0,67**	**28,83**	**0,335**	**15,50**	**2,0**	**2,0**	**2793,1**
13,00	**10,66**	**3,40**	**0,66**	**28,83**	**0,373**	**19,85**	**2,0**	**2,0**	**3060,1**
+ 14,00 +	**9,19**	**3,40**	**0,65**	**28,83**	**0,426**	**25,94**	**2,0**	**2,0**	**3349,9**
15,00	**8,00**	**3,40**	**0,65**	**28,83**	**0,506**	**35,18**	**2,3**	**2,3**	**3679,9**
16,00	**7,03**	**3,40**	**0,64**	**28,83**	**0,602**	**46,21**	**5,9**	**5,9**	**4018,3**
17,00	**6,23**	**3,40**	**0,63**	**28,83**	**0,689**	**56,19**	**11,4**	**11,4**	**4325,1**

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KT/J2	KQ/J3	CTH	CP	RNPROP	
8,00	**0,4093**	**0,0459**	**0,00675**	**0,27418**	**0,098498**	**0,69818**	**1,5645**	**1,81e7**	
9,00	**0,4104**	**0,0454**	**0,00672**	**0,26984**	**0,097265**	**0,68714**	**1,5449**	**2,03e7**	
10,00	**0,4342**	**0,0512**	**0,00740**	**0,27167**	**0,090386**	**0,69181**	**1,4356**	**2,14e7**	
11,00	**0,4777**	**0,0644**	**0,00905**	**0,28199**	**0,083002**	**0,71809**	**1,3183**	**2,14e7**	
12,00	**0,5213**	**0,0819**	**0,01145**	**0,30155**	**0,080852**	**0,76788**	**1,2842**	**2,15e7**	
13,00	**0,5648**	**0,1049**	**0,01491**	**0,32893**	**0,082746**	**0,83761**	**1,3143**	**2,16e7**	
+ 14,00 +	**0,6084**	**0,1371**	**0,02026**	**0,37047**	**0,089982**	**0,9434**	**1,4292**	**2,17e7**	
15,00	**0,6519**	**0,1860**	**0,02948**	**0,43764**	**0,10638**	**1,1144**	**1,6896**	**2,18e7**	
16,00	**0,6955**	**0,2443**	**0,04260**	**0,50501**	**0,12663**	**1,286**	**2,0112**	**2,19e7**	
17,00	**0,7391**	**0,2971**	**0,05703**	**0,5439**	**0,14125**	**1,385**	**2,2436**	**2,20e7**	

Propulsion

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Description
File name **buque proyecto.hcnc**

Hull data

General		
Configuration:		**Monohull**
Chine type:		**Round/multiple**
Length on WL:		**74,600 m**
Max beam on WL:	[LWL/BWL 5,007]	**14,900 m**
Max molded draft:	[BWL/T 2,129]	**7,000 m**
Displacement:	[CB 0,630]	**5032,00 t**
Wetted surface:	[CS 2,798]	**1692,2 m2**

ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,492]	**36,726 m**
LCF fwd TR:	[XCF/LWL 0,417]	**31,101 m**
Max section area:	[CX 0,970]	**101,2 m2**
Waterplane area:	[CWP 0,802]	**892,0 m2**
Bulb section area:		**13,5 m2**
Bulb ctr below WL:		**3,480 m**
Bulb nose fwd TR:		**81,106 m**
Imm transom area:	[ATR/AX 0,007]	**0,8 m2**
Transom beam WL:	[BTR/BWL 0,423]	**6,300 m**
Transom immersion:	[TTR/T 0,024]	**0,165 m**
Half entrance angle:		**27,00 deg**
Bow shape factor:	[WL flow]	**1,0**
Stern shape factor:	[BTK flow]	**-1,0**

Planing		
Proj chine length:		***0,000 m***
Proj bottom area:		***0,0 m2***
LCG fwd TR:	*[XCG/LP 0,000]*	***0,000 m***
VCG below WL:		***0,000 m***
Aft station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Fwd station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Propulsor type:		***Propeller***
Max prop diameter:		***4600,0 mm***
Shaft angle to WL:		***0,00 deg***
Position fwd TR:		***0,000 m***
Position below WL:		***0,000 m***
Transom lift device:		***Flap***
Device count:		***0***
Span:		***0,000 m***
Chord length:		***0,000 m***
Deflection angle:		***0,00 deg***
Tow point fwd TR:		***0,000 m***
Tow point below WL:		***0,000 m***

Propulsor data

Propulsor			
Count:		**1**	
Propulsor type:		**Propeller series**	
Propeller type:		**CPP**	
Propeller series:		**B Series**	
Propeller sizing:		**By power**	
Reference prop:			
Blade count:		**5**	
Expanded area ratio:		**0,5817**	**[Size]**
Propeller diameter:		**4600,0 mm**	**[Keep]**
Propeller mean pitch:	[P/D 0,9239]	**4249,9 mm**	**[Size]**
Hub immersion:		**4700,0 mm**	

Engine/gear		
Drive line:	**Standard**	
Gear input:	**Single engine**	
Engine data:	**Untitled Engine Obje...**	
Rated RPM:	**750 RPM**	
Rated power:	**4800,0 kW**	
Primary fuel:	**Defined**	
Secondary fuel:	**None**	
Gear efficiency:	**0,970**	
Load correction:	**Off**	
Gear ratio:	**6,266**	**[Size]**
Shaft efficiency:	**0,970**	

Propeller options	
Oblique angle corr:	**Off**
Shaft angle to WL:	**0,00 deg**
Added rise of run:	**0,00 deg**
Propeller cup:	**0,0 mm**
KTKQ corrections:	**Standard**
Scale correction:	**Full ITTC**
KT multiplier:	**1,000**
KQ multiplier:	**1,000**
Blade T/C [0.7R]:	**Standard**
Roughness:	**Standard**
Cav breakdown:	**Off**

Design condition [By power]	
Max prop diam:	**4600,0 mm**
Design speed:	**14,00 kt**
Reference power:	**4800,0 kW**
Design point:	**0,850**
Reference RPM:	**750,0 RPM**
Design point:	**1,050**

Propulsion

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Symbols and values

SPEED =	Vessel speed
PETOTAL =	Total vessel effective power
WFT =	Taylor wake fraction coefficient
THD =	Thrust deduction coefficient
EFFR =	Relative-rotative efficiency
RPMENG =	Engine RPM
PBENG =	Brake power per engine
VOLRATE =	Volumetric fuel rate total Primary
LOADENG =	Engine load as a percentage of engine rated power
RPMPROP =	Propulsor RPM
QPROP =	Propulsor open water torque
QENG =	Engine torque
PDPROP =	Delivered power per propulsor
PSPROP =	Shaft power per propulsor
PSTOTAL =	Total vessel shaft power
PBTOTAL =	Total vessel brake power
TRANSP =	Transport factor
EFFO =	Propulsor open-water efficiency
EFFG =	Gear efficiency (load corrected)
EFFOA =	Overall propulsion efficiency [=PETOTAL/PSTOTAL]
MERIT =	Propulsor merit coefficient
THRPROP =	Open-water thrust per propulsor
DELTHR =	Total vessel delivered thrust
J =	Propulsor advance coefficient
KT =	Propulsor thrust coefficient [horizontal, if in oblique flow]
KQ =	Propulsor torque coefficient
KT/J2 =	Propulsor thrust loading ratio
KQ/J3 =	Propulsor torque loading ratio
CTH =	Horizontal component of bare-hull resistance coefficient
CP =	Propulsor thrust loading coefficient
RNPROP =	Propeller Reynolds number at 0.7R
SIGMAV =	Cavitation number of propeller by vessel speed
SIGMAN =	Cavitation number of propeller by RPM
SIGMA07R =	Cavitation number of blade section at 0.7R
TIPSPEED =	Propeller circumferential tip speed
MINBAR =	Minimum expanded blade area ratio recommended by selected cavitation criteria
PRESS =	Average propeller loading pressure
CAVAVG =	Average predicted back cavitation percentage
CAVMAX =	Peak predicted back cavitation percentage [if in oblique flow]
PITCHFC =	Minimum recommended pitch to avoid face cavitation
+ =	Design speed indicator
* =	Exceeds recommended parameter limit
! =	Exceeds recommended cavitation criteria [warning]
!! =	Substantially exceeds recommended cavitation criteria [critical]
!!! =	Thrust breakdown is indicated [severe]
--- =	Insignificant or not applicable

Propulsion

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Description
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Analysis parameters

Hull-propulsor interaction	
Technique:	**[Calc] Prediction**
Prediction:	**Holtrop**
Reference ship:	
Max prop diam:	**4600,0 mm**
Corrections	
Viscous scale corr:	**[Off]**
Rudder location:	
Friction line:	
Hull form factor:	
Corr allowance:	
Roughness [mm]:	
Ducted prop corr:	**[Off]**
Tunnel stern corr:	**[Off]**

System analysis	
Cavitation criteria:	**Keller eqn**
Analysis type:	**Free run**
CPP method:	**Fixed RPM**
Engine RPM:	
Mass multiplier:	
RPM constraint:	
Limit [RPM/s]:	
Water properties	
Water type:	**Salt**
Density:	**1026,00 kg/m3**
Viscosity:	**1,18920e-6 m2/s**

Prediction method check [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T
Value	**0,27**	**0,65**	**5,01**	**2,13**
Range	**0,06··0,80**	**0,55··0,85**	**3,90··14,90**	**2,10··4,00**

Prediction results [System]

	HULL-PROPULSOR				ENGINE			FUEL PER ENGINE	
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBENG [kW]	LOADENG [% rated]	VOLRATE [L/h]	MASSRATE [t/h]
8,00	**203,3**	**0,2259**	**0,1822**	**1,0047**	**689**	**472,0**	**9,8**	**---**	**---**
9,00	**285,1**	**0,2257**	**0,1822**	**1,0047**	**750**	**638,8**	**13,3**	**---**	**---**
10,00	**394,0**	**0,2254**	**0,1822**	**1,0047**	**750**	**778,7**	**16,2**	**---**	**---**
11,00	**544,6**	**0,2253**	**0,1822**	**1,0047**	**750**	**971,8**	**20,2**	**---**	**---**
12,00	**756,3**	**0,2251**	**0,1822**	**1,0047**	**750**	**1245,2**	**25,9**	**---**	**---**
13,00	**1049,3**	**0,2249**	**0,1822**	**1,0047**	**750**	**1631,4**	**34,0**	**---**	**---**
+ 14,00 +	**1476,7**	**0,2248**	**0,1822**	**1,0047**	**750**	**2221,7**	**46,3**	**---**	**---**
15,00	**2146,2**	**0,2247**	**0,1822**	**1,0047**	**750**	**3232,1**	**67,3**	**---**	**---**
16,00	**3006,6**	**0,2246**	**0,1822**	**1,0047**	**750**	**4677,9**	**97,5**	**---**	**---**
17,00	**3885,1**	**0,2245**	**0,1822**	**1,0047**	**750**	**6303,7**	**131,3**	**---**	**---**

	EFFICIENCY			THRUST	
SPEED [kt]	EFFO	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
8,00	**0,4314**	**0,4441**	**0,25486**	**60,41**	**49,41**
9,00	**0,4471**	**0,4602**	**0,26207**	**75,30**	**61,58**
10,00	**0,5069**	**0,5216**	**0,29815**	**93,65**	**76,58**
11,00	**0,5616**	**0,5777**	**0,3365**	**117,67**	**96,23**
12,00	**0,6089**	**0,6262**	**0,37727**	**149,82**	**122,52**
13,00	**0,6449**	**0,6631**	**0,41735**	**191,86**	**156,90**
+ 14,00 +	**0,6665**	**0,6852**	**0,45775**	**250,71**	**205,03**
15,00	**0,6660**	**0,6846**	**0,49713**	**340,09**	**278,13**
16,00	**0,6447**	**0,6626**	**0,51698**	**446,65**	**365,27**
17,00	**0,6183**	**0,6354**	**0,51453**	**543,21**	**444,23**

	POWER DELIVERY								
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP	CPPITCH [mm]
8,00	**103**	**41,52**	**6,19**	**444,1**	**457,9**	**457,9**	**472,0**	**430,3**	**2070,3**
9,00	**112**	**51,59**	**7,69**	**601,0**	**619,6**	**619,6**	**638,8**	**357,7**	**2147,5**
10,00	**112**	**62,89**	**9,37**	**732,7**	**755,3**	**755,3**	**778,7**	**326,0**	**2444,8**
11,00	**112**	**78,48**	**11,70**	**914,4**	**942,7**	**942,7**	**971,8**	**287,3**	**2768,5**
12,00	**112**	**100,56**	**14,99**	**1171,6**	**1207,8**	**1207,8**	**1245,2**	**244,6**	**3130,3**
13,00	**112**	**131,75**	**19,63**	**1535,0**	**1582,4**	**1582,4**	**1631,4**	**202,3**	**3539,2**
+ 14,00 +	**112**	**179,42**	**26,74**	**2090,4**	**2155,1**	**2155,1**	**2221,7**	**160,0**	**4031,0**
15,00	**112**	**261,02**	**38,90**	**3041,1**	**3135,2**	**3135,2**	**3232,1**	**117,8**	**4681,6**
16,00	**112**	**377,78**	**56,30**	**4401,4**	**4537,5**	**4537,5**	**4677,9**	**86,8**	**5442,7**
17,00	**112**	**509,08**	**75,87**	**5931,2**	**6114,6**	**6114,6**	**6303,7**	**68,5**	**6194,0**

Propulsion

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Project ID

Description

File name **buque proyecto.hcnc**

Prediction results [Propulsor]

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
8,00	**28,22**	**4,63**	**0,93**	**24,72**	**0,260**	**5,80**	**2,0**	**2,0**	**2145,1**
9,00	**22,28**	**3,90**	**0,78**	**26,92**	**0,275**	**7,23**	**2,0**	**2,0**	**2212,1**
10,00	**18,04**	**3,90**	**0,77**	**26,92**	**0,293**	**8,99**	**2,0**	**2,0**	**2460,5**
11,00	**14,90**	**3,90**	**0,77**	**26,92**	**0,317**	**11,29**	**2,0**	**2,0**	**2719,0**
12,00	**12,51**	**3,90**	**0,76**	**26,92**	**0,349**	**14,38**	**2,0**	**2,0**	**2991,1**
13,00	**10,66**	**3,90**	**0,75**	**26,92**	**0,391**	**18,41**	**2,0**	**2,0**	**3277,1**
+ 14,00 +	**9,19**	**3,90**	**0,74**	**26,92**	**0,450**	**24,06**	**2,0**	**2,0**	**3587,4**
15,00	**8,00**	**3,90**	**0,73**	**26,92**	**0,539**	**32,63**	**2,3**	**2,3**	**3940,7**
16,00	**7,03**	**3,90**	**0,72**	**26,92**	**0,645**	**42,86**	**5,9**	**5,9**	**4303,2**
17,00	**6,23**	**3,90**	**0,71**	**26,92**	**0,742**	**52,13**	**11,6**	**11,6**	**4631,7**

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KT/J2	KQ/J3	CTH	CP	RNPROP	
8,00	**0,4049**	**0,0450**	**0,00672**	**0,27417**	**0,10116**	**0,69818**	**1,6111**	**1,64e7**	
9,00	**0,4184**	**0,0472**	**0,00703**	**0,26984**	**0,096056**	**0,68714**	**1,5298**	**1,79e7**	
10,00	**0,4650**	**0,0587**	**0,00857**	**0,27167**	**0,085294**	**0,69181**	**1,3584**	**1,80e7**	
11,00	**0,5116**	**0,0738**	**0,01070**	**0,28199**	**0,079919**	**0,71809**	**1,2728**	**1,80e7**	
12,00	**0,5582**	**0,0940**	**0,01371**	**0,30155**	**0,078823**	**0,76788**	**1,2553**	**1,81e7**	
13,00	**0,6049**	**0,1203**	**0,01796**	**0,32893**	**0,081176**	**0,83761**	**1,2928**	**1,82e7**	
+ 14,00 +	**0,6515**	**0,1573**	**0,02446**	**0,37047**	**0,088466**	**0,9434**	**1,4089**	**1,83e7**	
15,00	**0,6982**	**0,2133**	**0,03559**	**0,43764**	**0,10459**	**1,1144**	**1,6656**	**1,84e7**	
16,00	**0,7448**	**0,2802**	**0,05151**	**0,50501**	**0,12467**	**1,286**	**1,9855**	**1,85e7**	
17,00	**0,7915**	**0,3407**	**0,06942**	**0,5439**	**0,14001**	**1,385**	**2,2297**	**1,86e7**	

Propulsion

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Project ID
Description
File name **buque proyecto.hcnc**

Hull data

General		
Configuration:		**Monohull**
Chine type:		**Round/multiple**
Length on WL:		**74,600 m**
Max beam on WL:	[LWL/BWL 5,007]	**14,900 m**
Max molded draft:	[BWL/T 2,129]	**7,000 m**
Displacement:	[CB 0,630]	**5032,00 t**
Wetted surface:	[CS 2,798]	**1692,2 m2**

ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,492]	**36,726 m**
LCF fwd TR:	[XCF/LWL 0,417]	**31,101 m**
Max section area:	[CX 0,970]	**101,2 m2**
Waterplane area:	[CWP 0,802]	**892,0 m2**
Bulb section area:		**13,5 m2**
Bulb ctr below WL:		**3,480 m**
Bulb nose fwd TR:		**81,106 m**
Imm transom area:	[ATR/AX 0,007]	**0,8 m2**
Transom beam WL:	[BTR/BWL 0,423]	**6,300 m**
Transom immersion:	[TTR/T 0,024]	**0,165 m**
Half entrance angle:		**27,00 deg**
Bow shape factor:	[WL flow]	**1,0**
Stern shape factor:	[BTK flow]	**-1,0**

Planing		
Proj chine length:		***0,000 m***
Proj bottom area:		***0,0 m2***
LCG fwd TR:	*[XCG/LP 0,000]*	***0,000 m***
VCG below WL:		***0,000 m***
Aft station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Fwd station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Propulsor type:		***Propeller***
Max prop diameter:		***4600,0 mm***
Shaft angle to WL:		***0,00 deg***
Position fwd TR:		***0,000 m***
Position below WL:		***0,000 m***
Transom lift device:		***Flap***
Device count:		***0***
Span:		***0,000 m***
Chord length:		***0,000 m***
Deflection angle:		***0,00 deg***
Tow point fwd TR:		***0,000 m***
Tow point below WL:		***0,000 m***

Propulsor data

Propulsor		
Count:	**1**	
Propulsor type:	**Propeller series**	
Propeller type:	**CPP**	
Propeller series:	**B Series**	
Propeller sizing:	**By power**	
Reference prop:		
Blade count:	**6**	
Expanded area ratio:	**0,6271**	**[Size]**
Propeller diameter:	**4600,0 mm**	**[Keep]**
Propeller mean pitch:	[P/D 1,0032] **4614,6 mm**	**[Size]**
Hub immersion:	**4700,0 mm**	

Engine/gear	
Drive line:	**Standard**
Gear input:	**Single engine**
Engine data:	**Untitled Engine Obje...**
Rated RPM:	**750 RPM**
Rated power:	**4800,0 kW**
Primary fuel:	**Defined**
Secondary fuel:	**None**
Gear efficiency:	**0,970**
Load correction:	**Off**
Gear ratio:	**6,710** **[Size]**
Shaft efficiency:	**0,970**

Propeller options	
Oblique angle corr:	**Off**
Shaft angle to WL:	**0,00 deg**
Added rise of run:	**0,00 deg**
Propeller cup:	**0,0 mm**
KTKQ corrections:	**Standard**
Scale correction:	**Full ITTC**
KT multiplier:	**1,000**
KQ multiplier:	**1,000**
Blade T/C [0.7R]:	**Standard**
Roughness:	**Standard**
Cav breakdown:	**Off**

Design condition [By power]	
Max prop diam:	**4600,0 mm**
Design speed:	**14,00 kt**
Reference power:	**4800,0 kW**
Design point:	**0,850**
Reference RPM:	**750,0 RPM**
Design point:	**1,050**

Propulsion

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Symbols and values

SPEED =	Vessel speed
PETOTAL =	Total vessel effective power
WFT =	Taylor wake fraction coefficient
THD =	Thrust deduction coefficient
EFFR =	Relative-rotative efficiency
RPMENG =	Engine RPM
PBENG =	Brake power per engine
VOLRATE =	Volumetric fuel rate total Primary
LOADENG =	Engine load as a percentage of engine rated power
RPMPROP =	Propulsor RPM
QPROP =	Propulsor open water torque
QENG =	Engine torque
PDPROP =	Delivered power per propulsor
PSPROP =	Shaft power per propulsor
PSTOTAL =	Total vessel shaft power
PBTOTAL =	Total vessel brake power
TRANSP =	Transport factor
EFFO =	Propulsor open-water efficiency
EFFG =	Gear efficiency (load corrected)
EFFOA =	Overall propulsion efficiency [=PETOTAL/PSTOTAL]
MERIT =	Propulsor merit coefficient
THRPROP =	Open-water thrust per propulsor
DELTHR =	Total vessel delivered thrust
J =	Propulsor advance coefficient
KT =	Propulsor thrust coefficient [horizontal, if in oblique flow]
KQ =	Propulsor torque coefficient
KT/J2 =	Propulsor thrust loading ratio
KQ/J3 =	Propulsor torque loading ratio
CTH =	Horizontal component of bare-hull resistance coefficient
CP =	Propulsor thrust loading coefficient
RNPROP =	Propeller Reynolds number at 0.7R
SIGMAV =	Cavitation number of propeller by vessel speed
SIGMAN =	Cavitation number of propeller by RPM
SIGMA07R =	Cavitation number of blade section at 0.7R
TIPSPEED =	Propeller circumferential tip speed
MINBAR =	Minimum expanded blade area ratio recommended by selected cavitation criteria
PRESS =	Average propeller loading pressure
CAVAVG =	Average predicted back cavitation percentage
CAVMAX =	Peak predicted back cavitation percentage [if in oblique flow]
PITCHFC =	Minimum recommended pitch to avoid face cavitation
+ =	Design speed indicator
* =	Exceeds recommended parameter limit
! =	Exceeds recommended cavitation criteria [warning]
!! =	Substantially exceeds recommended cavitation criteria [critical]
!!! =	Thrust breakdown is indicated [severe]
--- =	Insignificant or not applicable