Escola Politécnica Superior

Trabajo Fin de Grado
CURSO 2021/22

BUQUE PORTACONTENEDORES 16000 TEUs

Grado en Ingeniería Naval y Oceánica

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UNIVERSIDADE DA CORUÑA

Escola Politécnica Superior

TRABAJO FIN DE GRADO

CURSO 2020/21

BUQUE PORTACONTENEDORES 16000 TEUs

Grado en Ingeniería Naval y Oceánica

CUADERNO 6.

PREDICCIÓN DE POTENCIA Y SELECCIÓN DE LA PLANTA PROPULSORA

UNIVERSIDADE DA CORUÑA

TIPO DE BUQUE: Portacontenedores

CLASIFICACIÓN, COTA Y REGLAMENTOS DE APLICACIÓN: DNV, SOLAS, MARPOL

CARACTERÍSTICAS DE LA CARGA: 16000 TEUS

VELOCIDAD Y AUTONOMÍA: 22 nudos de velocidad de servicio con una autonomía de 20000 millas.

SISTEMAS Y EQUIPOS DE CARGA / DESCARGA: Sin grúas

PROPULSIÓN: Motor Diesel acoplado a línea de ejes

TRIPULACIÓN Y PASAJE: 30

OTROS EQUIPOS E INSTALACIONES:

ALUMNO: **D. Javier García Ávila**

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ACRÓNIMOS USADOS

SÍMBOLO	SIGNIFICADO	UNIDADES
Δ	Desplazamiento	Tn
B	Manga del buque	m
Cb	Coeficiente de bloque	-
Cf	Coeficiente de la flotación	-
Cm	Coeficiente de la maestra	-
Cp	Coeficiente prismático	-
D	Puntal	m
Dp	Diámetro Hélice	m
Fb	Francobordo	m
Fn	Número de Fraude	-
g	Gravedad	m/s^2
GM	Radio metacéntrico	m
KB	Posición vertical del centro de carena	-
KG	Posición vertical del centro de gravedad	-
KM	Posición vertical del metacentro	-
Lpp	Longitud entre perpendiculares del buque	-
Loa	Longitud total del buque	-
P	Potencia	KW
PM	Peso muerto	Tn
PR	Peso en Rosca	Tn
T	Calado	m
Vmx	Velocidad máxima	$m/s \text{ o } Kn$
Vsv	Velocidad servicio	$m/s \text{ o } Kn$
XB, XC	Posición longitudinal del centro de carena	m
XG	Posición longitudinal del centro de gravedad	m

1. Introducción

En el presente cuaderno se procederá al cálculo definitivo de la resistencia al avance y la estimación de la potencia propulsora necesaria para que el buque proyecto cumpla con las especificaciones marcadas por el RPA.

Así mismo, se definirá el propulsor más adecuado para el buque en base a los criterios de cavitación y al rendimiento de éste.

Para ello se emplearán las hidrostáticas obtenidas en el Cuaderno 3 y el software de cálculo Hydrocomp NavCad 2018.

Finalmente se calculará el timón y su ubicación en el buque, se adjuntan a continuación las dimensiones principales del buque, su curva de áreas y sus hidrostáticas.

TEUs Totales	16000 TEUs	Cb	0,7 [-]
TEUs Bodega	6963 TEUs	Cm	0,998[-]
Lpp	356 [m]	Cp	0,7 [-]
Loa	377 [m]	V	22 [Kn]
B	53 [m]	Fn	0.192 [-]
D	31 [m]	Δ	210499 [t]
T	15,5 [m]		

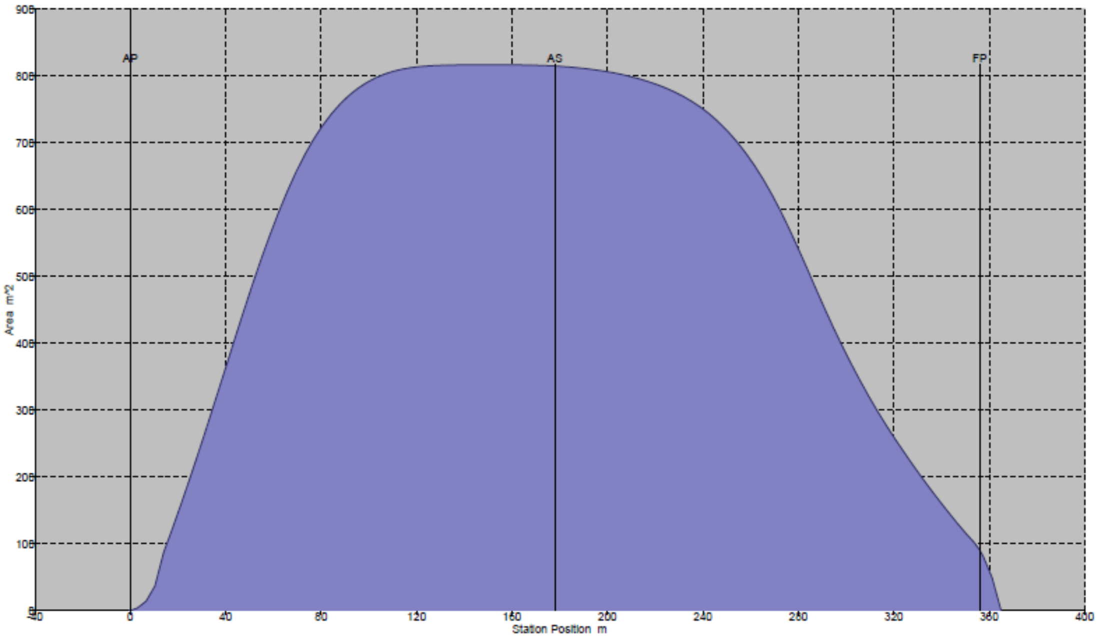


Ilustración 1. Dimensiones principales y curva de áreas

Displacement	210499	t
Volume (displaced)	205365,26	m^3
Draft Amidships	15,51	m
Immersed depth	15,51	m
WL Length	356,769	m
Beam max extents on WL	53	m
Wetted Area	23448,463	m^2
Max sect. area	815,946	m^2
Waterpl. Area	15236,708	m^2
C_P	0,705	-
C_B	0,698	-
C_M	0,99	-
C_F	0,806	-
LCB length	174,296	m
LCF length	163,787	m
LCB %	48,854	-
LCF %	45,909	-
KB	8,163	m
BMt	14,435	m
BML	568,833	m
GMt corrected	22,598	m
GML	576,997	m
KMt	22,598	m
KML	576,997	m
TPc	156,176	t/cm
MTc	3411,726	t/cm
L/B	6,731	-
B/D	3,408	-
$L/V^{1/3}$	6,047	-

Tabla 1. Hidrostáticas del modelo

2. ESTIMACIÓN DE LA POTENCIA PROPULSORA.

La potencia propulsora se calculará mediante la estimación de la resistencia del buque con el software Hydrocomp NavCad.

Para ello se emplearán los datos obtenidos en las hidrostáticas del cuaderno 3, y en caso de requerirse áreas más específicas, estas se justificarán a partir de las formas generadas en cuadernos anteriores y de la curva de áreas.

2.1 Resistencia de formas.

En primer lugar se calculará la resistencia provocada por las formas de la carena, sin contar apéndices.

2.1.1 Casco

El primer paso será introducir los datos correspondientes a las características del casco, siendo estas obtenidas directamente de las hidrostáticas.

Hull	
Configuration	Monohull
Chine Type	Rounf/Multiple
General	
Length on WL	356
Max Beem on WL	53
Max molded draft	15,5
Displacement	210499
Wetted surface	23448,463

Tabla 2. Características principales del casco

2.1.2 Posición longitudinal del centro de flotación desde el espejo de popa.

A continuación, se introducen los datos necesarios para calcular el coeficiente de resistencia total a partir de la ITTC-78, para ello es necesario obtener la ubicación de los centros de flotación y carena desde el espejo de popa y las características del bulbo.

Partiendo de las hidrostáticas, desde la perpendicular de popa, $LCF = 163{,}79\ [m]$, al estar le perpendicular de popa a $12{,}25[m]$ del espejo:

$$\boldsymbol{LCF\ fwd\ TR = 176,04[m]}$$

2.1.3 Posición longitudinal del centro de carena desde el espejo de popa.

Análogamente, $LCB = 174{,}30[m]$, desde la perpendicular de popa, luego:

$$\boldsymbol{LCB\ fwd\ TR = 186,55\ [m]}$$

2.1.4 Bulbo de proa

El área del bulbo se obtiene de la curva de áreas.

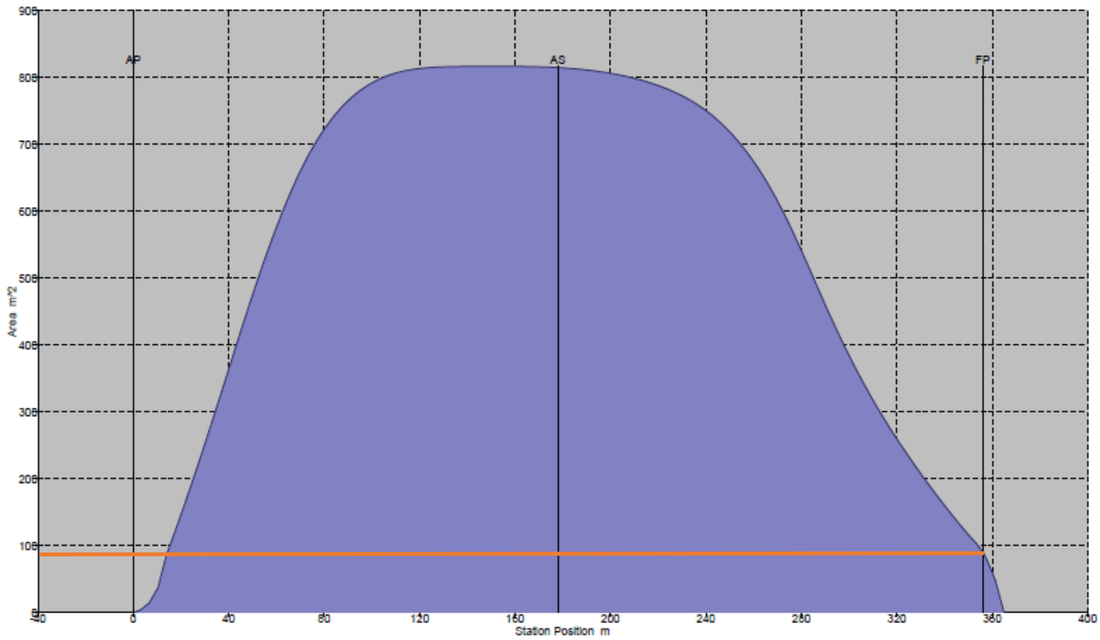


Ilustración 2. Área del bulbo

Se calcula el área que se corresponde a la intersección de la curva con la perpendicular de proa, obteniendo un valor aproximado de

$$A_{Tb} = 95[m^2]$$

La posición longitudinal del bulbo desde el espejo se obtiene de las formas del buque obtenidas en el Cuaderno 3, acotadas con AutoCAD.

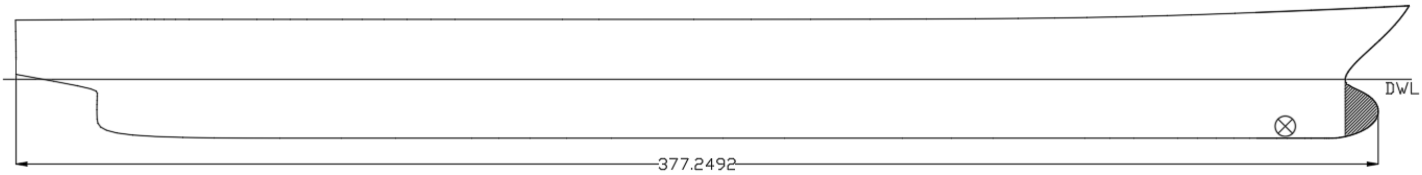


Ilustración 3. Posición longitudinal del bulbo de proa

Luego $Bulb\ nose\ fwd\ TR = 377{,}25[m]$

La posición del bulbo por debajo de la flotación se obtiene restando su altura sobre la línea base al calado.

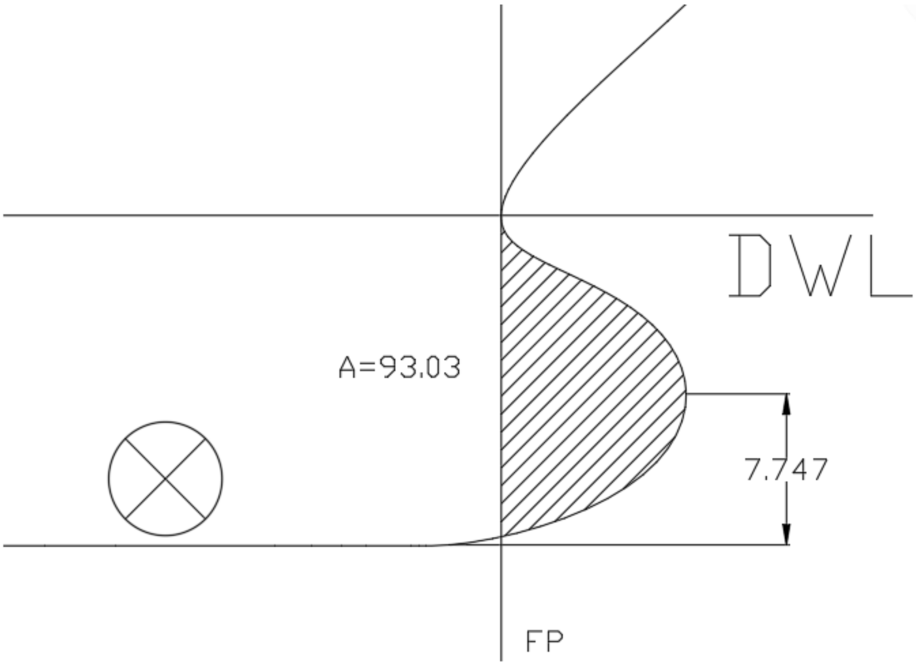


Ilustración 4. Altura del bulbo sobre la línea base

$$Bulb\ ctr\ below\ WL = 15{,}5 - 7{,}75 = 7{,}75\ [m]$$

El semiángulo de entrada se calcula de igual manera a partir de las formas con el software AutoCAD.

A partir de la línea de aguas correspondiente a la altura de la flotación, se trazan dos tangentes y se calcula el ángulo.

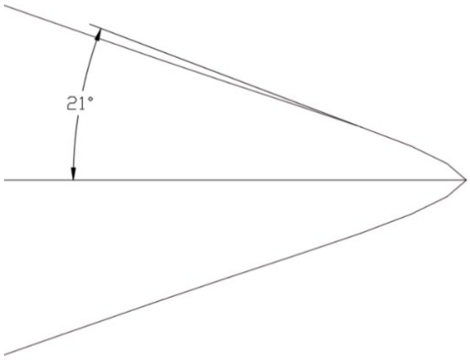


Ilustración 4. Semiángulo de entrada

$$Semiangulo\ =\ 21°$$

2.1.5 Formas de la proa y de la popa.

Se considera que el buque tiene formas en U, por lo que se establecen coeficientes de forma de 1 para ambos.

2.1.6 Área del espejo de popa.

Se calcula de igual manera con AutoCAD, aunque en el buque proyecto no existe ninguna parte del espejo sumergido por lo que en NavCad no se mantendrán como 0 todos los datos relacionados con el espejo sumergido.

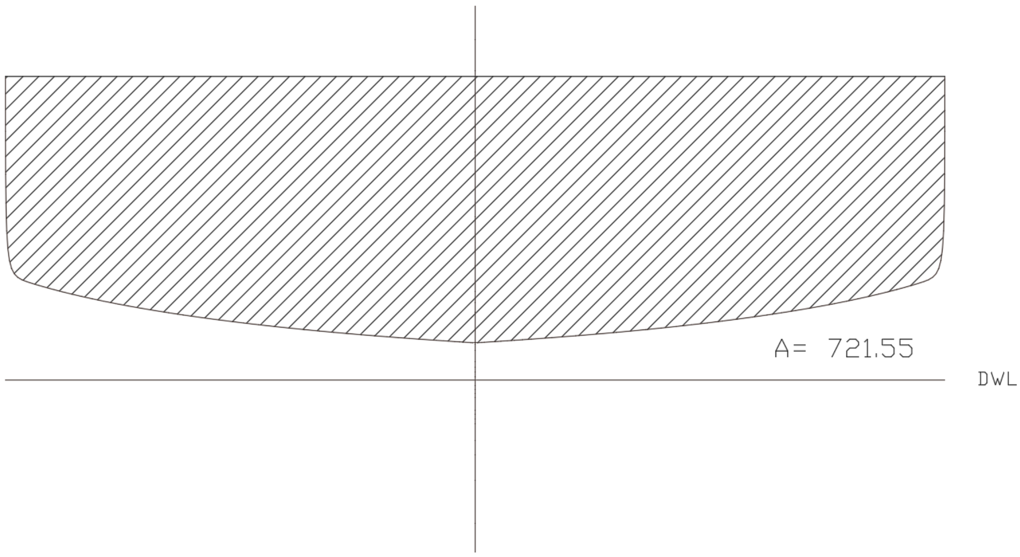


Ilustración 5. Área del espejo de popa

Obteniendo de esta manera los siguientes datos de entrada a NavCad.

ITTC-78 (CT)	
LCB fwd TR	186,55
LCF fwd TR	176,04
Max section Area	815,946
Waterplane Area	15236,708
Bulbsection Area	95
Bulb center below WL	7,75
Bulb nose fwd TR	377,25
IMM transom area	0
Transom beam WL	0
Transom inmersion	0
Half entrance angle	21
Bow shape factor	1
Stern shape factor	1

Tabla 3. ITTC-78 (CT)

2.2 Resistencia por apéndices

La resistencia de apéndices se calculará apéndice por apéndice de manera individual.

El buque proyecto no es una embarcación de planeo, luego no se establece influencia de este sobre los apéndices.

Como apéndices existirán únicamente el timón y el túnel de la hélice de proa.

2.2.1 Ejes

El buque tendrá una única línea de ejes, que no tendrá inclinación, y se considera que no tendrá ninguna parte expuesta.

El eje carece de arbotantes al no estar expuesto.

El diámetro máximo del propulsor se calculó en el Cuaderno 3, y se establece cómo $10{,}8[m]$.

2.2.2 Timón

Se procede ahora a realizar todos los cálculos del timón como son el área, fuerza y par de giro.

El primer paso será calcular el área del timón (con DNV-Pt3-Chapter 3-Sec2):

$$A_T = \frac{L \cdot T}{100} \cdot \left[1 + 50 \cdot C_b^2 \cdot (B/L)^2\right] = 85{,}1\ [m^2]$$

Donde:

- L, eslora entre perpendiculares, 356 [m].
- B, manga, 53 [m].
- T, calado de escantillonado 15,5 [m].
- C_b, coeficiente de bloque, 0,7 [-].

Esta área se considera como válida al estar el timón trabajando tras la hélice, y al no existir configuraciones especiales.

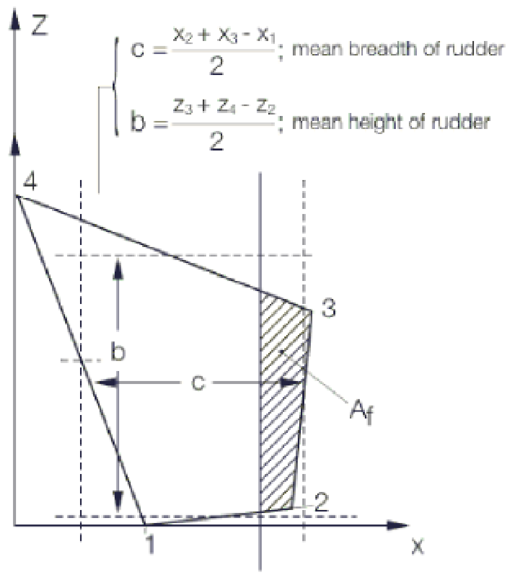


Ilustración 6. Dimensiones del timón (DNV)

Se escoge un timón con forma "*Flat side*", por facilidad constructiva.

Se calcula de esta manera a continuación la fuerza a ejercer por el timón:

$$C_R = 132 \cdot k_1 \cdot k_2 \cdot k_3 \cdot A \cdot V^2 = 6339\ [kN]$$

Donde:

- $k_1 = \frac{\left(\frac{b^2}{A_t}+2\right)}{3} = 1{,}06\ [-]$
- k_2, se toma 1,1 [-] por ser del tipo fastidie. (*Table 3, Rudder profile type*).
- k_3, 1, por no estar el timón detrás de una hélice con tobera.
- A_t, Área del timón, $85{,}1[m^2]$.
- V, Velocidad de servicio, 22 [Kn].
- b, altura del timón, según la *Ilustración 6,* se establece 10 [m] obtenido a partir del buque base.

En caso de que el buque se encuentre ciando:

$$C_{Rciando} = 132 \cdot k_1 \cdot k_2 \cdot k_3 \cdot A \cdot V^2 = 830\ [kN]$$

- $V_{cia} = 0{,}4 \cdot V_{sv} = 8{,}8[kn]$
- $k_2 = 0{,}9$

Table 3 Rudder profile type - coefficient

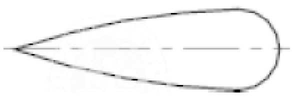
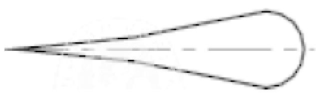
Profile Type	K_2	
	Ahead condition	*Astern condition*
NACA-00 series Göttingen 	1.10	0.80
Flat side 	1.10	0.90
Hollow 	1.35	0.90

Tabla 4. K_2 según tipo de timón

El par del timón será entonces:

$$Q_R = C_R \cdot r = 6339 \cdot 0{,}9 = 5705\ [kN \cdot m]$$

Donde:

- r, es el máximo entre $c \cdot (\alpha - k)$ o $0{,}1 \cdot c$, $r = 9 \cdot 0{,}1 = 0{,}9[m]$.
- c, según la *Ilustración 6*, obtenido del buque referencia, 9 [m].
- $\alpha = 0{,}33$, para el buque navegando avante.

- $k = \frac{A\_f}{A} = 0{,}3$, la relación de áreas entre el área a proa de la mecha y el área total del timón, obtenida del buque referencia.

En el caso de estar ciando:

$$Q_{Rciando} = C_R \cdot r = 830 \cdot 3{,}24 = 2689\ [kN \cdot m]$$

- $r = 9 \cdot (0{,}66 - 0{,}3) = 3{,}24[m]$
- $\alpha = 0{,}66$

El área mojada del timón se estimará con NavCad al no tener datos suficientes para su cálculo.

2.2.3 Resumen de resistencia por apéndices

Se obtienen los siguientes valores para el cálculo de la resistencia de apéndices:

Appendage	
Definition	Component
Percentage	-
Shafting	
Count	1
Max Prop diameter	0
Shaft angle	0
Rudder	
Count	1
Rudder location	Behid Propeller
Root chord	9
Tip chord	5,4
Span	10
T/C ratio	0,15
LE sweep	0
Projected Area	85,1
Wetted Surface	146,15

Tabla 5. Resistencia por apéndices

2.3 Resistencia debida al entorno

Se considerará únicamente la resistencia debida al viento, al considerarse que la resistencia se calculará en condiciones de prueba de puerto, sin existencia de olas ni corrientes.

Se considerará viento moderado de 3 nudos.

Al ser un buque portacontenedores, se considerará la presencia de estos sobre cubierta para calcular las áreas expuestas.

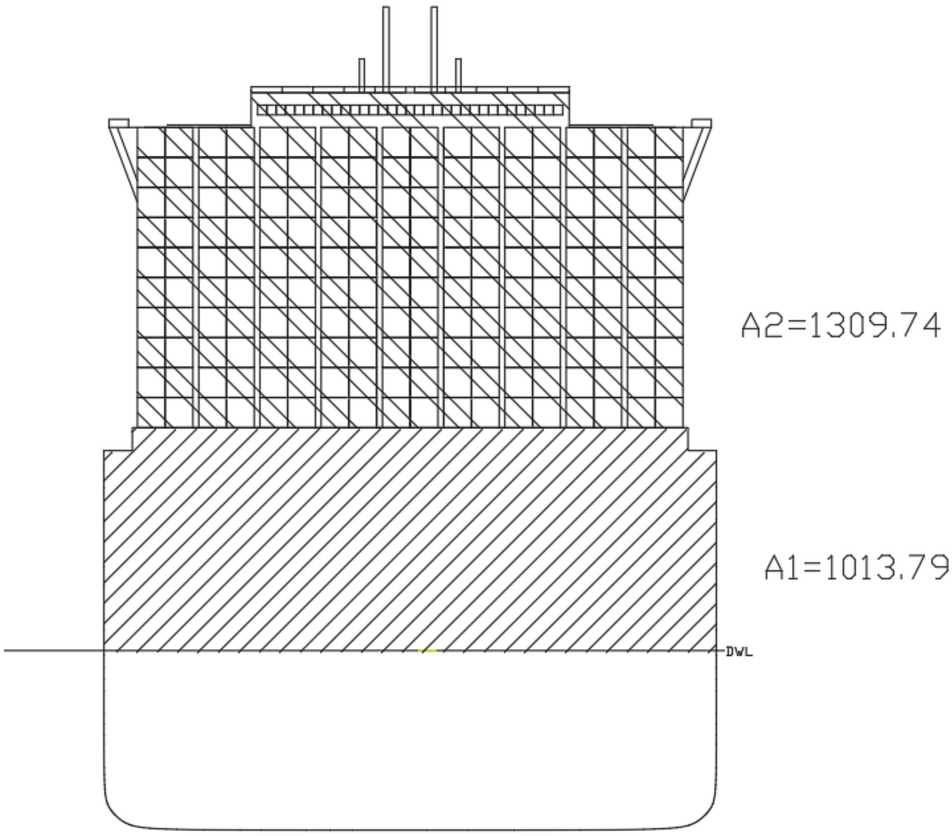


Ilustración 7. Área transversal expuesta al viento.

Considerando el área uno como el área de casco expuesto, y el área dos el área de superestructura (incluyendo puente y contenedores).

Se obtiene de igual manera el centro vertical de cada una de las áreas con respecto a la línea de flotación, obteniendo de esta manera los siguientes datos:

$$A_{Thull} = 1013{,}79[m^2]$$

$$VCE_{Ahull} = 8{,}5[m]$$

$$A_{Tspr} = 1309{,}74[m^2]$$

$$VCE_{Aspr} = 33[m]$$

En cuanto a las áreas de perfil:

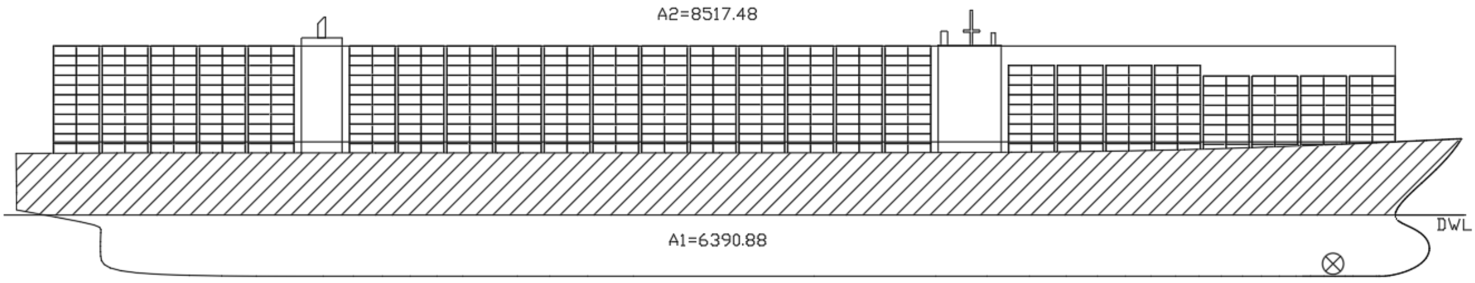


Ilustración 8. Áreas en el perfil

Se obtienen los siguientes valores:

$$A_{Phull} = 6390{,}88\ [m^2]$$

$$A_{Pspr} = 8517{,}48\ [m^2]$$

Obteniéndose las siguientes datos para el viento.

Wind	
Wind Speed	Component
Angle of Bow	0
Gradient Correction	Off

Exsposed Hull	
Transverse Area	1013,79
VCE above WL	8,5
Profile area	6390,88

Superestructure	
Superestrictire shape	Container Ship
Transverse Area	1309,74
VCE above WL	33
Profile Area	8517,48

Tabla 6. Resistencia por viento

2.4 Calculo de la resistencia total

Finalmente se establece un margen a todo de un 8% de todas las partidas calculadas, por ser un cálculo preliminar de resistencia.

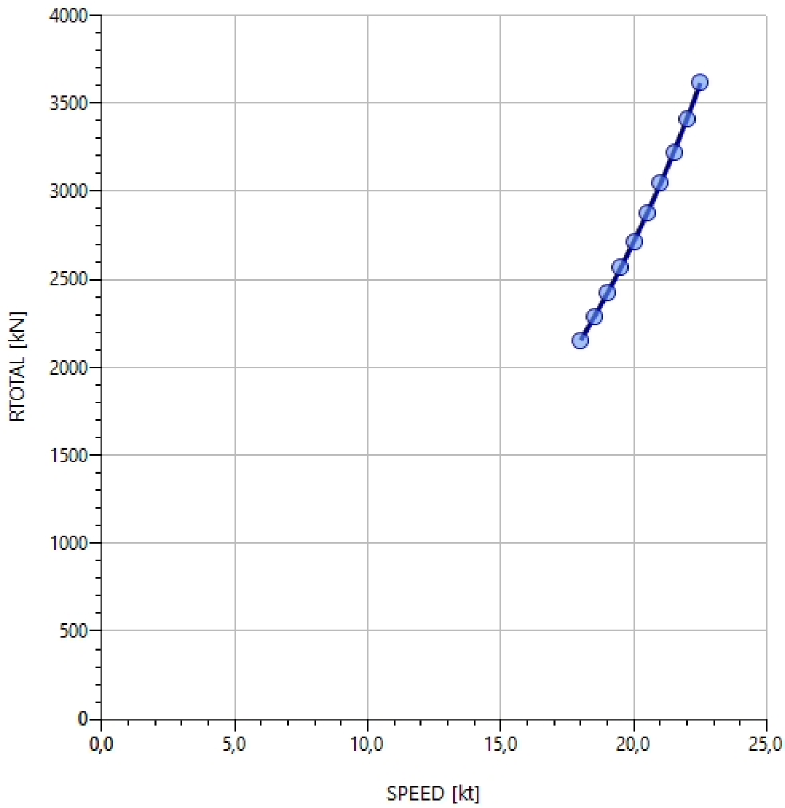
El cálculo se realizará por el método de Holtrop usando la línea de fricción de la ITTC-57 y un factor de forma calculado por Holtrop por mantener uniformidad en los métodos empleados.

Se establece una rugosidad media de 0,15 [mm], correspondiente a un casco nuevo.

Los apéndices se calcularán de igualmente mediante Holtrop, componente a componente.

El viento se calculará mediante Taylor al ser apropiado para todo tipo de buques.

Se obtiene la siguiente gráfica:



Gráfica 1. Resistencia calculada.

Se anexionan los reportes obtenidos de este cálculo.

3. ELECCIÓN DEL MOTOR PROPULSOR

El motor propulsor se escogerá en función de la potencia propulsiva que ha de calcularse a partir de la resistencia anteriormente obtenida.

3.1 Cálculo de la potencia propulsiva

La potencia propulsiva se calcula con NavCad en el apartado de propulsión.

Se empleará una técnica de predicción de Holtrop por uniformidad con la resistencia.

El diámetro máximo del propulsor se calculó en el cuaderno 3 y se establece en $D_{mx} = 10{,}8[m]$.

Para el cálculo se activan las correcciones debidas a la viscosidad. Se establece que el timón se encuentra detrás de la hélice y se aplica el factor de forma del casco calculado en el apartado de resistencia.

En el análisis se tendrá en cuenta un análisis de tiro libre que esté sujeto bajo los criterios de cavitación de Keller.

A continuación se introducen los datos del propulsor para calcular la potencia propulsiva, para ello se introducirán las siguientes características del propulsor:

Propulsor	
Count	1
Propulsor Type	Propeller Series
Type	FPP
Series	B Series
Sizing	By Trust
Blade Count	4
Expanded Area Ratio	-
Propeller Diameter	-
Propeller Mean Pitch	-
Hub inmersion	10000

Engine/gear	
Drive line	Dorect drive
Engine Data	None defined
Primary fuel	Defined
Shaft efficiency	0,97

Tabla 7. Datos para la estimación de la potencia propulsiva

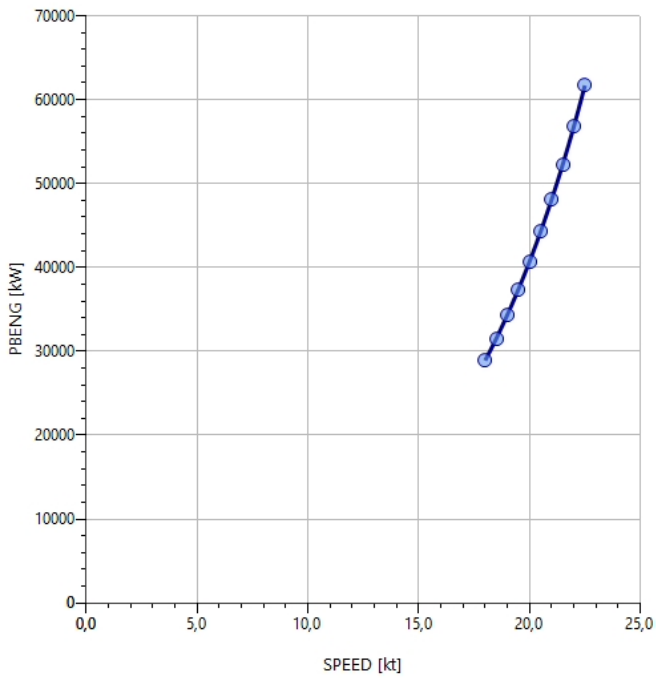
Una vez introducidos estos datos se calculan los siguientes parámetros marcando “size” en ellos:

To size		
Shaft RPM	Size	75,1
Expanded Area Ratio	Size	0,66
Propeller Diameter	Size	10800
Propeller mean pitch	Size	9667

Design condition	
Design speed	22 kn
Reference Thrust	Total in service
Design point	Standard
Reference RPM	-
Design point	3% Margin
Max Prop Diam	10800

Tabla 8. Resultados obtenidos de la estimación de la potencia propulsiva.

Se obtiene la siguiente curva de potencia:



Gráfica 2. Curva de potencia

Que arroja un valor a la velocidad de servicio de $P_{Vsrv} = 56795{,}9[KW]$.

Aplicando un margen de mar del 15% y un alternador de cola de 4000 [KW]:

$$\boldsymbol{P_{Eng} = \frac{56795,9\ + 4000}{0,85} = 71525\ [KW]}$$

Se selecciona ahora un motor del fabricante Wärtsilä, concretamente el X92 de 12 cilindros R1 que aporta una potencia de $73560[KW]$ a $76\ [rpm]$ Cuyo catálogo se encuentra en el Anexo 3.

4. DISEÑO DEL PROPULSOR

Una vez seleccionado el motor propulsor se procede a calcular el propulsor más adecuado de acuerdo con el rendimiento y el criterio de cavitación.

Para ello, manteniendo los datos del cálculo anterior se cambia el parámetro *"propeller Sizing*" a "*By power*".

Se calculará el propulsor con 4, 5 y 6 palas y se compararán los resultados.

4.1 4 palas

To size		
Shaft RPM	Keep	76
Expanded Area Ratio	Size	0,758
Propeller Diameter	Size	10800
Propeller mean pitch	Size	9952,5

Design condition	
Design speed	22 kn
Reference Power	73560
Design point	Standard
Reference RPM	76
Design point	3% Margin
Max Prop Diam	10800

Tabla 9. 4 palas

Se obtiene un rendimiento EFFO de $0{,}520[-]$ y una cavitación máxima de 3,2 %.

4.2 5 Palas

To size		
Shaft RPM	Keep	76
Expanded Area Ratio	Size	0,833
Propeller Diameter	Size	10800
Propeller mean pitch	Size	9757,5

Design condition	
Design speed	22 kn
Reference Power	73560
Design point	Standard
Reference RPM	76
Design point	3% Margin
Max Prop Diam	10800

Tabla 10. 5 palas

Obteniendo un rendimiento EFFO de $0{,}578\ [-]$ y una cavitación máxima de 2,4 %.

4.3 6 Palas

To size		
Shaft RPM	Keep	76
Expanded Area Ratio	Size	0,894
Propeller Diameter	Size	10800
Propeller mean pitch	Size	9534,6

Design condition	
Design speed	22 kn
Reference Power	73560
Design point	Standard
Reference RPM	76
Design point	3% Margin
Max Prop Diam	10800

Tabla 11. 6 palas

Obteniendo un rendimiento EFFO de $0{,}571\ [-]$ y una cavitación máxima de 2,0 %.

4.4 Selección del propulsor

Comparando los tres propulsores calculados:

Número de palas	Rendimiento	Criterio de cavitación
4	0,520	3,2%
5	0,578	2,4%
6	0,571	2,0%

Tabla 12. Comparativa de propulsores

En base al rendimiento el propulsor de cinco palas resulta el óptimo a pesar de perder con el propulsor de seis palas en el apartado del criterio de cavitación de Keller.

Al no ser una probabilidad de cavitación elevada y tener el rendimiento más elevado, se decide optar por el propulsor de 5 palas, quedando las características del propulsor reflejadas en la siguiente tabla.

Potencia del motor	73560 [KW]
RPM	76 [rpm]
Ratio de área expandida	0,833 [-]
Diámetro	10800 [mm]
Paso efectivo	9757,5 [mm]

Tabla 13. Propulsor seleccionado

6. CLARAS DE CODASTE

Se procede a continuación a diseñar los huelgos de la hélice necesarios para si correcta operación, a partir de la siguiente ilustración:

Table C1 Minimum clearances	
For single screw ships:	*For twin screw ships:*
a ≥ 0,2 R (m)	
b ≥ (0,7 – 0,04 Z_P) R (m)	
c ≥ (0,48 – 0,02 Z_P) R (m)	c ≥ (0,6 – 0,02 Z_P) R (m)
e ≥ 0,07 R (m)	

R =propeller radius in m
Z_P =number of propeller blades.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

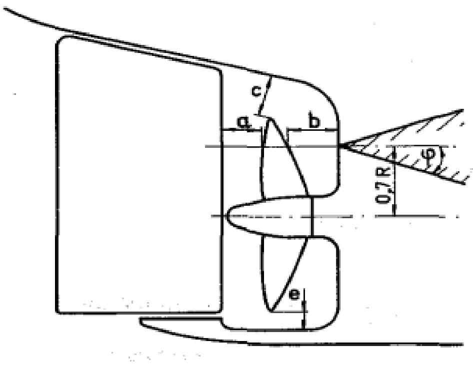


Fig. 2
Propeller clearances

Ilustración 9. Huelgos de la hélice

Teniendo en cuenta las fórmulas de la ilustración 1:

$$a \geq 0{,}2 \cdot R = 1{,}08\ [m]$$

$$b \geq \left(0{,}7 - 0{,}04 \cdot Z_p\right) \cdot R = 3{,}24\ [m]$$

$$c \geq \left(0{,}48 - 0{,}02 \cdot Z_p\right) \cdot R = 2{,}05\ [m]$$

$$e \geq 0{,}07 \cdot R = 0{,}76\ [m]$$

Estación radial a 0,7: $0{,}7 \cdot R = 3{,}78[m]$

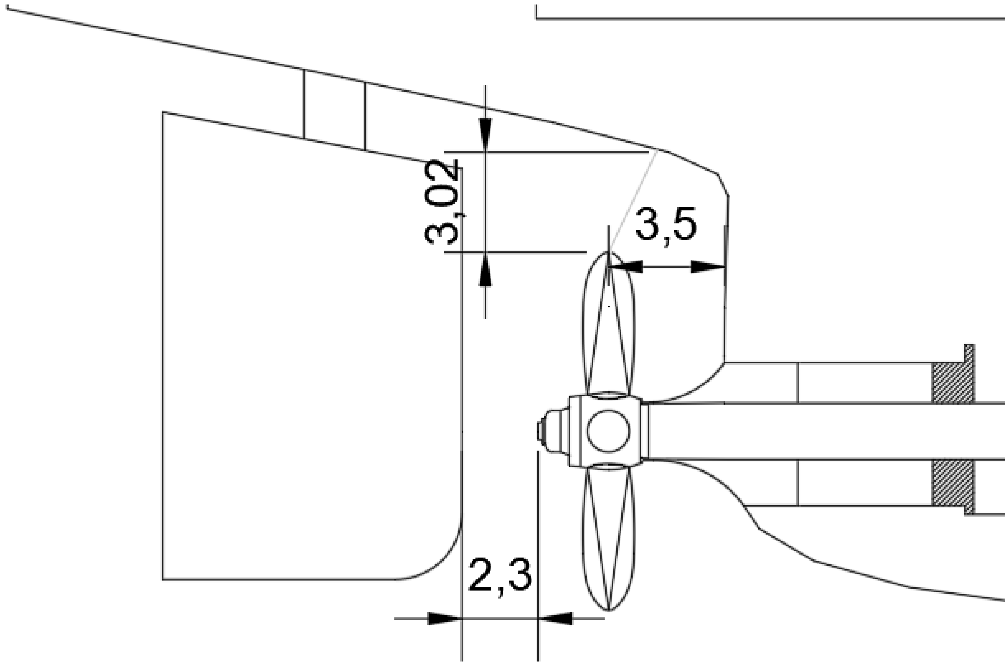


Ilustración 10. Diseño del codastre

BIBLIOGRAFÍA

[1] ABRAMOWSKI, Tomasz, Tomasz CEPOWSKI y Peter ZVOLENSKY. Determination Of Regression Formulas for key Design characteristics container ships at preliminary design stage. 2018.

[2] JUNCO OCAMPO, Fernando Antonio. *Proyectos de buques y artefactos. Anteproyecto y dimensionamiento del buque*. Ferrol: Universidade da Coruña, [sin fecha].

[3] CONDE ALONSO, Nadia. *Buque portacontenedores post panamax 9000 TEU's* . Trabajo fin de máster, Universidade da Coruña, 2017.

[4] DNV-GL. *Rules for classification of ships. July 2021.* Oslo, Norway. 2021

[5] PARSONS, M. G. *Parametric ship design*.

[6] PUENTE VARELA, B. y DIAZ CASAS, V. *Apuntes de proyectos de buques y artefactos I*. Ferrol: Universidade da Coruña, 2021.

[7] PUENTE VARELA, B. y DIAZ CASAS, V. Apuntes de proyectos de buques y artefactos II. Ferrol: Universidade da Coruña, 2022.

[8] RODRÍGUEZ GONZÁLEZ, Miguel Ángel. *Buque portacontenedores de 20000 TEUS adaptado a ruta Asia-Europa*. Ferrol: Universidade da Coruña, 2021.

[9] SCHNEEKLUTH, H. y V. BERTRAM. *Ship design for efficency and economy*. Oxford: Butterworth-Heinemann, 1989.

[10] VAN DOKKMUN, Klaas. *Ship Knowledge. Ship Design, construction and operation*. 5ª ed. Enkhuizen: Dokmar.

[11] WATSON, D. G. M. Proyecto del buque mercante.

ANEXO 1. CÁLCULO DE LA RESISTENCIA

Resistance

18 feb 2022 10:48
HydroComp NavCad 2018

Project ID
Description
File name C-6.hcnc

Analysis parameters

Vessel drag	ITTC-78 (CT)	Added drag	
Technique:	[Calc] Prediction	Appendage:	[Calc] Holtrop (Component)
Prediction:	Holtrop	Wind:	[Calc] Taylor
Reference ship:		Seas:	[Off]
Model LWL:		Shallow/channel:	[Off]
Expansion:	Custom	Towed:	[Off]
Friction line:	ITTC-57	Margin:	[Calc] Hull + added drag [8%]
Hull form factor:	[On] 1,214	**Water properties**	
Speed corr:	[On]	Water type:	Salt
Spray drag corr:	[Off]	Density:	1026,00 kg/m3
Corr allowance:	0,000050	Viscosity:	1,18920e-6 m2/s
Roughness [mm]:	[On] 0,15		

Prediction method check [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T	Lambda
Value	0,19	0,71	6,72	3,42	0,82
Range	0,06--0,40	0,55--0,85	3,90--14,90	2,10--4,00	0,01--1,07

Prediction results

	SPEED COEFS		ITTC-78 COEFS						
SPEED [kt]	FN	FV	RN	CF	[CV/CF]	CR	dCF	CA	CT
18,00	0,157	0,385	2,77e9	0,001354	1,211	0,000103	0,000000	0,000050	0,001792
18,50	0,161	0,396	2,85e9	0,001350	1,211	0,000116	0,000000	0,000050	0,001800
19,00	0,165	0,406	2,93e9	0,001345	1,210	0,000132	0,000000	0,000050	0,001810
19,50	0,170	0,417	3,00e9	0,001341	1,210	0,000149	0,000000	0,000050	0,001822
20,00	0,174	0,428	3,08e9	0,001337	1,209	0,000169	0,000000	0,000050	0,001836
20,50	0,178	0,439	3,16e9	0,001334	1,209	0,000191	0,000000	0,000050	0,001853
21,00	0,183	0,449	3,23e9	0,001330	1,208	0,000215	0,000000	0,000050	0,001871
21,50	0,187	0,460	3,31e9	0,001326	1,207	0,000241	0,000000	0,000050	0,001893
+ 22,00 +	0,192	0,471	3,39e9	0,001323	1,207	0,000270	0,000000	0,000050	0,001916
22,50	0,196	0,481	3,47e9	0,001319	1,206	0,000302	0,000000	0,000050	0,001942

	RESISTANCE							
SPEED [kt]	RBARE [kN]	RAPP [kN]	RWIND [kN]	RSEAS [kN]	RCHAN [kN]	RTOWED [kN]	RMARGIN [kN]	RTOTAL [kN]
18,00	1848,80	22,08	124,74	0,00	0,00	0,00	159,65	2155,27
18,50	1961,49	23,25	130,75	0,00	0,00	0,00	169,24	2284,73
19,00	2080,29	24,45	136,90	0,00	0,00	0,00	179,33	2420,97
19,50	2205,72	25,68	143,19	0,00	0,00	0,00	189,97	2564,56
20,00	2338,33	26,93	149,63	0,00	0,00	0,00	201,19	2716,09
20,50	2478,70	28,22	156,21	0,00	0,00	0,00	213,05	2876,18
21,00	2627,44	29,53	162,92	0,00	0,00	0,00	225,59	3045,49
21,50	2785,20	30,87	169,78	0,00	0,00	0,00	238,87	3224,72
+ 22,00 +	2952,65	32,24	176,78	0,00	0,00	0,00	252,93	3414,61
22,50	3130,38	33,63	183,92	0,00	0,00	0,00	267,84	3615,78

	EFFECTIVE POWER		OTHER		
SPEED [kt]	PEBARE [kW]	PETOTAL [kW]	CTLR	CTLT	RBARE/W
18,00	17119,9	19957,8	0,00209	0,03648	0,00090
18,50	18667,9	21744,3	0,00236	0,03664	0,00095
19,00	20333,7	23663,6	0,00268	0,03684	0,00101
19,50	22127,0	25726,8	0,00304	0,03708	0,00107
20,00	24058,8	27945,5	0,00344	0,03737	0,00113
20,50	26140,7	30332,5	0,00388	0,03771	0,00120
21,00	28385,1	32901,4	0,00437	0,03809	0,00127
21,50	30805,9	35667,2	0,00491	0,03852	0,00135
+ 22,00 +	33417,5	38645,8	0,00550	0,03900	0,00143
22,50	36234,2	41852,6	0,00614	0,03953	0,00152

Report ID20220218-1048 HydroComp NavCad 2018 18.04.0073.0539.U1002

Resistance

18 feb 2022 10:48
HydroComp NavCad 2018

Project ID
Description
File name **C-6.hcnc**

Hull data

General			Planing		
Configuration:		**Monohull**	Proj chine length:		**0,000 m**
Chine type:		**Round/multiple**	Proj bottom area:		**0,000 m2**
Length on WL:		**356,000 m**	LCG fwd TR:	[XCG/LP 0,000]	**0,000 m**
Max beam on WL:	[LWL/BWL 6,717]	**53,000 m**	VCG below WL:		**0,000 m**
Max molded draft:	[BWL/T 3,419]	**15,510 m**	Aft station (fwd TR):		**0,000 m**
Displacement:	[CB 0,701]	**210499,00 t**	Deadrise:		**0,00 deg**
Wetted surface:	[CS 2,744]	**23448,463 m2**	Chine beam:		**0,000 m**
ITTC-78 (CT)			Chine ht below WL:		**0,000 m**
LCB fwd TR:	[XCB/LWL 0,524]	**186,550 m**	Fwd station (fwd TR):		**0,000 m**
LCF fwd TR:	[XCF/LWL 0,494]	**176,040 m**	Deadrise:		**0,00 deg**
Max section area:	[CX 0,993]	**815,946 m2**	Chine beam:		**0,000 m**
Waterplane area:	[CWP 0,808]	**15236,708 m2**	Chine ht below WL:		**0,000 m**
Bulb section area:		**95,000 m2**	Propulsor type:		**Propeller**
Bulb ctr below WL:		**7,750 m**	Max prop diameter:		**10,8 mm**
Bulb nose fwd TR:		**377,250 m**	Shaft angle to WL:		**0,00 deg**
Imm transom area:	[ATR/AX 0,000]	**0,000 m2**	Position fwd TR:		**0,000 m**
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**	Position below WL:		**0,000 m**
Transom immersion:	[TTR/T 0,000]	**0,000 m**	Transom lift device:		**Flap**
Half entrance angle:		**21,00 deg**	Device count:		**0**
Bow shape factor:	[WL flow]	**1,0**	Span:		**0,000 m**
Stern shape factor:	[WL flow]	**1,0**	Chord length:		**0,000 m**
			Deflection angle:		**0,00 deg**
			Tow point fwd TR:		**0,000 m**
			Tow point below WL:		**0,000 m**

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Resistance

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HydroComp NavCad 2018

Project ID
Description
File name **C-6.hcnc**

Appendage data

General		**Skeg/Keel**	
Definition:	**Component**	Count:	**0**
Percent of hull drag:	**0,00 %**	Type:	**Skeg**
Planing influence		Mean length:	**0,000 m**
LCE fwd TR:	**0,000 m**	Mean width:	**0,000 m**
VCE below WL:	**0,000 m**	Height aft:	**0,000 m**
Shafting		Height mid:	**0,000 m**
Count:	**1**	Height fwd:	**0,000 m**
Max prop diameter:	**10,8 mm**	Projected area:	**0,000 m2**
Shaft angle to WL:	**0,00 deg**	Wetted surface:	**0,000 m2**
Exposed shaft length:	**0,000 m**	**Stabilizer**	
Shaft diameter:	**0,000 m**	Count:	**0**
Wetted surface:	**0,000 m2**	Root chord:	**0,000 m**
Strut bossing length:	**0,000 m**	Tip chord:	**0,000 m**
Bossing diameter:	**0,000 m**	Span:	**0,000 m**
Wetted surface:	**0,000 m2**	T/C ratio:	**0,000**
Hull bossing length:	**0,000 m**	LE sweep:	**0,00 deg**
Bossing diameter:	**0,000 m**	Wetted surface:	**0,000 m2**
Wetted surface:	**0,000 m2**	Projected area:	**0,000 m2**
Strut (per shaft line)		Dynamic multiplier:	**1,00**
Count:	**0**	**Bilge keel**	
Root chord:	**0,000 m**	Count:	**0**
Tip chord:	**0,000 mm**	Mean length:	**0,000 m**
Span:	**0,000 m**	Mean base width:	**0,000 m**
T/C ratio:	**0,000**	Mean projection:	**0,000 m**
Projected area:	**0,000 m2**	Wetted surface:	**0,000 m2**
Wetted surface:	**0,000 m2**	**Tunnel thruster**	
Exposed palm depth:	**0,000 m**	Count:	**0**
Exposed palm width:	**0,000 m**	Diameter:	**0,000 m**
Rudder		**Sonar dome**	
Count:	**1**	Count:	**0**
Rudder location:	**Behind propeller**	Wetted surface:	**0,000 m2**
Type:	**Balanced foil**	**Miscellaneous**	
Root chord:	**9,000 m**	Count:	**0**
Tip chord:	**5,400 m**	Drag area:	**0,000 m2**
Span:	**10,000 m**	Drag coef:	**0,00**
T/C ratio:	**0,150**		
LE sweep:	**0,00 deg**		
Projected area:	**85,100 m2**		
Wetted surface:	**146,150 m2**		

Environment data

Wind		**Seas**	
Wind speed:	**3,00 kt**	Significant wave ht:	**0,000 m**
Angle off bow:	**0,00 deg**	Modal wave period:	**0,0 sec**
Gradient correction:	**Off**	**Shallow/channel**	
Exposed hull		Water depth:	**0,000 m**
Transverse area:	**1013,790 m2**	Type:	**Shallow water**
VCE above WL:	**8,500 m**	Channel width:	**0,000 m**
Profile area:	**6390,880 m2**	Channel side slope:	**0,00 deg**
Superstructure		Hull girth:	**0,000 m**
Superstructure shape:	**Container ship**		
Transverse area:	**1309,740 m2**		
VCE above WL:	**33,000 m**		
Profile area:	**8517,480 m2**		

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Resistance

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HydroComp NavCad 2018

Project ID
Description
File name C-6.hcnc

Symbols and values

SPEED = Vessel speed
FN = Froude number [LWL]
FV = Froude number [VOL]

RN = Reynolds number [LWL]
CF = Frictional resistance coefficient
CV/CF = Viscous/frictional resistance coefficient ratio [dynamic form factor]
CR = Residuary resistance coefficient
dCF = Added frictional resistance coefficient for roughness
CA = Correlation allowance [dynamic]
CT = Total bare-hull resistance coefficient

RBARE = Bare-hull resistance
RAPP = Additional appendage resistance
RWIND = Additional wind resistance
RSEAS = Additional sea-state resistance
RCHAN = Additional shallow/channel resistance
RTOWED = Additional towed object resistance
RMARGIN = Resistance margin
RTOTAL = Total vessel resistance

PEBARE = Bare-hull effective power
PETOTAL = Total effective power

CTLR = Telfer residuary resistance coefficient
CTLT = Telfer total bare-hull resistance coefficient
RBARE/W = Bare-hull resistance to weight ratio

+ = Design speed indicator
* = Exceeds parameter limit

Report ID20220218-1048 HydroComp NavCad 2018 18.04.0073.0539.U1002

ANEXO 2. ESTIMACIÓN POTENCIA PROPULSORA

Propulsion

18 feb 2022 11:30
HydroComp NavCad 2018

Project ID
Description
File name C-6.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:	
Max prop diam:	10800,0 mm	Engine RPM:	
Corrections		Mass multiplier:	
Viscous scale corr:	[On] Custom	RPM constraint:	
Rudder location:	Behind propeller	Limit [RPM/s]:	
Friction line:	ITTC-57	**Water properties**	
Hull form factor:	1,214	Water type:	Salt
Corr allowance:	0,000050	Density:	1026,00 kg/m3
Roughness [mm]:	[On] 0,15	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	0,19	0,71	6,72	3,42
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]
18,00	19957,8	0,3458	0,2047	1,0016	60	28910,8	0,0	---	---
18,50	21744,3	0,3457	0,2047	1,0016	62	31528,6	0,0	---	---
19,00	23663,6	0,3455	0,2047	1,0016	64	34352,0	0,0	---	---
19,50	25726,8	0,3453	0,2047	1,0016	66	37399,8	0,0	---	---
20,00	27945,5	0,3451	0,2047	1,0016	67	40692,7	0,0	---	---
20,50	30332,5	0,3450	0,2047	1,0016	69	44253,2	0,0	---	---
21,00	32901,4	0,3448	0,2047	1,0016	71	48105,6	0,0	---	---
21,50	35667,2	0,3446	0,2047	1,0016	73	52276,9	0,0	---	---
+ 22,00 +	38645,8	0,3445	0,2047	1,0016	75	56795,9	0,0	---	---
22,50	41852,6	0,3443	0,2047	1,0016	77	61691,2	0,0	---	---

	EFFICIENCY			THRUST	
SPEED [kt]	EFFO	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
18,00	0,5844	0,6903	0,51801	2709,86	2155,26
18,50	0,5840	0,6897	0,51843	2872,63	2284,73
19,00	0,5835	0,6889	0,51901	3043,93	2420,97
19,50	0,5828	0,6879	0,51975	3224,46	2564,55
20,00	0,5820	0,6867	0,52064	3414,97	2716,07
20,50	0,5810	0,6854	0,5217	3616,25	2876,16
21,00	0,5799	0,6839	0,52291	3829,13	3045,47
21,50	0,5786	0,6823	0,52429	4054,50	3224,71
+ 22,00 +	0,5772	0,6804	0,52582	4293,25	3414,60
22,50	0,5756	0,6784	0,5275	4546,18	3615,77

	POWER DELIVERY							
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
18,00	60	4445,16	4445,16	28043,5	28910,8	28910,8	28910,8	660,9
18,50	62	4711,06	4711,06	30582,7	31528,6	31528,6	31528,6	622,9
19,00	64	4990,37	4990,37	33321,4	34352,0	34352,0	34352,0	587,1
19,50	66	5284,17	5284,17	36277,8	37399,8	37399,8	37399,8	553,5
20,00	67	5593,59	5593,59	39471,9	40692,7	40692,7	40692,7	521,7
20,50	69	5919,82	5919,82	42925,6	44253,2	44253,2	44253,2	491,7
21,00	71	6264,10	6264,10	46662,4	48105,6	48105,6	48105,6	463,4
21,50	73	6627,76	6627,76	50708,6	52276,9	52276,9	52276,9	436,6
+ 22,00 +	75	7012,15	7012,15	55092,0	56795,9	56795,9	56795,9	411,2
22,50	77	7418,48	7418,48	59840,5	61691,2	61691,2	61691,2	387,2

Report ID20220218-1130 HydroComp NavCad 2018 18.04.0073.0539.U1002

Propulsion

18 feb 2022 11:30
HydroComp NavCad 2018

Project ID
Description
File name C-6.hcnc

Prediction results [Propulsor]

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
18,00	10,64	3,31	0,64	34,12	0,490	44,85	2,0	2,0	7840,8
18,50	10,06	3,12	0,61	35,11	0,507	47,55	2,1	2,1	7838,1
19,00	9,54	2,95	0,57	36,12	0,526	50,38	2,3	2,3	7834,5
19,50	9,05	2,79	0,54	37,13	0,545	53,37	2,6	2,6	7830,0
20,00	8,60	2,64	0,51	38,17	0,566	56,52	2,9	2,9	7824,4
20,50	8,18	2,50	0,49	39,22	0,587	59,85	3,2	3,2	7817,8
21,00	7,79	2,37	0,46	40,29	0,610	63,38	3,6	3,6	7810,2
21,50	7,43	2,25	0,44	41,38	0,634	67,11 !	4,0	4,0	7801,6
+ 22,00 +	7,09	2,13	0,42	42,50	0,660	71,06 !	4,5	4,5	7792,0
22,50	6,78	2,02	0,39	43,63	0,687	75,24 !!	5,1	5,1	7781,4

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KT/J2	KQ/J3	CTH	CP	RNPROP	
18,00	0,5577	0,1919	0,02915	0,61711	0,16807	1,5714	2,6847	8,51e7	
18,50	0,5572	0,1922	0,02918	0,61894	0,16868	1,5761	2,6944	8,75e7	
19,00	0,5565	0,1925	0,02922	0,62143	0,16951	1,5825	2,7077	9,00e7	
19,50	0,5557	0,1929	0,02926	0,62463	0,17057	1,5906	2,7247	9,26e7	
20,00	0,5546	0,1933	0,02932	0,62854	0,17188	1,6006	2,7456	9,51e7	
20,50	0,5534	0,1939	0,02939	0,63319	0,17344	1,6124	2,7706	9,77e7	
21,00	0,5519	0,1945	0,02947	0,6386	0,17526	1,6262	2,7996	1,00e8	
21,50	0,5503	0,1953	0,02955	0,6448	0,17735	1,642	2,833	1,03e8	
+ 22,00 +	0,5485	0,1961	0,02965	0,65178	0,17972	1,6597	2,8708	1,06e8	
22,50	0,5465	0,1970	0,02976	0,65955	0,18236	1,6795	2,9129	1,09e8	

Report ID20220218-1130
HydroComp NavCad 2018 18.04.0073.0539.U1002

Propulsion

18 feb 2022 11:30
HydroComp NavCad 2018

Project ID
Description
File name **C-6.hcnc**

Hull data

General			Planing		
Configuration:		**Monohull**	Proj chine length:		**0,000 m**
Chine type:		**Round/multiple**	Proj bottom area:		**0,000 m2**
Length on WL:		**356,000 m**	LCG fwd TR:	[XCG/LP 0,000]	**0,000 m**
Max beam on WL:	[LWL/BWL 6,717]	**53,000 m**	VCG below WL:		**0,000 m**
Max molded draft:	[BWL/T 3,419]	**15,510 m**	Aft station (fwd TR):		**0,000 m**
Displacement:	[CB 0,701]	**210499,00 t**	Deadrise:		**0,00 deg**
Wetted surface:	[CS 2,744]	**23448,463 m2**	Chine beam:		**0,000 m**
ITTC-78 (CT)			Chine ht below WL:		**0,000 m**
LCB fwd TR:	[XCB/LWL 0,524]	**186,550 m**	Fwd station (fwd TR):		**0,000 m**
LCF fwd TR:	[XCF/LWL 0,494]	**176,040 m**	Deadrise:		**0,00 deg**
Max section area:	[CX 0,993]	**815,946 m2**	Chine beam:		**0,000 m**
Waterplane area:	[CWP 0,808]	**15236,708 m2**	Chine ht below WL:		**0,000 m**
Bulb section area:		**95,000 m2**	Propulsor type:		**Propeller**
Bulb ctr below WL:		**7,750 m**	Max prop diameter:		**10800,0 mm**
Bulb nose fwd TR:		**377,250 m**	Shaft angle to WL:		**0,00 deg**
Imm transom area:	[ATR/AX 0,000]	**0,000 m2**	Position fwd TR:		**0,000 m**
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**	Position below WL:		**0,000 m**
Transom immersion:	[TTR/T 0,000]	**0,000 m**	Transom lift device:		**Flap**
Half entrance angle:		**21,00 deg**	Device count:		**0**
Bow shape factor:	[WL flow]	**1,0**	Span:		**0,000 m**
Stern shape factor:	[WL flow]	**1,0**	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				Propeller options		
Count:		**1**		Oblique angle corr:	**Off**	
Propulsor type:		**Propeller series**		Shaft angle to WL:	**0,00 deg**	
Propeller type:		**FPP**		Added rise of run:	**0,00 deg**	
Propeller series:		**B Series**		Propeller cup:	**0,0 mm**	
Propeller sizing:		**By thrust**		KTKQ corrections:	**Custom**	
Reference prop:				Scale correction:	**None**	
Blade count:		**4**		KT multiplier:	**1,000**	
Expanded area ratio:		**0,6595**	**[Size]**	KQ multiplier:	**1,000**	
Propeller diameter:		**10800,0 mm**	**[Size]**	Blade T/C [0.7R]:	**0,00**	
Propeller mean pitch:	[P/D 0,8951]	**9667,3 mm**	**[Size]**	Roughness:	**0,00 mm**	
Hub immersion:		**10000,0 mm**		Cav breakdown:	**Off**	
Engine/gear				**Design condition [By thrust]**		
Drive line:		**Direct drive**		Max prop diam:	**10800,0 mm**	
Gear input:		**No gearbox**		Design speed:	**22,00 kt**	
Engine data:				Reference thrust:	**4293,26 kW**	
Rated RPM:		**0 RPM**		Design point:	**1,000**	
Rated power:		**0,0 kW**		Reference RPM:	**0,0 RPM**	
Primary fuel:		**Defined**		Design point:	**1,000**	
Secondary fuel:		**None**		Shaft RPM:	**75,1 RPM**	**[Size]**
Gear efficiency:		**1,000**				
Load correction:		**Off**				
Gear ratio:		**1,000**				
Shaft efficiency:		**0,970**				

Report ID20220218-1130 HydroComp NavCad 2018 18.04.0073.0539.U1002

Propulsion

18 feb 2022 11:30
HydroComp NavCad 2018

Project ID
Description
File name **C-6.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

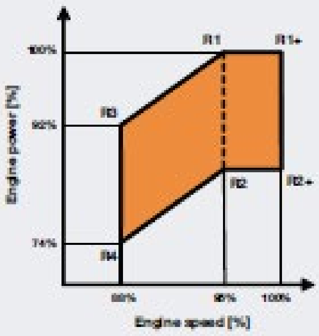
SIGMAV = Cavitation number of propeller by vessel speed
SIGMAN = Cavitation number of propeller by RPM
SIGMA07R = Cavitation number of blade section at 0.7R
TIPSPEED = Propeller circumferential tip speed
MINBAR = Minimum expanded blade area ratio recommended by selected cavitation criteria
PRESS = Average 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

Report ID20220218-1130 HydroComp NavCad 2018 18.04.0073.0539.U1002

ANEXO 3. CATÁLOGO MOTOR WÄRTSILÄ X92

At Wärtsilä, we are passionate about optimising lifecycle value by offering precisely what each of our customers need. We can deliver on this promise because we provide the only true total offering of marine products, integrated solutions and services in the industry – worldwide. We help our customers find the shorter route to robust growth and bigger profits through operational efficiency, environmental excellence, fuel flexibility and services. Even though this brochure is just a beginning to learn why Wärtsilä nowadays powers one in every three ships worldwide, it still demonstrates how we are able to customise our comprehensive offering in order to give customers a crucial competitive edge. What can we do for you?



Wärtsilä X92 rating field

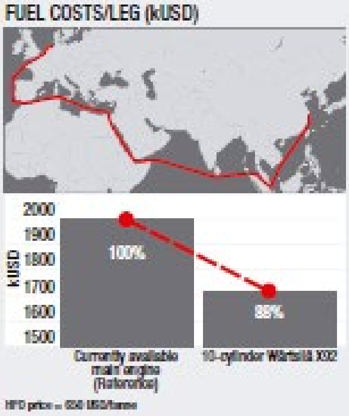
WÄRTSILÄ X92 CASE STUDY

13,200TEU Container vessel: Asia – Europe (Shanghai, Ningbo, Singapore, Rotterdam, Bremerhaven) comparison

Sailing profile

- Distance: 10,726 nm/leg
- HFO price = 650 USD/tonne

FUEL COSTS/LEG (kUSD)



The Wärtsilä X92 is the marine two-stroke diesel engine designed to provide propulsion power for modern large and ultra large container vessels following the latest trends in container vessel propulsion. The combination of the large bore, long stroke, and low shaft speeds together with the advanced proven common-rail technology results in an engine with particularly high efficiency and environmental performance.

The Wärtsilä X92, which has a cylinder bore of 920 mm, provides a power output of 24,420 to 73,560 kW and is available in 6–12 cylinder configurations.

The key benefits of the Wärtsilä X92 include:

- Extra low fuel consumption over the whole operating range together with low cylinder oil consumption
- Flexibility of optimum rpm selection to enable increased propeller diameter
- Stable operation down to 12% nominal engine speed for slow steaming
- Reduced CO_2, SO_X and NO_X emissions, offering shipyards excellent possibilities for improved EEDI

WÄRTSILÄ

TYPICAL APPLICATION AREAS

The Wärtsilä X92 has been designed as a main engine for large and ultra large container vessels of 8000TEU and beyond. The Wärtsilä X92 engine offers flexibility for changing market conditions, providing minimum daily fuel consumption. When comparing the Wärtsilä X92 to previous generation main engine options, a gain of approximately 10% and beyond in daily fuel consumption can be achieved. This can be attributed mainly to the low shaft speeds of the engine allowing larger propeller diameters to be installed on the vessel.

OPERATIONAL FEATURES

The engine offers high efficiency due to the large bore, high stroke-to-bore ratio and Wärtsilä's well proven electronically-controlled common-rail technology which plays a key role in enabling ship owners to reduce fuel costs, mainly through the flexibility of the fuel injection and exhaust valve operations. A unique feature of Wärtsilä low-speed electronically controlled engines is the possibility to control each fuel injector separately. This flexibility results in lower fuel consumption across the entire operating range, especially at low and part loads. In addition, different engine tunings are available in order to meet specific customer requirements according to their particular needs Standard, Delta, Delta Bypass and Low Load). Other advantages of this technology include stable low running speeds (down to 12% of nominal speed), smokeless operation, and improved control of exhaust emissions. As far as cylinder lubrication is concerned, an oil feed rate of 0.6 g/kWh can be achieved. The engines are equipped as standard with intelligent combustion control (ICC) system enabling further fuel savings and balanced working of each cylinder.

ENVIRONMENTAL COMPLIANCE

The engine is fully compliant with IMO Tier II requirements. It can also be equipped with a SCR catalyst to meet IMO Tier III NO_x emission levels, and a scrubber to reduce SO_x emissions to 0.1% – even with high sulphur fuels. The introduction of the EEDI index also puts an emphasis on CO_2 emissions and total vessel efficiency. The Wärtsilä X92 internal engine efficiency, and the possibility to apply various Power Take Off (PTO) arrangements for onboard electricity production, make it easy for shipyards to meet these new requirements. Thanks to Wärtsilä's common-rail fuel injection technology, the engine has no visible smoke at any load.

TOTAL COST OF OWNERSHIP

Minimum total cost of ownership can be achieved by a low engine cost and low operational costs during the lifetime of the engine. The Wärtsilä X92 is designed for exceptional reliability and for long periods of maintenance-free operation. It also allows extended Time Between Overhaul (TBO) of the critical components, to as much as 5 years. The service-friendly design will reduce downtime, maintain vessel operation and cut operating costs. Together with Condition Based Maintenance (CBM) and service agreements, the overhaul interval can be even further extended, thus minimizing maintenance costs and maximizing the revenue-earning

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Wärtsilä X92	IMO Tier II
Cylinder bore	920 mm
Piston stroke	3468 mm
Speed	70–80 rpm
Mean effective pressure at R1/R1+	21.0/20.0 bar
Stroke / bore	3.77

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
	76/80 rpm		70 rpm			
	R1 / R1+	R2 / R2+	R3	R4		
6	36 780	26 520	33 900	24 420	11 630	1 120
7	42 910	30 940	39 550	28 490	13 210	1 280
8	49 040	35 360	45 200	32 560	16 350	1 460
9	55 170	39 780	50 850	36 630	17 850	1 630
10	61 300	44 200	56 500	40 700	19 520	1 790
11	67 430	48 620	62 150	44 770	21 280	1 960
12	73 560	53 040	67 800	48 840	22 870	2 140

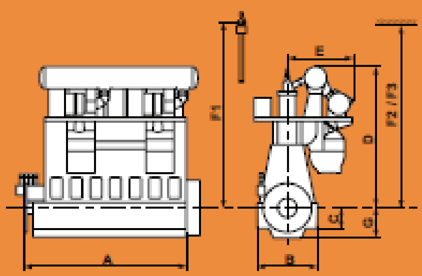
Dimensions mm	B	C	D	E
	5550	1900	12 950	6050
	F1	F2	F3	G
	15 420	15 450	14 240	2930

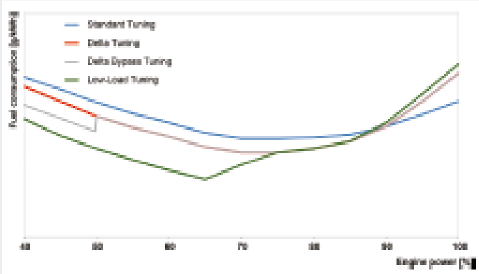
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1/R1+	R2/R2+	R3	R4
BMEP, bar		21.0/20.0	15.1/14.4	21.0	15.1
BSFC	Standard Tuning	166/165	159	166	159

Part load, % of R1/R1+	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	162.4/161.4	162.0/161.0	161.7/160.7	160.5/159.5	157.2/156.4





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Wärtsilä X92	IMO Tier II
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Piston stroke	3468 mm
Speed	70–80 rpm
Mean effective pressure at R1/R1+	21.0/20.0 bar
Stroke / bore	3.77

Rated power, principal dimensions and weights

Cyl.	Output in kW at				Length A mm	Weight tonnes
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	R1 / R1+	R2 / R2+	R3	R4		
6	36 780	26 520	33 900	24 420	11 630	1 120
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10	61 300	44 200	56 500	40 700	19 520	1 790
11	67 430	48 620	62 150	44 770	21 280	1 960
12	73 560	53 040	67 800	48 840	22 870	2 140

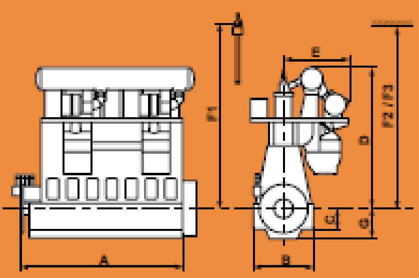
Dimensions mm	B	C	D	E
	5550	1900	12 950	6050
	F1	F2	F3	G
	15 420	15 450	14 240	2930

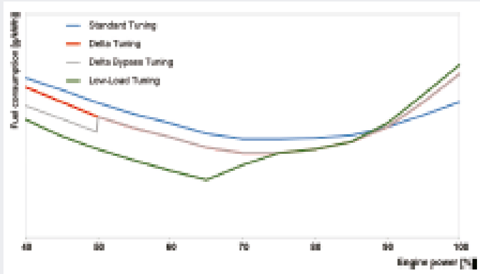
Brake specific fuel consumption (BSFC) in g/kWh

Full load

Rating point		R1/R1+	R2/R2+	R3	R4
BMEP, bar		21.0/20.0	15.1/14.4	21.0	15.1
BSFC	Standard Tuning	166/165	159	166	159

Part load, % of R1/R1+	85	70	85	70	65
Tuning variant	Standard	Standard	Delta	Delta	Low-Load
BSFC	162.4/161.4	162.0/161.0	161.7/160.7	160.5/159.5	157.2/156.4





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ANEXO 4. PROPULSOR 4 PALAS

Propulsion

18 feb 2022 12:07
HydroComp NavCad 2018

Project ID
Description
File name C-6.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:	
Max prop diam:	10800,0 mm	Engine RPM:	
Corrections		Mass multiplier:	
Viscous scale corr:	[On] Custom	RPM constraint:	
Rudder location:	Behind propeller	Limit [RPM/s]:	
Friction line:	ITTC-57	**Water properties**	
Hull form factor:	1,214	Water type:	Salt
Corr allowance:	0,000050	Density:	1026,00 kg/m3
Roughness [mm]:	[On] 0,15	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	0,19	0,71	6,72	3,42
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]
18,00	19957,8	0,3458	0,2047	0,9958	59	29388,0	40,0	---	---
18,50	21744,3	0,3457	0,2047	0,9958	61	32049,1	43,6	---	---
19,00	23663,6	0,3455	0,2047	0,9958	63	34919,4	47,5	---	---
19,50	25726,8	0,3453	0,2047	0,9958	64	38017,8	51,7	---	---
20,00	27945,5	0,3451	0,2047	0,9958	66	41365,4	56,2	---	---
20,50	30332,5	0,3450	0,2047	0,9958	68	44985,1	61,2	---	---
21,00	32901,4	0,3448	0,2047	0,9958	70	48901,7	66,5	---	---
21,50	35667,2	0,3446	0,2047	0,9958	72	53142,7	72,2	---	---
+ 22,00 +	38645,8	0,3445	0,2047	0,9958	74	57737,4	78,5	---	---
22,50	41852,6	0,3443	0,2047	0,9958	76	62714,9	85,3	---	---

	EFFICIENCY			THRUST	
SPEED [kt]	EFFO	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
18,00	0,5783	0,6791	0,51258	2709,85	2155,26
18,50	0,5779	0,6785	0,51299	2872,63	2284,73
19,00	0,5774	0,6777	0,51357	3043,93	2420,97
19,50	0,5767	0,6767	0,51429	3224,46	2564,55
20,00	0,5759	0,6756	0,51517	3414,97	2716,07
20,50	0,5749	0,6743	0,51621	3616,25	2876,16
21,00	0,5738	0,6728	0,51741	3829,13	3045,47
21,50	0,5725	0,6712	0,51876	4054,49	3224,71
+ 22,00 +	0,5711	0,6693	0,52027	4293,25	3414,60
22,50	0,5695	0,6673	0,52193	4546,18	3615,77

	POWER DELIVERY							
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
18,00	59	4581,62	4581,62	28506,4	29388,0	29388,0	29388,0	650,2
18,50	61	4855,75	4855,75	31087,6	32049,1	32049,1	32049,1	612,8
19,00	63	5143,76	5143,76	33871,8	34919,4	34919,4	34919,4	577,6
19,50	64	5446,73	5446,73	36877,2	38017,8	38017,8	38017,8	544,5
20,00	66	5765,85	5765,85	40124,4	41365,4	41365,4	41365,4	513,2
20,50	68	6102,36	6102,36	43635,5	44985,1	44985,1	44985,1	483,7
21,00	70	6457,53	6457,53	47434,7	48901,7	48901,7	48901,7	455,9
21,50	72	6832,76	6832,76	51548,4	53142,7	53142,7	53142,7	429,5
+ 22,00 +	74	7229,46	7229,46	56005,3	57737,4	57737,4	57737,4	404,5
22,50	76	7648,85	7648,85	60833,5	62714,9	62714,9	62714,9	380,8

Report ID20220218-1207 HydroComp NavCad 2018 18.04.0073.0539.U1002

Propulsion

18 feb 2022 12:07
HydroComp NavCad 2018

Project ID
Description
File name **C-6.hcnc**

Prediction results [Propulsor]

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
18,00	10,64	3,44	0,67	33,46	0,490	39,02	2,0	2,0	7996,8
18,50	10,06	3,25	0,63	34,43	0,507	41,36	2,0	2,0	7994,2
19,00	9,54	3,07	0,60	35,41	0,526	43,83	2,0	2,0	7990,6
19,50	9,05	2,91	0,56	36,41	0,545	46,43	2,0	2,0	7986,1
20,00	8,60	2,75	0,53	37,42	0,566	49,17	2,1	2,1	7980,6
20,50	8,18	2,61	0,51	38,45	0,587	52,07	2,3	2,3	7974,1
21,00	7,79	2,47	0,48	39,50	0,610	55,13	2,6	2,6	7966,6
21,50	7,43	2,34	0,45	40,57	0,634	58,38	2,9	2,9	7958,1
+ 22,00 +	7,09	2,22	0,43	41,66	0,660	61,81	3,2	3,2	7948,7
22,50	6,78	2,11	0,41	42,77	0,687	65,45	3,6	3,6	7938,3

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KT/J2	KQ/J3	CTH	CP	RNPROP	
18,00	0,5688	0,1996	0,03125	0,61711	0,16985	1,5714	2,729	9,60e7	
18,50	0,5683	0,1999	0,03128	0,61893	0,17046	1,5761	2,7389	9,88e7	
19,00	0,5676	0,2002	0,03133	0,62143	0,17131	1,5825	2,7524	1,02e8	
19,50	0,5667	0,2006	0,03138	0,62463	0,17238	1,5906	2,7697	1,04e8	
20,00	0,5657	0,2011	0,03144	0,62854	0,17371	1,6006	2,791	1,07e8	
20,50	0,5644	0,2017	0,03152	0,63319	0,17529	1,6124	2,8164	1,10e8	
21,00	0,5630	0,2024	0,03160	0,6386	0,17713	1,6262	2,846	1,13e8	
21,50	0,5613	0,2032	0,03170	0,64479	0,17924	1,642	2,8799	1,16e8	
+ 22,00 +	0,5595	0,2040	0,03181	0,65178	0,18163	1,6597	2,9184	1,19e8	
22,50	0,5575	0,2050	0,03193	0,65955	0,1843	1,6795	2,9613	1,23e8	

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Propulsion

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Project ID
Description
File name **C-6.hcnc**

Hull data

General			Planing		
Configuration:		**Monohull**	Proj chine length:		**0,000 m**
Chine type:		**Round/multiple**	Proj bottom area:		**0,000 m2**
Length on WL:		**356,000 m**	LCG fwd TR:	[XCG/LP 0,000]	**0,000 m**
Max beam on WL:	[LWL/BWL 6,717]	**53,000 m**	VCG below WL:		**0,000 m**
Max molded draft:	[BWL/T 3,419]	**15,510 m**	Aft station (fwd TR):		**0,000 m**
Displacement:	[CB 0,701]	**210499,00 t**	Deadrise:		**0,00 deg**
Wetted surface:	[CS 2,744]	**23448,463 m2**	Chine beam:		**0,000 m**
ITTC-78 (CT)			Chine ht below WL:		**0,000 m**
LCB fwd TR:	[XCB/LWL 0,524]	**186,550 m**	Fwd station (fwd TR):		**0,000 m**
LCF fwd TR:	[XCF/LWL 0,494]	**176,040 m**	Deadrise:		**0,00 deg**
Max section area:	[CX 0,993]	**815,946 m2**	Chine beam:		**0,000 m**
Waterplane area:	[CWP 0,808]	**15236,708 m2**	Chine ht below WL:		**0,000 m**
Bulb section area:		**95,000 m2**	Propulsor type:		**Propeller**
Bulb ctr below WL:		**7,750 m**	Max prop diameter:		**10800,0 mm**
Bulb nose fwd TR:		**377,250 m**	Shaft angle to WL:		**0,00 deg**
Imm transom area:	[ATR/AX 0,000]	**0,000 m2**	Position fwd TR:		**0,000 m**
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**	Position below WL:		**0,000 m**
Transom immersion:	[TTR/T 0,000]	**0,000 m**	Transom lift device:		**Flap**
Half entrance angle:		**21,00 deg**	Device count:		**0**
Bow shape factor:	[WL flow]	**1,0**	Span:		**0,000 m**
Stern shape factor:	[WL flow]	**1,0**	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				Propeller options		
Count:		**1**		Oblique angle corr:	**Off**	
Propulsor type:		**Propeller series**		Shaft angle to WL:	**0,00 deg**	
Propeller type:		**FPP**		Added rise of run:	**0,00 deg**	
Propeller series:		**B Series**		Propeller cup:	**0,0 mm**	
Propeller sizing:		**By power**		KTKQ corrections:	**Custom**	
Reference prop:				Scale correction:	**None**	
Blade count:		**4**		KT multiplier:	**1,000**	
Expanded area ratio:		**0,7582**	**[Size]**	KQ multiplier:	**1,000**	
Propeller diameter:		**10800,0 mm**	**[Size]**	Blade T/C [0.7R]:	**0,00**	
Propeller mean pitch:	[P/D 0,9215]	**9952,5 mm**	**[Size]**	Roughness:	**0,00 mm**	
Hub immersion:		**10000,0 mm**		Cav breakdown:	**Off**	
Engine/gear				**Design condition [By power]**		
Drive line:		**Direct drive**		Max prop diam:	**10800,0 mm**	
Gear input:		**No gearbox**		Design speed:	**22,00 kt**	
Engine data:		**Generic diesel**		Reference power:	**73560,0 kW**	
Rated RPM:		**76 RPM**		Design point:	**1,000**	
Rated power:		**73560,0 kW**		Reference RPM:	**76,0 RPM**	
Primary fuel:		**Defined**		Design point:	**1,030**	
Secondary fuel:		**None**		Shaft RPM:	**76,0 RPM**	**[Keep]**
Gear efficiency:		**1,000**				
Load correction:		**Off**				
Gear ratio:		**1,000**				
Shaft efficiency:		**0,970**				

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Propulsion

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Description
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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

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ANEXO 5. PROPULSOR 5 PALAS

Propulsion

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Project ID
Description
File name **C-6.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:	
Max prop diam:	10800,0 mm	Engine RPM:	
Corrections		Mass multiplier:	
Viscous scale corr:	[On] Custom	RPM constraint:	
Rudder location:	Behind propeller	Limit [RPM/s]:	
Friction line:	ITTC-57	**Water properties**	
Hull form factor:	1,214	Water type:	Salt
Corr allowance:	0,000050	Density:	1026,00 kg/m3
Roughness [mm]:	[On] 0,15	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	0,19	0,71	6,72	3,42
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]
18,00	19957,8	0,3458	0,2047	0,9914	59	29205,6	39,7	---	---
18,50	21744,3	0,3457	0,2047	0,9914	61	31848,5	43,3	---	---
19,00	23663,6	0,3455	0,2047	0,9914	62	34698,2	47,2	---	---
19,50	25726,8	0,3453	0,2047	0,9914	64	37773,7	51,4	---	---
20,00	27945,5	0,3451	0,2047	0,9914	66	41095,3	55,9	---	---
20,50	30332,5	0,3450	0,2047	0,9914	68	44685,3	60,7	---	---
21,00	32901,4	0,3448	0,2047	0,9914	70	48568,3	66,0	---	---
21,50	35667,2	0,3446	0,2047	0,9914	72	52771,2	71,7	---	---
+ 22,00 +	38645,8	0,3445	0,2047	0,9914	73	57322,8	77,9	---	---
22,50	41852,6	0,3443	0,2047	0,9914	75	62251,7	84,6	---	---

	EFFICIENCY			THRUST	
SPEED [kt]	EFFO	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
18,00	0,5845	0,6834	0,51807	2709,84	2155,25
18,50	0,5841	0,6827	0,51852	2872,62	2284,72
19,00	0,5836	0,6820	0,51913	3043,93	2420,96
19,50	0,5830	0,6811	0,51991	3224,47	2564,56
20,00	0,5822	0,6800	0,52087	3414,99	2716,09
20,50	0,5813	0,6788	0,52199	3616,26	2876,16
21,00	0,5803	0,6774	0,52328	3829,13	3045,47
21,50	0,5791	0,6759	0,52474	4054,48	3224,70
+ 22,00 +	0,5778	0,6742	0,52636	4293,24	3414,59
22,50	0,5763	0,6723	0,52814	4546,18	3615,77

	POWER DELIVERY							
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
18,00	59	4544,88	4544,88	28329,4	29205,6	29205,6	29205,6	654,2
18,50	61	4816,63	4816,63	30893,0	31848,5	31848,5	31848,5	616,6
19,00	62	5102,05	5102,05	33657,3	34698,2	34698,2	34698,2	581,3
19,50	64	5402,23	5402,23	36640,5	37773,7	37773,7	37773,7	548,0
20,00	66	5718,30	5718,30	39862,5	41095,3	41095,3	41095,3	516,6
20,50	68	6051,44	6051,44	43344,8	44685,3	44685,3	44685,3	487,0
21,00	70	6402,95	6402,95	47111,3	48568,3	48568,3	48568,3	459,0
21,50	72	6774,17	6774,17	51188,1	52771,2	52771,2	52771,2	432,5
+ 22,00 +	73	7166,48	7166,48	55603,1	57322,8	57322,8	57322,8	407,4
22,50	75	7581,10	7581,10	60384,1	62251,7	62251,7	62251,7	383,7

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Propulsion

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Description
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Prediction results [Propulsor]

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
18,00	10,64	3,46	0,67	33,37	0,525	35,52	2,0	2,0	8017,7
18,50	10,06	3,27	0,63	34,34	0,544	37,66	2,0	2,0	8015,2
19,00	9,54	3,09	0,60	35,32	0,565	39,90	2,0	2,0	8011,8
19,50	9,05	2,92	0,57	36,31	0,587	42,27	2,0	2,0	8007,5
20,00	8,60	2,77	0,54	37,32	0,609	44,77	2,0	2,0	8002,2
20,50	8,18	2,62	0,51	38,35	0,634	47,40	2,0	2,0	7996,0
21,00	7,79	2,48	0,48	39,39	0,659	50,20	2,0	2,0	7988,8
21,50	7,43	2,35	0,46	40,45	0,686	53,15	2,1	2,1	7980,7
+ 22,00 +	7,09	2,23	0,43	41,54	0,715	56,28	2,4	2,4	7971,7
22,50	6,78	2,12	0,41	42,64	0,745	59,60	2,7	2,7	7961,8

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KT/J2	KQ/J3	CTH	CP	RNPROP	
18,00	0,5703	0,2007	0,03117	0,6171	0,16805	1,5714	2,712	8,41e7	
18,50	0,5698	0,2009	0,03120	0,61893	0,16865	1,5761	2,7217	8,66e7	
19,00	0,5691	0,2013	0,03124	0,62143	0,16947	1,5825	2,735	8,90e7	
19,50	0,5682	0,2017	0,03129	0,62463	0,17052	1,5906	2,752	9,15e7	
20,00	0,5672	0,2022	0,03135	0,62854	0,17181	1,6006	2,7728	9,41e7	
20,50	0,5660	0,2028	0,03143	0,63319	0,17335	1,6124	2,7976	9,66e7	
21,00	0,5645	0,2035	0,03151	0,6386	0,17514	1,6262	2,8266	9,92e7	
21,50	0,5629	0,2043	0,03161	0,64479	0,1772	1,642	2,8598	1,02e8	
+ 22,00 +	0,5611	0,2052	0,03172	0,65178	0,17953	1,6597	2,8974	1,05e8	
22,50	0,5591	0,2062	0,03184	0,65954	0,18213	1,6795	2,9394	1,07e8	

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Propulsion

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Project ID
Description
File name **C-6.hcnc**

Hull data

General			Planing		
Configuration:		**Monohull**	Proj chine length:		**0,000 m**
Chine type:		**Round/multiple**	Proj bottom area:		**0,000 m2**
Length on WL:		**356,000 m**	LCG fwd TR:	[XCG/LP 0,000]	**0,000 m**
Max beam on WL:	[LWL/BWL 6,717]	**53,000 m**	VCG below WL:		**0,000 m**
Max molded draft:	[BWL/T 3,419]	**15,510 m**	Aft station (fwd TR):		**0,000 m**
Displacement:	[CB 0,701]	**210499,00 t**	Deadrise:		**0,00 deg**
Wetted surface:	[CS 2,744]	**23448,463 m2**	Chine beam:		**0,000 m**
ITTC-78 (CT)			Chine ht below WL:		**0,000 m**
LCB fwd TR:	[XCB/LWL 0,524]	**186,550 m**	Fwd station (fwd TR):		**0,000 m**
LCF fwd TR:	[XCF/LWL 0,494]	**176,040 m**	Deadrise:		**0,00 deg**
Max section area:	[CX 0,993]	**815,946 m2**	Chine beam:		**0,000 m**
Waterplane area:	[CWP 0,808]	**15236,708 m2**	Chine ht below WL:		**0,000 m**
Bulb section area:		**95,000 m2**	Propulsor type:		**Propeller**
Bulb ctr below WL:		**7,750 m**	Max prop diameter:		**10800,0 mm**
Bulb nose fwd TR:		**377,250 m**	Shaft angle to WL:		**0,00 deg**
Imm transom area:	[ATR/AX 0,000]	**0,000 m2**	Position fwd TR:		**0,000 m**
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**	Position below WL:		**0,000 m**
Transom immersion:	[TTR/T 0,000]	**0,000 m**	Transom lift device:		**Flap**
Half entrance angle:		**21,00 deg**	Device count:		**0**
Bow shape factor:	[WL flow]	**1,0**	Span:		**0,000 m**
Stern shape factor:	[WL flow]	**1,0**	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				Propeller options		
Count:		**1**		Oblique angle corr:	**Off**	
Propulsor type:		**Propeller series**		Shaft angle to WL:	**0,00 deg**	
Propeller type:		**FPP**		Added rise of run:	**0,00 deg**	
Propeller series:		**B Series**		Propeller cup:	**0,0 mm**	
Propeller sizing:		**By power**		KTKQ corrections:	**Custom**	
Reference prop:				Scale correction:	**None**	
Blade count:		**5**		KT multiplier:	**1,000**	
Expanded area ratio:		**0,8327**	**[Size]**	KQ multiplier:	**1,000**	
Propeller diameter:		**10800,0 mm**	**[Size]**	Blade T/C [0.7R]:	**0,00**	
Propeller mean pitch:	[P/D 0,9035]	**9757,5 mm**	**[Size]**	Roughness:	**0,00 mm**	
Hub immersion:		**10000,0 mm**		Cav breakdown:	**Off**	
Engine/gear				**Design condition [By power]**		
Drive line:		**Direct drive**		Max prop diam:	**10800,0 mm**	
Gear input:		**No gearbox**		Design speed:	**22,00 kt**	
Engine data:		**Generic diesel**		Reference power:	**73560,0 kW**	
Rated RPM:		**76 RPM**		Design point:	**1,000**	
Rated power:		**73560,0 kW**		Reference RPM:	**76,0 RPM**	
Primary fuel:		**Defined**		Design point:	**1,030**	
Secondary fuel:		**None**		Shaft RPM:	**76,0 RPM**	**[Keep]**
Gear efficiency:		**1,000**				
Load correction:		**Off**				
Gear ratio:		**1,000**				
Shaft efficiency:		**0,970**				

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Propulsion

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Project ID
Description
File name **C-6.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

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ANEXO 6. PROPULSOR 6 PALAS

Propulsion

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Project ID
Description
File name **C-6.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:	
Max prop diam:	10800,0 mm	Engine RPM:	
Corrections		Mass multiplier:	
Viscous scale corr:	[On] Custom	RPM constraint:	
Rudder location:	Behind propeller	Limit [RPM/s]:	
Friction line:	ITTC-57	**Water properties**	
Hull form factor:	1,214	Water type:	Salt
Corr allowance:	0,000050	Density:	1026,00 kg/m3
Roughness [mm]:	[On] 0,15	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	0,19	0,71	6,72	3,42
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]
18,00	19957,8	0,3458	0,2047	0,9878	59	29678,5	40,3	---	---
18,50	21744,3	0,3457	0,2047	0,9878	61	32361,8	44,0	---	---
19,00	23663,6	0,3455	0,2047	0,9878	63	35254,0	47,9	---	---
19,50	25726,8	0,3453	0,2047	0,9878	64	38373,9	52,2	---	---
20,00	27945,5	0,3451	0,2047	0,9878	66	41742,0	56,7	---	---
20,50	30332,5	0,3450	0,2047	0,9878	68	45380,6	61,7	---	---
21,00	32901,4	0,3448	0,2047	0,9878	70	49313,7	67,0	---	---
21,50	35667,2	0,3446	0,2047	0,9878	72	53568,6	72,8	---	---
+ 22,00 +	38645,8	0,3445	0,2047	0,9878	74	58174,0	79,1	---	---
22,50	41852,6	0,3443	0,2047	0,9878	76	63158,4	85,9	---	---

	EFFICIENCY			THRUST	
SPEED [kt]	EFFO	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
18,00	0,5773	0,6725	0,51169	2709,84	2155,25
18,50	0,5769	0,6719	0,51217	2872,62	2284,71
19,00	0,5765	0,6712	0,51283	3043,92	2420,96
19,50	0,5760	0,6704	0,51366	3224,46	2564,55
20,00	0,5753	0,6695	0,51468	3414,99	2716,09
20,50	0,5745	0,6684	0,51588	3616,27	2876,18
21,00	0,5736	0,6672	0,51726	3829,14	3045,47
21,50	0,5726	0,6658	0,51883	4054,49	3224,71
+ 22,00 +	0,5714	0,6643	0,52057	4293,23	3414,59
22,50	0,5702	0,6627	0,52248	4546,17	3615,76

	POWER DELIVERY							
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
18,00	59	4582,27	4582,27	28788,2	29678,5	29678,5	29678,5	643,8
18,50	61	4855,98	4855,98	31390,9	32361,8	32361,8	32361,8	606,8
19,00	63	5143,34	5143,34	34196,4	35254,0	35254,0	35254,0	572,1
19,50	64	5445,43	5445,43	37222,7	38373,9	38373,9	38373,9	539,4
20,00	66	5763,36	5763,36	40489,8	41742,0	41742,0	41742,0	508,6
20,50	68	6098,30	6098,30	44019,2	45380,6	45380,6	45380,6	479,5
21,00	70	6451,50	6451,50	47834,3	49313,7	49313,7	49313,7	452,0
21,50	72	6824,31	6824,31	51961,6	53568,6	53568,6	53568,6	426,0
+ 22,00 +	74	7218,11	7218,11	56428,8	58174,0	58174,0	58174,0	401,4
22,50	76	7634,07	7634,07	61263,6	63158,4	63158,4	63158,4	378,2

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Prediction results [Propulsor]

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
18,00	10,64	3,43	0,67	33,51	0,560	33,08	2,0	2,0	7984,1
18,50	10,06	3,24	0,63	34,48	0,581	35,07	2,0	2,0	7981,7
19,00	9,54	3,06	0,59	35,46	0,604	37,16	2,0	2,0	7978,5
19,50	9,05	2,90	0,56	36,46	0,628	39,36	2,0	2,0	7974,5
20,00	8,60	2,74	0,53	37,47	0,653	41,69	2,0	2,0	7969,5
20,50	8,18	2,60	0,50	38,50	0,680	44,14	2,0	2,0	7963,7
21,00	7,79	2,46	0,48	39,55	0,708	46,74	2,0	2,0	7956,9
21,50	7,43	2,34	0,45	40,61	0,738	49,49	2,0	2,0	7949,3
+ 22,00 +	7,09	2,22	0,43	41,70	0,770	52,41	2,0	2,0	7940,7
22,50	6,78	2,10	0,41	42,81	0,803	55,49	2,1	2,1	7931,4

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KT/J2	KQ/J3	CTH	CP	RNPROP	
18,00	0,5679	0,1990	0,03116	0,6171	0,17014	1,5714	2,756	7,56e7	
18,50	0,5674	0,1993	0,03119	0,61893	0,17074	1,5761	2,7656	7,78e7	
19,00	0,5667	0,1996	0,03123	0,62143	0,17155	1,5825	2,7788	8,00e7	
19,50	0,5659	0,2000	0,03128	0,62463	0,17259	1,5906	2,7957	8,22e7	
20,00	0,5649	0,2006	0,03134	0,62854	0,17387	1,6006	2,8164	8,45e7	
20,50	0,5637	0,2012	0,03141	0,6332	0,1754	1,6124	2,8411	8,68e7	
21,00	0,5623	0,2019	0,03150	0,6386	0,17718	1,6262	2,8699	8,92e7	
21,50	0,5607	0,2027	0,03159	0,64479	0,17922	1,642	2,903	9,15e7	
+ 22,00 +	0,5589	0,2036	0,03170	0,65178	0,18153	1,6597	2,9404	9,40e7	
22,50	0,5570	0,2046	0,03182	0,65954	0,18411	1,6795	2,9822	9,64e7	

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Hull data

General			Planing		
Configuration:		**Monohull**	Proj chine length:		**0,000 m**
Chine type:		**Round/multiple**	Proj bottom area:		**0,000 m2**
Length on WL:		**356,000 m**	LCG fwd TR:	[XCG/LP 0,000]	**0,000 m**
Max beam on WL:	[LWL/BWL 6,717]	**53,000 m**	VCG below WL:		**0,000 m**
Max molded draft:	[BWL/T 3,419]	**15,510 m**	Aft station (fwd TR):		**0,000 m**
Displacement:	[CB 0,701]	**210499,00 t**	Deadrise:		**0,00 deg**
Wetted surface:	[CS 2,744]	**23448,463 m2**	Chine beam:		**0,000 m**
ITTC-78 (CT)			Chine ht below WL:		**0,000 m**
LCB fwd TR:	[XCB/LWL 0,524]	**186,550 m**	Fwd station (fwd TR):		**0,000 m**
LCF fwd TR:	[XCF/LWL 0,494]	**176,040 m**	Deadrise:		**0,00 deg**
Max section area:	[CX 0,993]	**815,946 m2**	Chine beam:		**0,000 m**
Waterplane area:	[CWP 0,808]	**15236,708 m2**	Chine ht below WL:		**0,000 m**
Bulb section area:		**95,000 m2**	Propulsor type:		**Propeller**
Bulb ctr below WL:		**7,750 m**	Max prop diameter:		**10800,0 mm**
Bulb nose fwd TR:		**377,250 m**	Shaft angle to WL:		**0,00 deg**
Imm transom area:	[ATR/AX 0,000]	**0,000 m2**	Position fwd TR:		**0,000 m**
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**	Position below WL:		**0,000 m**
Transom immersion:	[TTR/T 0,000]	**0,000 m**	Transom lift device:		**Flap**
Half entrance angle:		**21,00 deg**	Device count:		**0**
Bow shape factor:	[WL flow]	**1,0**	Span:		**0,000 m**
Stern shape factor:	[WL flow]	**1,0**	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				Propeller options		
Count:		**1**		Oblique angle corr:	**Off**	
Propulsor type:		**Propeller series**		Shaft angle to WL:	**0,00 deg**	
Propeller type:		**FPP**		Added rise of run:	**0,00 deg**	
Propeller series:		**B Series**		Propeller cup:	**0,0 mm**	
Propeller sizing:		**By power**		KTKQ corrections:	**Custom**	
Reference prop:				Scale correction:	**None**	
Blade count:		**5**		KT multiplier:	**1,000**	
Expanded area ratio:		**0,8327**	**[Size]**	KQ multiplier:	**1,000**	
Propeller diameter:		**10800,0 mm**	**[Size]**	Blade T/C [0.7R]:	**0,00**	
Propeller mean pitch:	[P/D 0,9035]	**9757,5 mm**	**[Size]**	Roughness:	**0,00 mm**	
Hub immersion:		**10000,0 mm**		Cav breakdown:	**Off**	
Engine/gear				**Design condition [By power]**		
Drive line:		**Direct drive**		Max prop diam:	**10800,0 mm**	
Gear input:		**No gearbox**		Design speed:	**22,00 kt**	
Engine data:		**Generic diesel**		Reference power:	**73560,0 kW**	
Rated RPM:		**76 RPM**		Design point:	**1,000**	
Rated power:		**73560,0 kW**		Reference RPM:	**76,0 RPM**	
Primary fuel:		**Defined**		Design point:	**1,030**	
Secondary fuel:		**None**		Shaft RPM:	**76,0 RPM**	**[Keep]**
Gear efficiency:		**1,000**				
Load correction:		**Off**				
Gear ratio:		**1,000**				
Shaft efficiency:		**0,970**				

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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

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