SEAHORSE 35 demonstrates 2025 EEDI compliance

With the first tier of the EEDI fast approaching Grontmij's SEAHORSE 35 bulk carrier design exceeds expectations with the potential to meet 2025 EEDI compliance. Michael H Schmidt, naval architect, at consultants Schmidt Maritime explains.

In 2008 Danish bulk carrier designer Grontmij (formerly known as Carl Bro/Dwinger Marine Consult) introduced a new generation of 35,000dwt handysize bulk carrier design, named SEAHORSE 35.

The SEAHORSE 35 was developed in close cooperation with handysize bulk carrier charterers and operators, with the focus on economical and efficient cargo handling, loading flexibility, safety, environmental and maintenance friendliness and low operational costs.

The SEAHORSE 35 has been very well received by owners and yards and since the first vessel was contracted by Danish owner Falcon Rederi back in 2008 at Daoda Heavy Industry, in China, a further 37 SEAHORSE 35's have been contracted at eight different Chinese yards, says Schmidt.

The SEAHORSE 35 vessels have been ordered by a wide range of shipping companies from Belgium, Denmark, Dubai, Germany, Greece, Hong Kong, Russia, The Netherlands and United Kingdom. By May 2012, six vessels had been successfully delivered from three Chinese yards.

Michael H Schmidt, naval architect, Schmidt Maritime states SEAHORSE 35 can meet EEDI requirements

Since the SEAHORSE 35 design was developed by the Grontmij design team, headed by Schmidt in 2007-08, the market situation for bulk carriers has changed dramatically:

- earning potential for bulk carrier owners has decreased significantly, due to low freight rates combined with high fuel oil costs
- over-supply of bulk carriers and over-capacity at yards
- environmental awareness and introduction of the Energy Efficiency Design Index (EEDI).

All the above factors have led to strong competition with a focus on fuel oil efficiency as:

- owners are looking for ships with lower fuel oil consumption in order to ensure a healthy business
- yards promote fuel efficient vessels to get a competitive edge in a market suffereing from capacity over-supply owners, yards and designers are trying to comply with future EEDI regulations.

To meet the request for more fuel efficient vessels, designers, machinery and equipment manufacturers have optimised their design and products and also new fuel saving devices have been invented and introduced to the market.

As the designer of the SEAHORSE 35, Grontmij / Schmidt Maritime have been working on optimising the SEAHORSE 35 design and making further reductions of fuel oil consumption and EEDI have been achieved.

Figure 1: SEAHORSE 35 (Source: Grontmij)

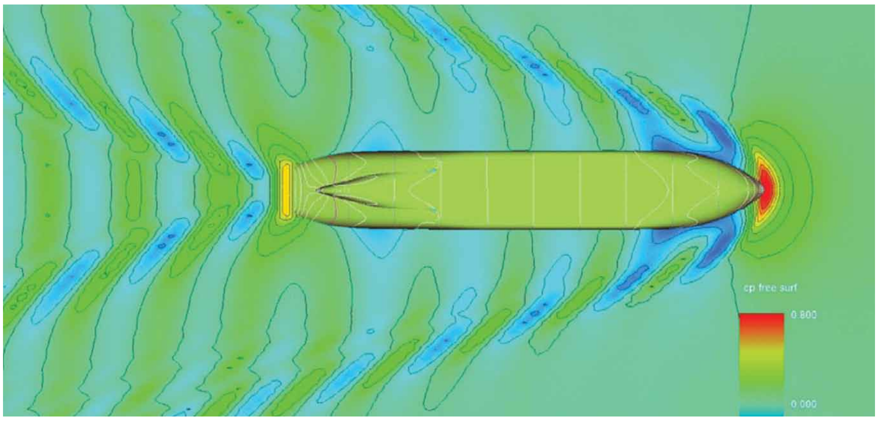

Figure 2: CFD analysis of SEAHORSE 35 hullform (Source: MARIN)

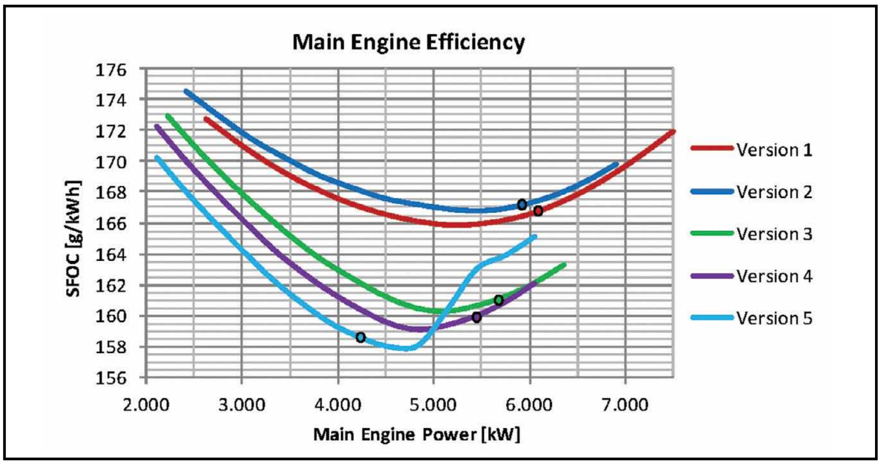

Figure 3: Main engine SFOC and NCR (Source: MAN D&T – CEAS)

The optimisation of fuel oil consumption and EEDI has been achieved by the introduction of highly efficient main engines, highly efficient propeller design and a newly invented fuel saving device.

Hullform

The original SEAHORSE 35 hullform was developed in close cooperation with FORCE Technology, Denmark. The hullform was developed on the basis of extensive CFD analysis and tank tests. In 2011 the Dutch testing tank MARIN was hired to perform a further hullform optimisation; utilising the latest CFD techniques. The MARIN analysis concluded that the original SEAHORSE 35 hullform was good and the potential for further optimisation of the hullform was a maximum of 1.5%.

Considering the results and the general tolerances of the MARIN study, it was decided to maintain the original hullform and to proceed the optimisation process with focus on main engine and propeller layout.

Main Engine

A significant development on 2-stroke diesel main engines has taken place within the past five years. The thermal efficiency of the main engines has been improved, ie the specific fuel oil consumption (SFOC), representing the amount of fuel oil required to develop one kilowatt-hour, has gone down.

The first SEAHORSE 35 was ordered with a full mechanical MAN B&W 5S50MC-C7.1 TI (NOX Tier I compliant) engine. The later SEAHORSE 35 vessels have been ordered with several different versions of the MAN B&W 5S50 and also Wärtsilä 5RT50-flex-D.

All the different main engines have been optimised with the propeller chosen. For the purpose of this overview of the optimisation process, three main engines were presented.

The thermal efficiency for the five versions included in this optimisation study is shown in figure 3. The SFOC curves for each main engine type and setup are plotted together with the normal continuous rating (NCR).

From Figure 3, it is clear that the electronically controlled ME-B9.2 TII engine used for version 3, 4 and 5, is significantly more efficient than the ME-B8.1 TII (version 2) and MC-C7.1

Version	Main Engine Type	M/E Layout Point	M/E Tuning	Comment
1	MAN B&W 5S50MC-C7.1 TI	SMCR 7.500kW @ 121 RPM	High Load	Ice class
2	MAN B&W 5S50ME-B8.1 TII	SMCR 6.900kW @ 110 RPM	High Load	
3	MAN B&W 5S50ME-B9.2 TII	SMCR 6.350kW @ 99 RPM	High Load	
4	MAN B&W 5S50ME-B9.2 TII	SMCR 6.050kW @ 99 RPM	High Load	
5	MAN B&W 5S50ME-B9.2 TII	SMCR 6.050kW @ 99 RPM	Part Load	Shaft Limitation 4.700kW

Thermal efficiency for five MAN Diesel & Turbo engines in an optimisation study

SEAHORSE 35 Version			1	2	3	4	5
1.	Main Engine Maker	[-]	MAN D&T	MAN D&T	MAN D&T	MAN D&T	MAN D&T
2.	Main Egine Type	[-]	5S50	5S50	5S50	5S50	5S50
3.	Main Engine Mark	[-]	MC-C7.1 TI	ME-B8.1 TII	ME-B9.2 TII	ME-B9.2 TII	ME-B9.2 TII
4.	Main Engine Tuning	[-]	High Load	High Load	High Load	High Load	Part Load
5.	Propeller	[-]	5,54m NPT	5,80m Wärts.	5,90m NPT	5,90m NPT	5,90m NPT
6.	Becker MEWIS Duct®	[-]	No	No	No	Yes	Yes
7.	Design Speed 1)	[knots]	14.0	14.0	14.0	14.0	13.0
8.	SMCR2)	[kW]	7,500	6,900	6,350	6,050	4,700
9.	NCR3)	[kW]	6,082	5,913	5,670	5,440	4,230
10.	NCR verified by:	[-]	Sea trial	Sea trial	Tanktest	Tanktest	Tanktest
11.	% of SMCR	[%]	81%	86%	89%	90%	90%
12.	NCR Index	[-]	100%	97%	93%	89%	70%
13.	SFOCNCR	[g/kWh]	166.8	167.2	161.0	159.9	158.6
14.	SFOC Index	[%]	100%	100%	97%	96%	95%
15.	M/E FOC-MDO4)	[mt/day]	24.3	23.7	21.9	20.9	16.1
16.	FOC Index	[%]	100%	97%	90%	86%	66%

Table 1: Summary of main engine fuel oil consumption

Notes:

1) Design speed at scantling draft of 10.1m (35.000dwt)
2) SMCR for Version 1 is increased due to ice class.
3) Main engine power to reach design speed at scantling draft including 15% sea margin and 1% shaft loss
4) Main engine fuel oil consumption at NCR based on MDO with LCV 42.700 kJ kg. Main engine SFOC tolerance of +5% is not included.

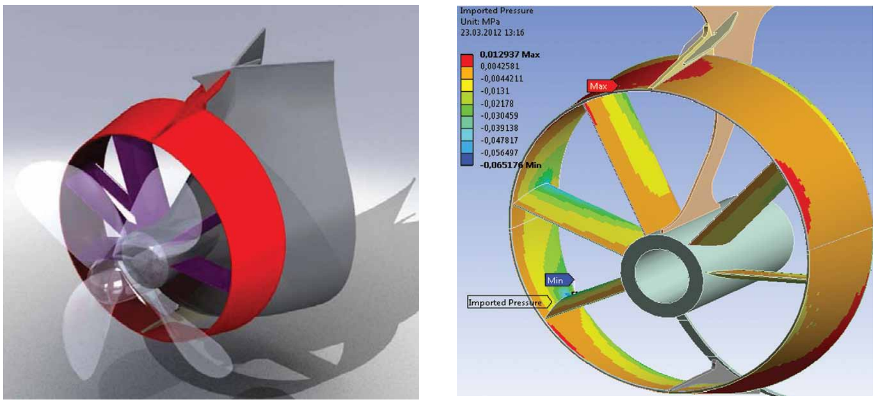

Figure 4: Becker Mewis Duct (R) (Source: Becker Marine Systems)

TI engines (version 1). The main engine efficiency has been improved 4% between version 1 and version 4. See Table 1, Row 14.

The reason that the main engine used for version 2 is less efficient than the main engine used for version 1, is the result of the version 2 engine being NOx Tier II compliant and the version 1 engine being NOx Tier I compliant.

Propeller

Not only has the thermal efficiency of the main engines been improved, but the revolutions (RPM) of the main engines have been reduced as well. The reduced RPM for the main engines has enabled larger diameter propellers to be used significantly improving efficiency.

Tank tests have been conducted with a variety of propellers but the NPT propeller design made by Stone Marine, of the UK proved the most efficient for the SEAHORSE 35. The reduced RPM for the main engines has enabled the propeller designer to improve the propeller efficiency by 7%, when comparing version 1 and 3. See Table 1, Row 12.

Becker Mewis Duct (R)

After the main engine and propeller layout had been fully optimised, various fuel saving devices have been evaluated. The Becker Mewis Duct (R) marketed by Becker Marin Systems (BMS), Germany was found most suitable for the SEAHORSE 35.

Tank tests with the Becker Mewis Duct (R) have been conducted in conjunction with Becker Marine Systems at SVA, Potsdam, Germany. The SEAHORSE 35 tank tests with the Becker Mewis Duct (R) documented a main engine power saving of 4% at scantling draft at 14knots and a 5% power saving at light ballast draft at 14knots.

The power savings for the Becker Mewis Duct (R) are on the lower side compared to the power savings BMS normally achieve for bulk carriers. The relatively lower saving is a consequence of the Becker Mewis duct being combined with a highly optimised hullform and propeller.

Fuel Oil Consumption

The main engine fuel oil consumption has been calculated for five different versions of the SEAHORSE 35.

Version 1 : First version of the SEAHORSE 35 delivered

Version 2 : Latest version of the SEAHORSE 35 delivered

Version 3 : Optimised standard SEAHORSE 35 without Mewis Duct (R)

Version 4 : Optimised SEAHORSE 35 with Mewis Duct (R)

Version 5 : Optimised SEAHORSE 35 with Mewis Duct (R) and design speed reduced to 13knots.

With the most efficient main engine, propeller and Becker Mewis Duct (R) the result of the optimisation process has been:

A. The main engine power (NCR) has been reduced by 7% by larger and thereby more efficient propellers (Table 1, Row 12, Version 1 –> 3)

B. The main engine power (NCR) has been reduced further by 4% by installing the Mewis Duct (R) (Table 1, Row 9, Version 3 –> 4)

SEAHORSE 35 Version			1	2	3	4	5
17.	EEDI1)	[g/DWTxnm]	6.53	6.23	5.60	5.32	4.50
18.	EEDI Index	[%]	100%	95%	86%	81%	69%
19.	EEDI Base Line	[g/DWTxnm]	6.54	6.54	6.54	6.54	6.54
20.	EEDI blw. Base Line	[%]	0%	5%	14%	19%	31%

Table 2: Summary of EEDI calculations

Main engine SFOC tolerance of +5% is included in the calculation of EEDI.

C. The SFOC has been reduced by 3-4% by introducing new more efficient main engines (Table 1, Row 14, Version 1 –> 3/4)

D. The main engine fuel oil consumption has been reduced by 10% by introducing more efficient main engines and propellers (Table 1, Row 16, Version 1 –> 3)

E. The main engine fuel oil consumption has been reduced by 14% by introducing more efficient main engines and propellers and the Mewis Duct (R) (Table 1, Row 16, Version 1 –> 4).

With the most efficient main engine, propeller and MEWIS Duct and a design speed reduced from 14knots to 13knots, the:

F. Main engine power can be reduced by 30% (Table 1, Row 12, Version 1 –> 5)

G. SFOC can be reduced by 5% (Table 1, Row 14, Version 1 –> 5)

H. The main engine fuel oil consumption can be reduced by 33% (Table 1, Row 16, Version 1 –> 5).

EEDI

The EEDI has been calculated for the five versions of the SEAHORSE 35 and the results are summarised in Table 2 and Figure 4.

The present IMO regulations dictate a scheme for reduction of EEDI for new vessels, ie new bulk carriers built after a certain date are to demonstrate an EEDI a certain percentage below the EEDI base line for bulk carriers.

The EEDI results listed in Table 2 have been presented together with the IMO EEDI threshold values in Figure 4 below.

With the most efficient main engine and propeller (version 3) the result of the optimisation process has led to:

I. the EEDI being reduced by 14%, being 14% below the EEDI base line for bulk carriers (Table 2, Row 18/20, Version 1 –> 3).

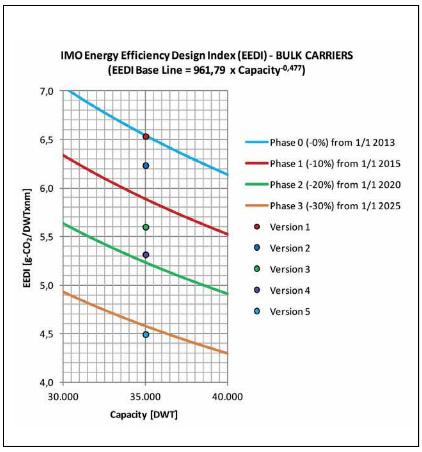

Figure 4: EEDI for Version 1 – 5

With the most efficient main engine and propeller and the Mewis Duct (R) (version 4) the result of the optimisation process has led to:

J. the EEDI being reduced by 19%, being 19% below the EEDI base line for bulk carriers with the Mewis Duct (R) installed (Table 2, Row 18/20, Version 1 –> 4).

With the most efficient main engine / propeller / the Mewis Duct (R) (version 5) and the design speed reduced from 14knots to 13knots, the result of the optimisation process has led to:

K. the EEDI being reduced by 31%, being 31% below the EEDI base line for bulk carriers with the Mewis Duct (R) installed (Table 2, Row 18/20, Version 1 –> 5).

Conclusion

The fuel oil optimisation process carried out for the SEAHORSE 35 has proved that even for a highly optimised hullform, it is possible to reduce the main engine fuel oil consumption by 10% to 15% by adopting the latest developments with main engine and propeller designs in combination with a Becker Mewis Duct (R).

The reduction in main engine fuel oil consumption results in a 14% to 19% reduction in EEDI. The reduction in EEDI is relatively higher than the reduction in fuel oil consumption, as the engine margin (NCR/SMCR) has been reduced from 19% for version 1 to 10% for version 3, 4 and 5.

The fully optimised SEAHORSE 35 with a Becker Mewis Duct (R) almost meets the EEDI requirement of 2020 of new vessels having an EEDI 20% below the base line. Considering the EEDI calculations include a SFOC margin of 5%, it is likely that the fully optimised SEAHORSE 35 will actually meet the 2020 EEDI requirement.

The fully optimised SEAHORSE 35 with a Mewis Duct (R) and a max power limitation on the main engine of 4,700kW meets the EEDI requirement of 2025 of new vessels having an EEDI 30% below the base line.

The max main engine power limitation of 4,700kW equals a reduction in scantling draft design speed from 14knots to 13knots.

It has been shown it is possible for a modern optimised handysize bulk carrier to meet the 2020 EEDI requirements of an EEDI 20% below base line and to maintain the design speed. To meet the 2025 requirement of an EEDI 30% below base line, the maximum installed main engine power (SMCR) has to be reduced by ~25% leading to a reduction of design speed from 14knots to 13knots.

Considering the significant reduction in fuel oil consumption, owners and charters might find a 1knot reduction in design speed acceptable, but how low can we go in maximum installed main engine power and still have a safe ship with sufficient manoeuvring speed in heavy weather? *NA*