

ENGINEERING
TOMORROW

Danfoss

Case story | VACON® NXP

High-efficiency hybrid
catapults MS Goblin
to the forefront in
bulk carrier shipping
propulsion

12.5%

less fuel consumed
thanks to
VACON® NXP
Liquid Cooled Drive

drives.danfoss.com

VLT | **VACON**

Hybrid replaces diesel

Venturing into hybrid propulsion was a bold step for the Vranken family's dry cargo bulk carrier business, which serves the inland waterways of the Rhine. It has paid off fast, delivering rock-bottom operating costs, thanks to an innovative diesel electric propulsion system. This hybrid system replaces the traditional diesel propulsion system used for example on the family's sister ship, the MS Lutin.

The propulsion supplier, Hybrid Ship Propulsion BV, predicts even more potential in this exciting technology. They have achieved as much as 20 - 25 % reduction in fuel costs with the introduction of hybrid and electric propulsion to harbour tugs and ferries. The MS Goblin propulsion was the first of many hybrid projects, which have since established Hybrid Ship Propulsion BV as one of the leading suppliers of hybrid and electric propulsion systems in the Netherlands.

Favorable comparison

The Vranken family ordered the new build of MS Goblin as sister ship to their first ship, the MS Lutin, which had operated since 2009. However, as they wanted to achieve the lowest possible operating costs, they chose

an innovative diesel electric propulsion system instead of the traditional diesel propulsion system used on the MS Lutin.

Their decision has repaid itself many times over. The captain and co-owner of the MS Goblin, Danny Pols explains: "My brother in law and I measured and compared the fuel consumption of the 2 vessels on a round trip where the vessels were loaded with equal load and travelling one after the other.

Furthermore, the maintenance cost is 3000 € / year lower on the MS Goblin due to less running hours of the diesel engines. The maintenance cost includes spare parts and consumables such as lubrication oil, filters, fuel injection nozzles, and more.

A typical diesel engine also needs a complete overhaul after 20,000 hour in operation. The lower operating hours per engine will postpone the need for the overhaul.

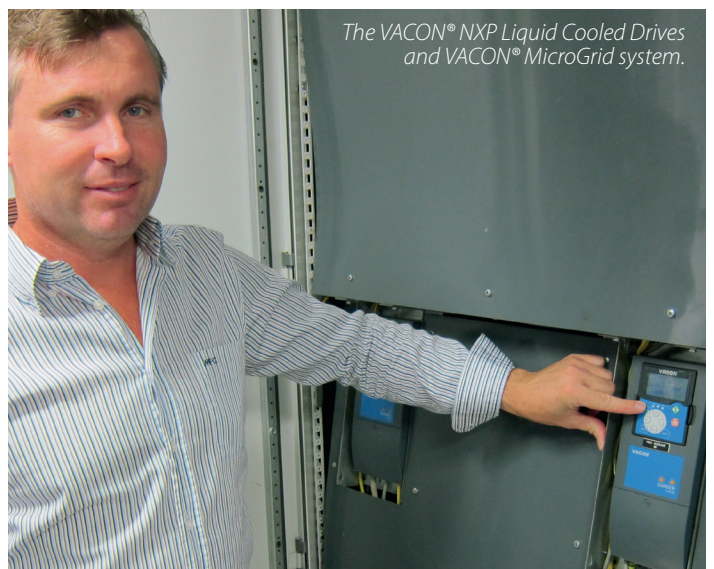
"The ships had exactly the same performance but the MS Goblin used 12.5 % less fuel than the MS Lutin." Captain and co-owner of the MS Goblin, Danny Pols



One of the main diesel engines (foreground) and the generator set (background).



The user-friendly touch screen propulsion control system developed by Hybrid Propulsion System BV.



The VACON® NXP Liquid Cooled Drives and VACON® MicroGrid system.

Upstream and downstream load profile

The mode of operation on the Rhine river is as follows:

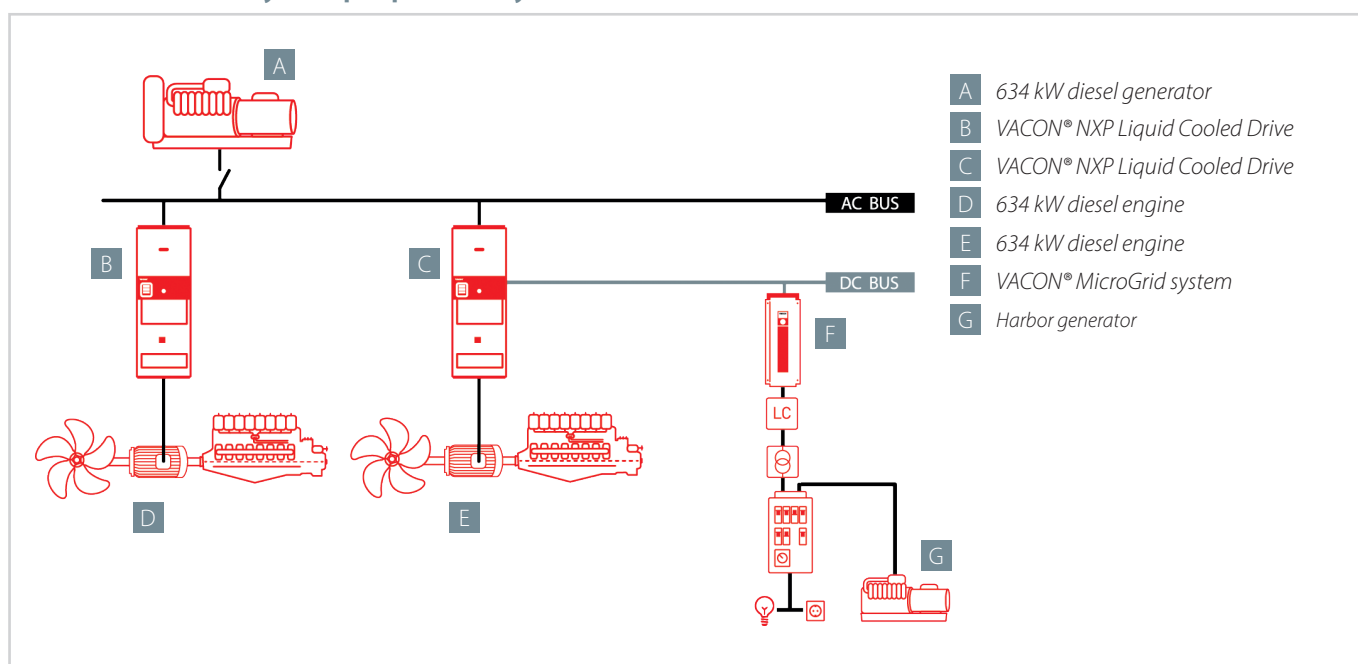
Load conditions	Typical speed [km per hour]	Fuel consumption [Litres of diesel per hour]
Travelling upstream ¹	10	200
Travelling downstream ²	20	70

¹ In downstream and lightly loaded conditions, the Goblin runs on one engine only and the propellers are powered by the electric drives system. These conditions represent 60% of the operating time.

² In upstream and heavily loaded conditions, the propellers are powered directly by the mechanical shaft of the engines. If a power boost is required, the generator produces additional electrical power which is converted to propulsion power by the electric drive system.



Schematic of the hybrid propulsion system



MS Goblin

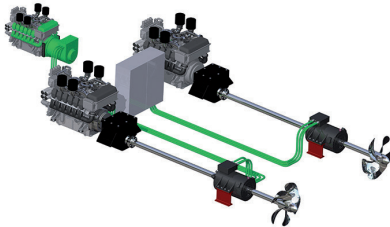
The MS Goblin is a dry cargo bulk carrier built for the family-owned company Scheepvaart Vranken. The ship was built at Schiffswerft Boost in Trier, Germany and the unique hybrid propulsion system was built by Koedood Dieselservice BV and Oechies Elektrotechnik BV in close cooperation. After the successful project with MS Goblin, Oechies Elektrotechnik founded a subsidiary, Hybrid Ship Propulsion BV (HSP), which is now one of the leading suppliers of hybrid and electric ship propulsion systems in the Netherlands.

MS Goblin:

Hull Number:	NB 1011.0128	Max load:	4400 tons
Type of ship:	Dry cargo inland bulk carrier	Classification:	Bureau Veritas
Ship owner:	Scheepvaart Vranken B.V.	Propulsion and power generation system:	2 propellers with 2 x Mitsubishi 634 kW diesel engines + 2 x 285 kW Baumüller electric torque motors controlled by 2 pcs VACON® NXP Liquid Cooled Drive.
Shipyard:	Schiffwerft Boost, Trier & Koedood Dieselservice, Hendrik-Ido-Ambacht		1 x floating frequency generator with Mitsubishi 634 kW diesel engine. The 50 Hz electrical ship grid is generated by a 75 kVA VACON® NXP Liquid Cooled Drive with MicroGrid functionality.
Main waterways:	The Rhine river and its tributaries in Netherlands, Germany, France and Switzerland		
Year:	2013		
Length:	135m		
Breadth:	11.45 m		
Draught:	3.56 m		

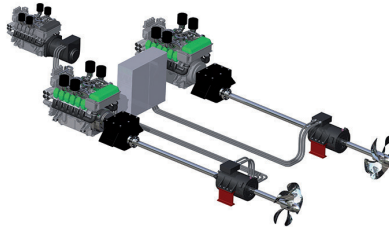
Hybrid propulsion in 3 power modes

The hybrid propulsion offers system three power modes. Optimum performance is achieved by adjusting the mode to the conditions of the voyage.



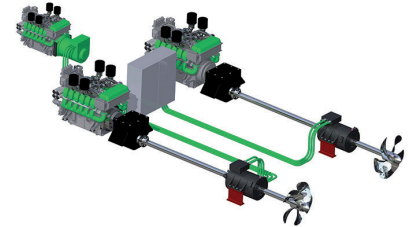
E-mode

In this mode, the Goblin runs without the main diesel engines and instead runs on the generator set. The main engine and the reverse clutch are out of operation and only the thrust bearing of the reverse clutch is used in the E-mode. The E-mode provides comfort while sailing. The generator can run at a variable speed to reduce fuel consumption and reduce the acoustic noise level.



Diesel-mode

In this mode the Goblin runs on the diesel engines only (conventional). The E-motor nevertheless also rotates while sailing in diesel mode because the E-motor is located around the propeller shaft, and connected to a flange on the propeller shaft. The E-motor therefore provides power to the on-board electrical system through an electronic grid generator, the VACON® MicroGrid. While sailing, the VACON® MicroGrid system always supplies pure 50 Hz to the on-board electrical system. This means that the diesel generator set does not need to run whilst the ship operates in diesel mode.



Hybrid Diesel + E-mode

The Goblin has the advantage of offering both diesel and E-mode modes of operation. This flexibility means that it uses all the available power for propulsion. The main engines run at a slightly higher speed and that part of the rotational speed gives the e-motor an extra boost. While sailing, the Goblin can switch seamlessly between the three modes of operation. Everything is programmed and approved by the ship classification society, to ensure that all operations function properly. Even from full speed ahead to full speed astern (in an emergency situation) it can switch from E-mode to Diesel-mode or hybrid mode.

Hybrid Ship Propulsion BV

Hybrid Ship Propulsion BV in Rotterdam offers tailor-made hybrid and electrical propulsion solutions with high reliability and maximum performance. These services comprise:

- Design, delivery and installation of electric propulsion
- Design of mechanical construction and the layout
- Software installation
- Installation of monitor and control equipment

Including 2016 figures, they have 15 ships in operation on their reference list both new-build and retrofitting projects. Commercial director, Henri Kruisinga explains: "Initially we focussed only on river vessels but we have also seen a big potential for hybrid and electric propulsion on harbour tugs and ferries – where the potential for fuel savings of 20-25% can be achieved"

HSP also utilizes the benefits of the latest battery energy storage technologies to reduce the energy consumption further:

- Power Peak Shaving with battery technology enables reduction of the power size of the diesel engines and avoids inefficient modes of operation
- The harbour shore-to ship power supply can remain switched off during on/off loading by powering the ship's electrical grid from a battery pack – this is reducing local port emissions and avoiding poor fuel efficiency operation of the harbour generator
- Fully electric ships where the batteries are charged from shore power systems can fully eliminate the need for diesel engines on board small ferries and passenger ships

Website <http://www.hybridshippropulsion.com/index.php/nl/>

VLT® | VAGON®

Danfoss Drives, Ulsnaes 1, DK-6300 Graasten, Denmark, Tel. +45 74 88 22 22, Fax +45 74 65 25 80, drives.danfoss.com, E-mail: info@danfoss.com

Danfoss can accept no responsibility for possible errors in catalogues, brochures and other printed material. Danfoss reserves the right to alter its products without notice. This also applies to products already on order provided that such alterations can be made without subsequential changes being necessary in specifications already agreed. All trademarks in this material are property of the respective companies. Danfoss and the Danfoss logotype are trademarks of Danfoss A/S. All rights reserved.