

Case story | VACON® NXP Liquid Cooled Drive

Danfoss VACON® NXP Liquid Cooled Drive provides **quiet and clean river cruising**

Comfortable river cruises that use less fuel

Holiday makers love floating hotels on the open seas and river cruises are also becoming increasingly popular. Unlike ocean cruises, river cruises combine city trips with a backdrop of beautiful landscapes. As far as equipment and accommodation are concerned, modern river cruisers are every bit as luxurious as the big ocean liners, even

without huge theatres and swimming pools due to their smaller size. However: In both cases, the operators endeavour to run these floating luxury hotels as energy-efficiently as possible. "If you love ocean cruises, you'll quickly fall in love with river cruises, too," comments Tor Hagen, Chairman and CEO at Viking River Cruises, the world's largest river cruise provider.

One option for achieving maximum energy efficiency on the ships: diesel-electrical hybrid drives. This trend is also taking river cruisers by storm. In 2009, Viking River Cruises commissioned the MV Viking Legend, the world's first river cruiser with an energy and drive system based on a highly efficient DC bus, and many other followed after that. Since then, the shipping company has built up a fleet of more than 50 such



Up to
20%
less fuel
consumption



ships. These ships were constructed by the experts at the Neptun shipyard in Warnemünde near Rostock. The company was established in 1850. In 2002 it specialized in the construction of river cruisers and has built more than 65 river cruisers to date.

Energy-efficient electricity generation on board

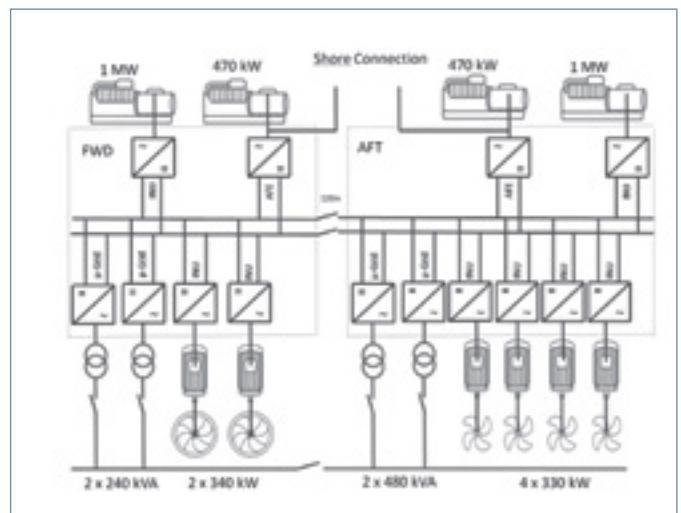
The electrical energy and drive systems are based on the VACON® NXP Liquid Cooled Drive by Danfoss. The ship is fitted with four diesel-electrical energy generators. Two in the front engine room and 2 in the stern engine room. The four asynchronous generators controlled by VACON® NXP drives power the electric propulsion system and the onboard grid. Asynchronous generators are significantly more cost-effective than conventional GenSets (standardized sets comprising a diesel engine and generator). They allow

variable speed operation to optimise fuel efficiency at all times. The VACON® NXP Liquid Cooled Drive also plays an important part in minimizing noise levels for the passengers. Compared with conventional diesel mechanical drive trains to propeller drives, they ensure that the diesel generators run at a optimum in a sound-insulated area. It is easy to turn the generators on or off with the PMS (Power Management System) controller. This ensures that energy production always matches the real-time energy demand. The intelligent internal system of the VACON® NXP Liquid Cooled Drive quickly and reliably spreads the load between the generators. The engineers used the programming tool VACON® Programming (IEC 61131-3) to develop a control concept specifically for this purpose and installed it in the easily-modified control software of the VACON® NXP drives.

Unlike in conventional diesel-electrical main drive systems, the experts at the Neptun shipyard did not have to install large switchboards, thanks to the DC bus concept. This provides a distinct advantage on ships where space is at a premium or could be better used to suit the ship's purpose. The main drives and onboard micro grid drives of the MV Viking ships are designed to be compact and redundant. They meet all EU standards and guidelines for river cruisers as well as the approval conditions of Germanischer Lloyd.



Diesel-electric generator



Overview of the power system

Up to 20% less fuel consumption

The numerous advantages provided by this innovative onboard grid and drive concept primarily include the significant reduction in fuel consumption by up to 20% and resulting reduction in emissions. This is made possible by the ability of the system to automatically calculate the current energy consumption of the ship at all times, and to deliver exactly the demanded energy amount from the generators. If the ship generates additional energy through actions such as braking, this energy does not have to be neutralized by resistors but is fed back through the DC bus and becomes available to other consumers on board. This takes the load off the generators, which need to produce less energy as a result. Thanks to this technology, as well as variable speed drives installed on pumps and fans, the total energy consumption of the ship is up to 20% lower than that of conventional ships.

It is no longer necessary to synchronize the generators, which is another major advantage provided by the DC bus. The required output is available within less than a second. In AC bus electrical systems, synchronization processes can take up to several minutes or fail altogether. The generators are only ready to output energy, such as that required to power the ship forward and away from a hazardous situation, once they have been successfully synchronized. The DC bus system therefore improves the ship's safety and dynamics. This is a particular advantage on narrow and busy rivers as it is possible to react quickly to any unforeseen situation encountered around a bend.

230/400 V onboard grid generation

The VACON® NXP Grid Converters feed four parallel onboard grid transformers to facilitate redundancy. Thanks to them, it is always possible to operate the various onboard grids at the same time, either for short-term switching processes or on a permanent basis. Additional external synchronization is not required as the grid converters complete this task themselves, quickly, simply and at any time. The VACON® NXP Grid Converters feature a programmable drooping function for frequency and voltage. They facilitate the compensation and spreading of loads between several generators. Thanks to this feature, the VACON® NXP Grid Converters act like GenSets in the system. The adjustment parameters required for an accurate selection process of the low-voltage switchboard are available in the grid converters.

Michael Güldner, responsible for the electrical onboard systems of all Viking ships: "We are very satisfied with the VACON® drives. Together, we have been able to further improve the electrical systems over the years."



Michael Güldner, Neptun Shipyard



Drives for cooling water pumps



One of the Schottel propellers



Also the refrigeration system is controlled by Danfoss components

Shipping and the environment

The shipping company gives high priority to the environmental sustainability of its ships. Viking River Cruises focuses all of its efforts on reducing emissions as much as possible. The main and auxiliary diesel engines are fitted with particle filters to prevent carbon emissions. The ship can also be connected to the shore grid. When moored in a city harbor which supplies the required electricity connection, all of the river cruiser's electricity is delivered by a shore to ship supply system. The shore to ship supply is also fed into the ship's grid through the VACON® NXP drive. As the diesel generators are turned off entirely during this process and therefore do not create any noise or emissions, both passengers and residents living close to the mooring do not experience any negative effects.

The ship requires two 400 A connections to maintain its hotel operations. Unfortunately, not every city harbor has the required shore to ship supply system. However, more and more harbors are providing such connections so as to minimize emissions, protect the environment and improve air quality in the cities.

Accurate manoeuvres

The power generation system of the Viking ships comprises a 470 kW and a 1,000 kW diesel generator both in the bow and in the stern of the ship. VACON® NXP drives feed the energy from the generators into the 1024 V DC grid. The DC switchboards in the bow and stern are connected by the 120 m DC bus. Four 330 kW Schottel twin propellers in the stern and two 340 kW Schottel pump jets in the bow drive the ship. They make it easy to manoeuvre the ship accurately and get it up to a maximum speed of 21 km/h, or 13 knots. The power drive system with its four small rudder propellers instead of two large ones also improves the manoeuvrability of the 135 m long and 11.4 m wide ship on narrow rivers. It works much more quietly and vibrates less. The maintenance costs are also considerably lower than those of conventional technology. All of the measures help to significantly increase the comfort of passengers and crew alike.

Great reliability

Emergencies are well covered. To deal with unexpected system errors, such as the sudden breakdown of a generator, the VACON® NXP drives are fitted

with rapid monitoring and control algorithms to prevent blackouts. This function is also achieved using the VACON® Programming tool, which is IEC 61131-3 compliant. In the unlikely event of fire in one of the engine rooms, the crew can isolate the stern and bow supplies at any time. The ship thus always remains manoeuvrable and can dock in the next harbour. Easy communication via fieldbus Thanks to the plug-in fieldbus option card, the VACON® NXP drive can be optimally adjusted to the required system. Due to the reduced wiring required, a fieldbus system is ideally suited to the conditions on board. PROFIBUS is used for communications with the technology on board the Viking ships. It provides all drives with instructions from the control unit, and also delivers feedback. This ensures that all important information from the drives is available to safely operate the ship from the bridge. All VACON® NXP drives are connected via a fast internal CAN bus used for internal communications, simple calibrations during commissioning and troubleshooting. The VACON® NCDrive software tool provides access to all the drives through just one central access point on this bus.