Voith Turbo

VOITH

Voith Schneider Propeller
Designer Manual

For safer shipping worldwide – Propulsion systems and ship concepts from Voith Turbo Marine.

Safety and precise maneuvering on the seas, lakes, rivers, waterways and harbors of the world is of maximum importance. Safe and eco-friendly drive systems are an essential prerequisite for this. For over 80 years, Voith has been designing systems that are safe for people and the environment: a unique propulsion system – the Voith Schneider Propeller, the Voith Radial Propeller, the Voith Turbo Fin and also worldwide proven ship concepts such as the Voith Water Tractor are proof of our comprehensive expertise in this branch of industry. And our customers benefit from the low-maintenance and operationally safe systems, which guarantee a high level of availability and outstanding quality.

Voith Schneider Propeller

Voith Turbo Schneider Propulsion provides customized propulsion systems for the full range of applications from harbor and escort duties, through to ferries, military applications and special ships.

Built in Voith Schneider Propeller

Voith Water Tractor “Baut”, Norway

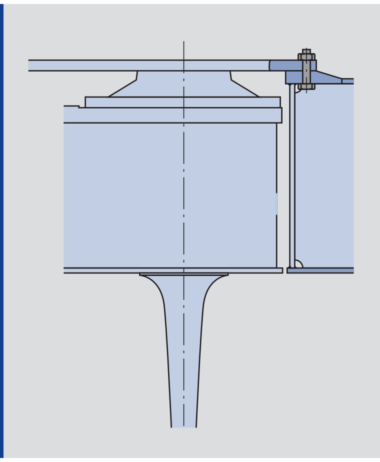
Double-ended ferry “Rheintal”, Germany

The Voith Schneider Propeller (VSP) delivers thrust in all directions. It is a fast, continuously variable and precise vessel propulsion system combining propulsion and steering in a single unit. VSP-equipped vessels do not require rudders. Thrust and steering forces between zero and maximum can be generated in any direction.

On Voith Schneider Propellers the propeller blades protrude at right angles from the rotor casing and rotate around a vertical axis. Each propeller blade performs an oscillatory motion around its own axis which is superimposed on the uniform rotary motion. The VSP is fitted in the vessel so that only the blades protrude from the hull.
The blades themselves are manufactured from high-strength materials and are extremely robust.

Propeller Well

The propeller well, which acts as the foundation of the Voith Schneider Propeller, consists of a cylindrical shell with a flange at the top. The propeller well must form an integral part of the bottom structure of the vessel so that, in addition to the propeller's weight, the forces and torque resulting from the propeller thrust can be transmitted into the ship's hull. This propeller thrust can vary by a full 360°.



Attachment of the propeller

Propeller foundation

Final machining of the flange

The sealing surface of the flange should be machined on board but this should be done only after installation of the complete well. The work should be performed with a suitable turning or milling machine according to the instructions provided by Voith. If such a machine is not available, a previously machined well can be welded in as a unit. After the welding the flange has to be checked on flatness and dimensional tolerances.

A flat, approximately 2 mm-thick gasket, which is resistant to sea water and oil is located between the propeller well and the propeller. This gasket is part of the Voith scope of supply.

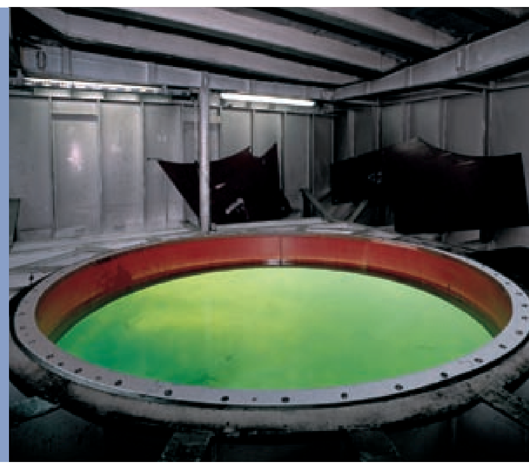
Through-bolts of quality class 8.8 according to DIN 931 are used to fasten the propeller in place.

Further details, especially in respect of propeller installation, the permissible tolerances, the number of connecting bolts and tightening torques, are described in the installation instructions that are provided by Voith.

Propeller Installation

To simplify transport, Voith Schneider Propellers above size 26 are supplied to the shipyard with the propeller blades removed. Blade installation is supervised by a Voith technician and can be carried out either prior to or following propeller installation to the vessel.

Blade installation



Propeller well

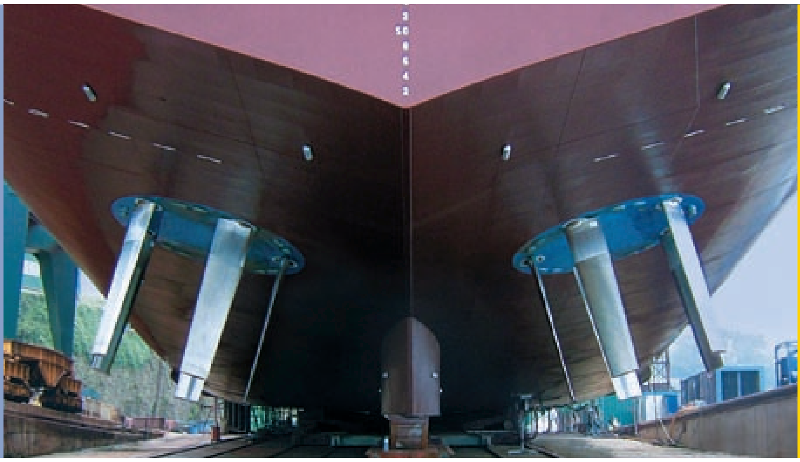
Preparations prior to installation

During propeller installation, the Voith Schneider Propeller is first lowered onto the ready machined foundation.

Alignment of the entire propulsion system is carried out in the following sequence:

1. Voith Schneider Propeller
2. Propulsion engine
3. Shaft line
   (final alignment with the vessel afloat)

Voith Schneider Propeller installation



Built in Voith Schneider Propeller

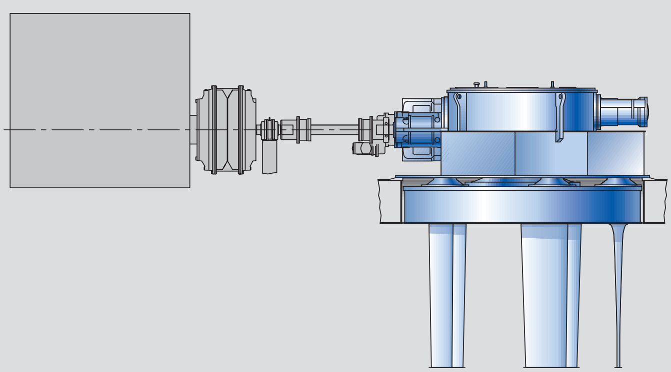
Propellers located below the design waterline are equipped with an elevated oil tank. This allows the static oil pressure in the rotor casing to be increased to prevent water ingress into the propeller even when it is at a standstill. The elevated oil tank is part of the Voith scope of supply and should be mounted midships in the propeller area at a transverse bulkhead approx. 0.5 to 2 m above the design waterline.

The propeller must be filled with oil before the vessel is launched.

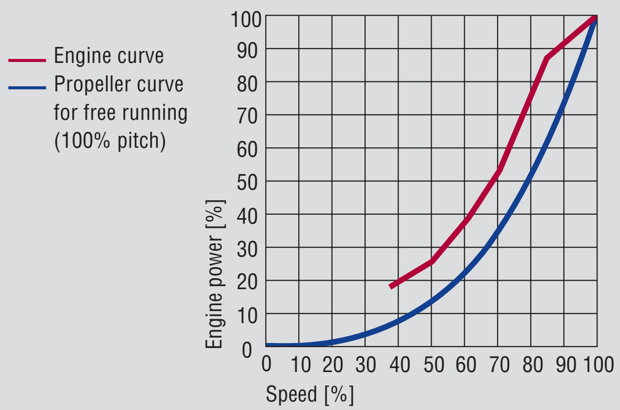
Voith Schneider Propellers are self-contained propulsion systems and do not require any secondary energy for operation. The VSP is ready for operation immediately after start-up of the main propulsion engine.

Propulsion Systems
Interaction of Motor and Propeller

The direction of the Voith Schneider Propeller's motor does not need to be reversed and the propeller can be operated at a constant speed. Thanks to its variable pitch characteristic, the propeller thrust is variable in direction and magnitude. The propulsion motor is speed-controlled for economically efficient partial-load operation.



Diesel engine and Voith Schneider Propeller



VSP power intake regulated by motor speed, at constant pitch

Diesel engine propulsion

In the power range of the VSP, ship diesel engines are the most widely used propulsion units. The permissible propeller input speed can be selected freely within certain limits.

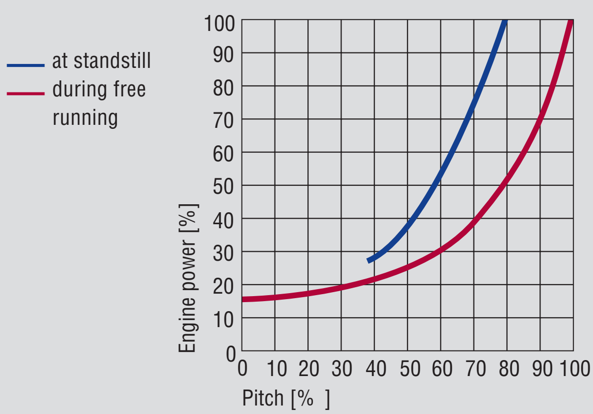
In contrast to fixed pitch propellers, the variable pitch of the VSP allows full utilization diesel engine output across all vessel operation conditions.

Pitch variability makes it possible to make full use of the diesel engine speed output range, even when the propeller is subjected to very different loads.

In contrast to propellers with a fixed pitch, overloading of the main motor, so-called stalling, is prevented.

From the viewpoint of economic efficiency, the power intake of the VSP should, whenever possible, only be varied under the following operating conditions:

- Under different propeller loads, e.g. change from free vessel movement to standstill conditions, braking operation, dynamic ship assistance by the Voith Water Tractor
- Vessel maneuvering
- Below the minimum permissible speed of the main engine.



VSP power input over pitch at constant speed

VWT "Svezia", Italy

Under defined partial load conditions, VSP power input at maximum pitch is controlled via the engine speed (e.g. varying speed settings for free-frunning vessels). The maximum power output of the main engine is measured during free running with a pitch setting of 100% and at a pitch setting of approx. 80% at bollard pull conditions.

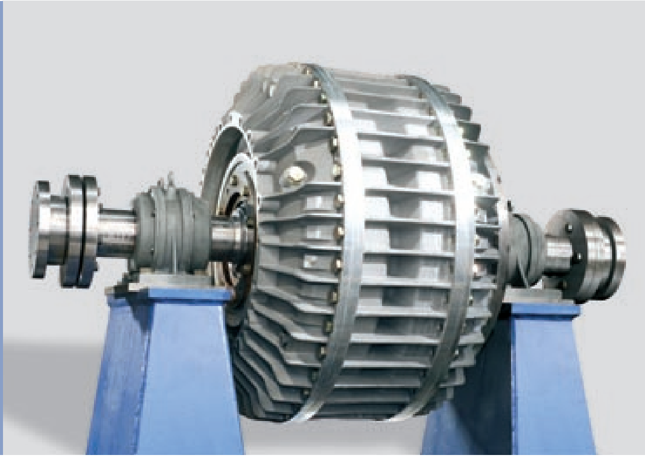
Electric propulsion

Electric VSP propulsion is used when large amounts of electrical energy are required for other onboard equipment such as on floating cranes or ferries.

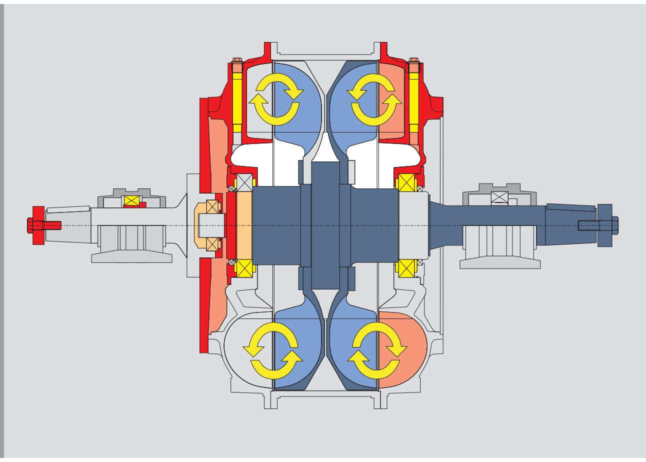
As VSP power input is controlled by the variable propeller pitch, robust and reliable three-phase asynchronous motors can be used for propulsion. Depending on the application requirements, speed-controlled motors can also be used.

To start the electro motors, a soft-start device, such as a star-delta starting must be provided. The respective breakaway torques are calculated by Voith Turbo Schneider Propulsion on the basis of the parameters of the entire propulsion system.

Shaft Line



Type DTL turbo coupling



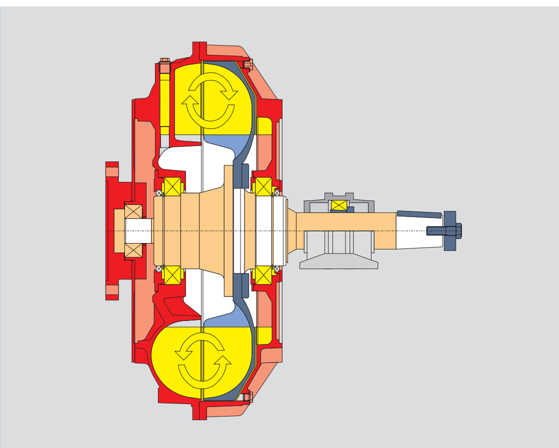
Type DTL turbo coupling with constant oil filling

The shaft line for transmitting the motor output to the Voith Schneider Propeller normally consists of a Voith turbo coupling and a displaceable curved teeth coupling with an intermediate shaft. The use of a hydrodynamic coupling guarantees smooth starting and stopping of the whole propulsion system.

Moreover, the turbo coupling divides the entire vibration system into a primary and secondary side, whereby all the oscillatory pulses from the main motor are extensively dampened in the coupling and almost none are transmitted to the secondary side.

There are basically two versions of the turbo coupling:

1. Turbo coupling with constant oil filling
2. Turbo coupling with oil flow control



Type TM1 VTK turbo coupling with constant oil filling

Double-ended ferry "Sahilbent", Turkey

For most applications turbo couplings with constant oil filling can be used. These are virtually wear-free and therefore require little maintenance. In the majority of cases we supply turbo couplings with constant oil filling for direct installation onto the engine. The engine manufacturer must determine whether the engine can withstand the load reaction on the turbo coupling input side. If this is not the case, turbo couplings with pedestal bearings at the input and output side can be supplied.

In this case, the engine manufacturer must design and supply the required resilient coupling between engine and turbo coupling.

Flow-controlled turbo couplings are only used for special applications such as when extremely high torques or speeds are required.

Smaller Type R4 propellers or propulsion units with an electric drive do not require turbo couplings.

For Type R4 propellers with diesel engine propulsion, clutch couplings must be used instead of turbo couplings.

The propeller input shaft must be linked to the downstream shaft line/turbo coupling output shaft by means of a displaceable coupling or drive shaft.

Fire-fighting boat for Los Angeles, USA

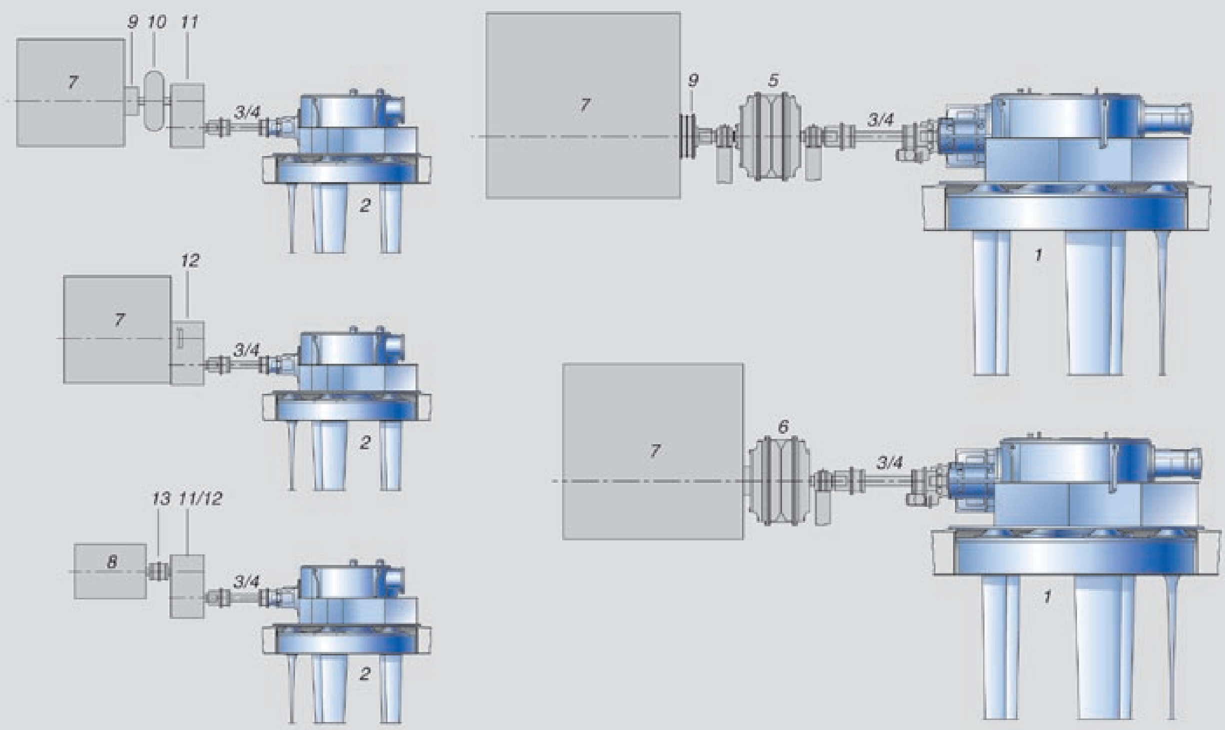
Buoy laying vessel "Chef de Caux", France

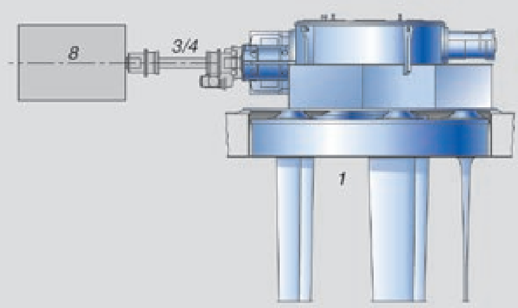
Provision of fire-fighting capacity

Today, increasing the fire fighting capacity of ships is becoming increasingly important in modern harbors. For the provision of higher fire-fighting capacities, powerful motors are needed which are operated only rarely. As a result, the cost of maintenance increases.

When the VSP with a variable pitch characteristics is used, it is possible to connect firefighting pumps to the main engine via a power take-off (PTO). Additional motors for fire-fighting pumps are not necessary. During firefighting, the pitch and therefore the power intake of the VSPs are reduced to 30 %.

The remaining power can then be used for the fire-fighting pumps, without the main engine being overloaded. The ship continues to be fully maneuverable and can therefore assume and retain the optimum position for fighting the fire.





1 VSP type R5/…-2 (two-step)
2 VSP type R5/…-1 (one-step)
3 Displaceable coupling with intermediate shaft
4 Cardan shaft
5 VTK, type DTL/TL
6 VTK, type DTm1/Tm1
7 Diesel engine
8 Electric motor
9 Elastic coupling
10 VTK, type T
11 Step-down gear
12 Step-down gear with clutch
13 Displaceable coupling

These illustrations show some proven examples of shaft lines as an orientation aid for project planning.

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Engineered reliability.

G 1861 e 2009-12 3000 ak/WA Printed in Germany. Dimensions and illustrations non-committal, subject to change.