

Efficient Control of Pumps and Compressors. Vorecon Variable Speed Planetary Gear





Voith sets standards in the energy, oil & gas, paper, raw materials and transportation & automotive markets.

Founded in 1867, Voith employs almost 39000 people, generates 5.3 billion Euro in sales and operates in about 50 countries around the world. It is currently one of the largest family-owned companies in Europe.

Reliable Speed Control.

The Vorecon

Using the Vorecon allows you to control the speed of your driven machine. Your process is carried out at exactly the speed required. As a result, the process runs with optimal efficiency saving you costly energy. But that is not all it does.

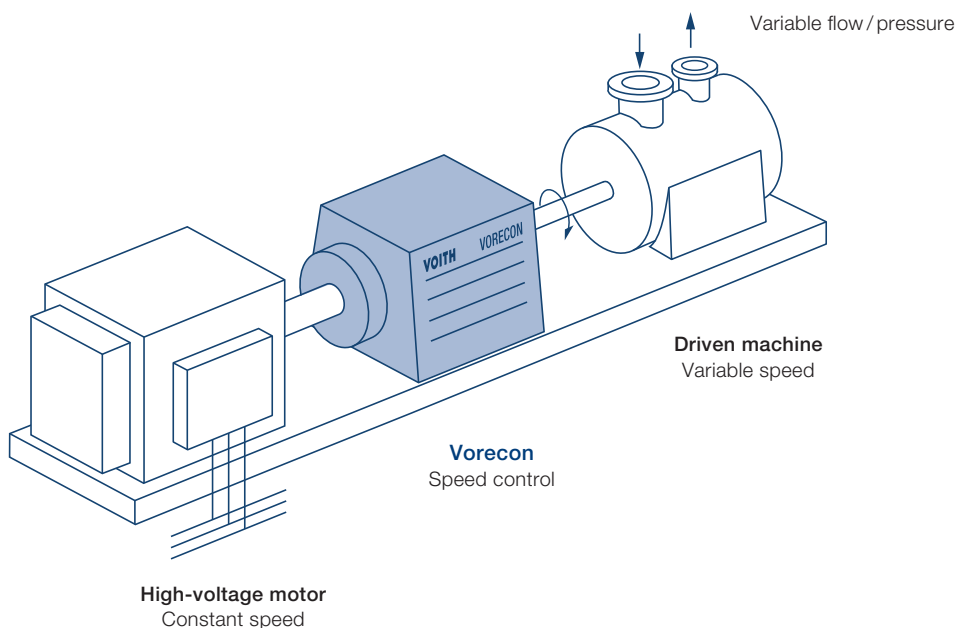
The principle

- The Vorecon is a hydrodynamic variable speed planetary gear for output of up to 50 MW and speeds exceeding 20 000 rpm.
- It combines reliable mechanical design with hydrodynamic power transmission.

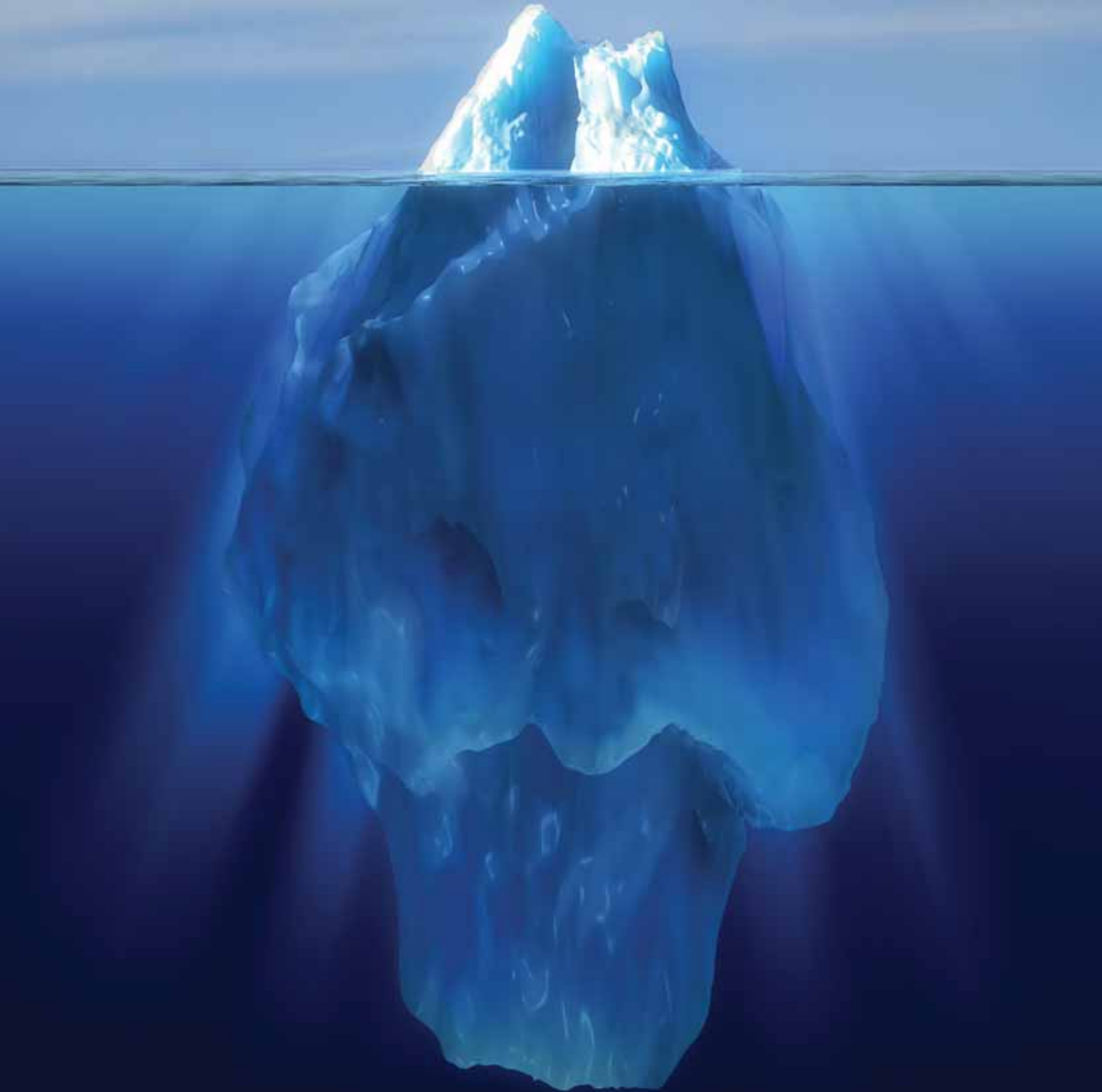
Unique characteristics

- Hydrodynamic power transmission is wear-free.
- The service life of the Vorecon spans many decades and is, in general terms, more than 3 times longer than that of variable frequency drives (VFD).
- The mean time between failures (MTBF) is 48 years.
- The overall efficiency of a drive system equipped with Vorecon is up to 2 % better than that of an electric variable speed drive.
- A single aggregate for handling speed control, speed increase and oil supply.

Driveline with Vorecon, power transmission 1 – 50 MW



Consider both the visible
and the hidden costs.



Reduce Costs by Using the Vorecon. Total Cost of Ownership (TCO)

It doesn't matter whether you build, operate or design drive systems, there is still a common goal: to reduce overall operating costs. Vorecon, very efficiently helps to achieve exactly that.

Drive solutions

Are you planning a project with variable speed drive? Please contact us and we can look for the best solution together. Jointly, we can consider all of the costs incurred over the planned system service life. Rather than telling you how to arrange the calculation, we prefer to work through it with you as a team.

TCO in the Iceberg model	Cost factors	Drive systems fitted with Vorecon compared with electric variable speed drives
Visible costs	Procurement	Similar or lower costs
	Capital procurement	Same costs
	Commissioning	Lower costs
Hidden costs	Infrastructure	Lower costs
	Energy	Typically lower costs
	Space	Lower costs
	Maintenance and Repair	Significantly lower costs
	Standstill	Significantly lower costs
	Disposal	Lower costs



Intelligent Drive Control. Applications

The Vorecon is ideal for variable speed drive applications in power ranges from 1 to over 50 MW in the oil and gas industry, as well as in thermal power plants.

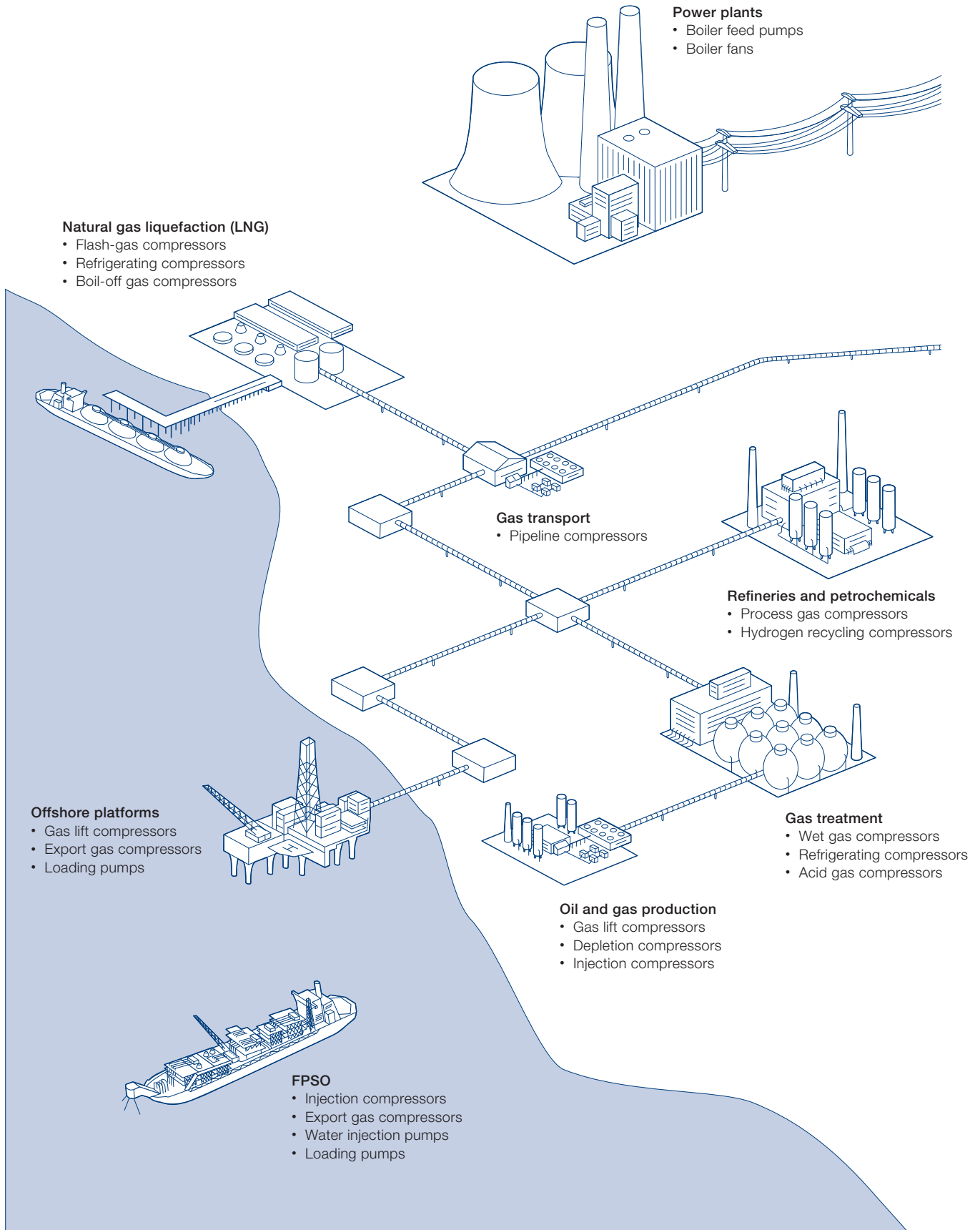
Energy efficiency

Controlling the speed of pumps, compressors and blowers translates into major energy savings. The typical Vorecon installation can be amortized in just a few short years of service.

Productivity

The robust Vorecon, with its characteristic reliability, provides the basis for your system to achieve high productivity. And this applies anywhere in the world – even under extreme environmental conditions.

The Vorecon in variable speed drives in the oil and gas industry, as well as in thermal power plants



Setting the Highest Standards. The Benefits of the Vorecon

Power from

1–50 MW

Overall efficiency up to

2%

higher than that of electric variable speed drive systems.

More than

5000

drives in use worldwide.

Controlling speeds up to and exceeding

20 000 rpm

Unbeatable reliability of

99.988%

48 years

mean time between failures (MTBF).

3x

longer service life than a variable frequency drive (VFD).

Up to

68%

saving on installation space, compared with electric variable speed drive systems.

Our Vorecon – your advantage.



With the Vorecon, you avoid costly downtime so overall your system is more productive. At the same time, you use less energy and installation space while enjoying both low investment and maintenance costs.

Productivity

+ Your system can run uninterrupted by unscheduled outages and downtime; your overall process productivity is increased.

Why? We combine hydrodynamic power transmission with mechanical parts designed for a long life. The mean time between failures (MTBF) of all Vorecons in operation is 48 years.

Reliability, MTBF

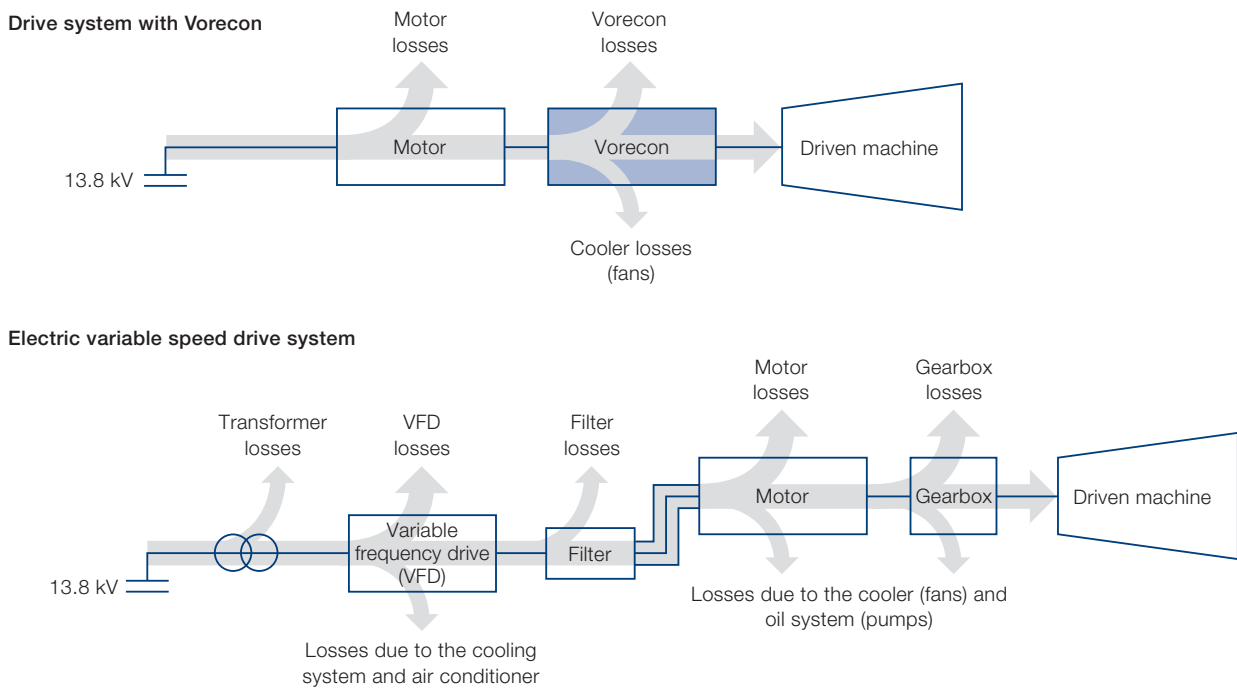
Machines considered	201
Operating hours	8 065 000 hours
Reliability	99.98 %
MTBF	≈ 48 years

Energy

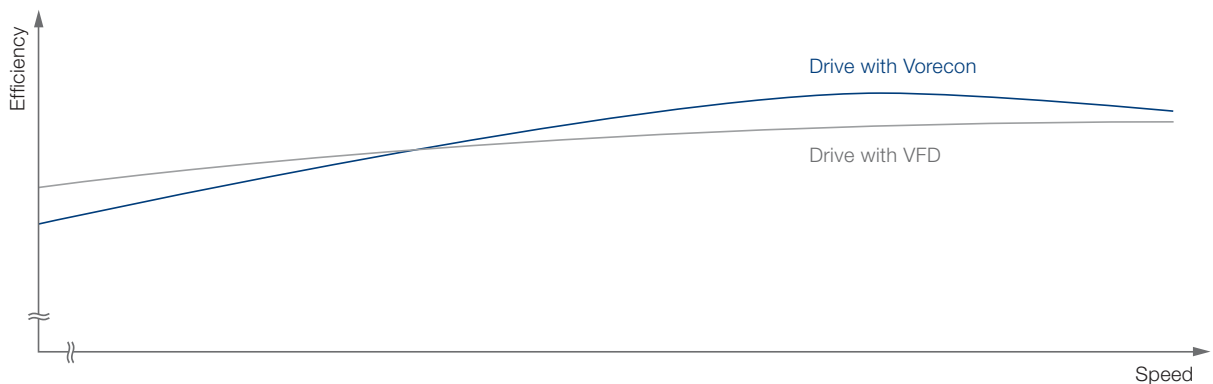
+ Speed control saves energy. You reduce your operating costs and lower CO₂ emissions.

Why? The Vorecon operates based on the principle of power splitting. This permits the Vorecon to achieve an efficiency of more than 95%. Drive systems featuring the Vorecon have fewer added accessories requiring energy. The result: overall efficiency is up to 2% greater than that of electric variable speed drive systems.

Comparison of overall efficiency



Look at the overall efficiency of the system:



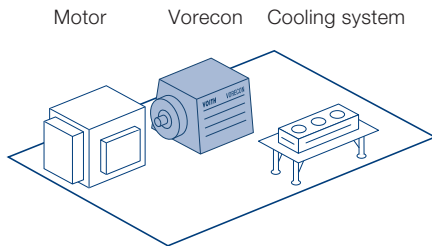
Installation Space

+ The Vorecon saves on installation space and reduces the overall system weight. This saves on overall construction costs – quite significantly in the case of space-critical offshore platforms and FPSO vessels.

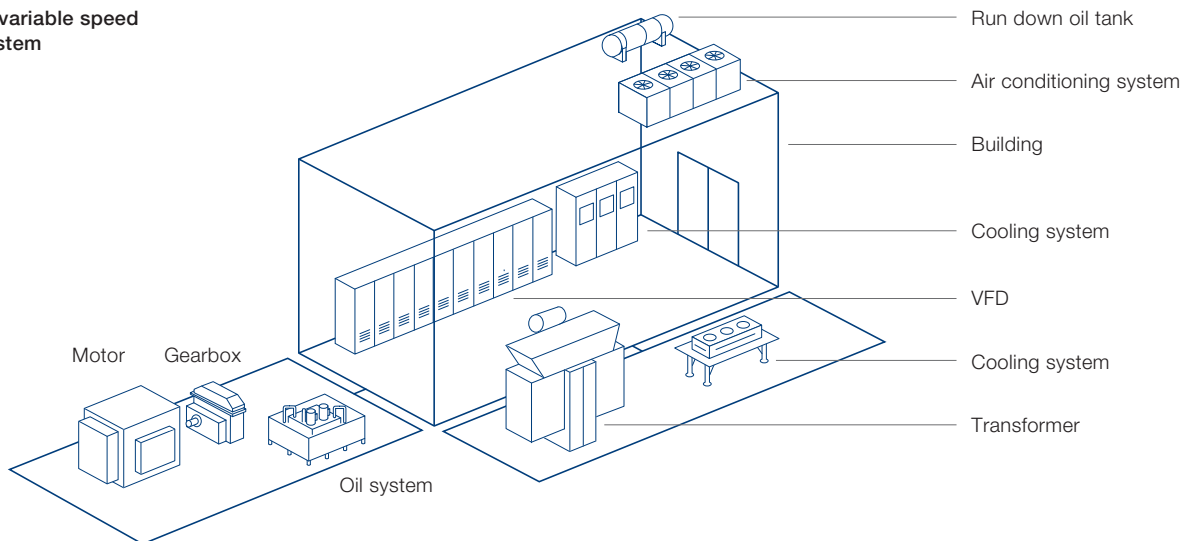
Why? The Vorecon is an aggregated system comprising a speed control system, gearbox and oil supply. Thus, the Voith drive system needs up to 68% less installation space than comparative electronically speed controlled drive systems. The reduced space required for installation means much lower infrastructure costs, particularly in offshore applications.

Comparison of required installation space

Drive system with Vorecon



Electric variable speed drive system

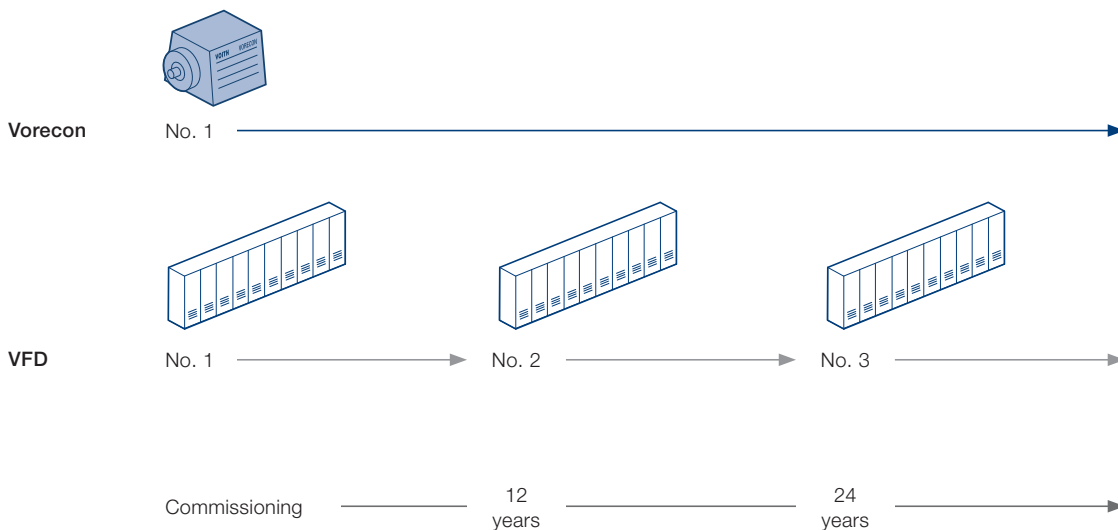


Service Life

+ The Vorecon is a product built for the long term. It gives you long-term planning security – over many decades.

Why? Hydrodynamic power transmission is wear-free. The mechanical power transmitting components are robust and designed for a long service life. Compared with a variable frequency drive (VFD), the service life of the Vorecon is more than three times as long.

Comparison of service life

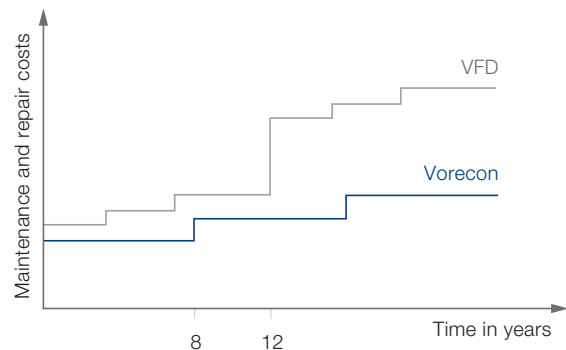


Maintenance and Repair

+ Maintenance costs are low and service outages can be planned and scheduled in advance. You reduce both the downtime and operating costs of your equipment.

Why? Our system components don't just have a long service life. We also manufacture our systems to be low-maintenance. This, combined with overhaul intervals of 8 years, ensures both low operating costs and high availability.

Comparison of maintenance and repair costs



Clever Combination of Hydrodynamics and Mechanics.

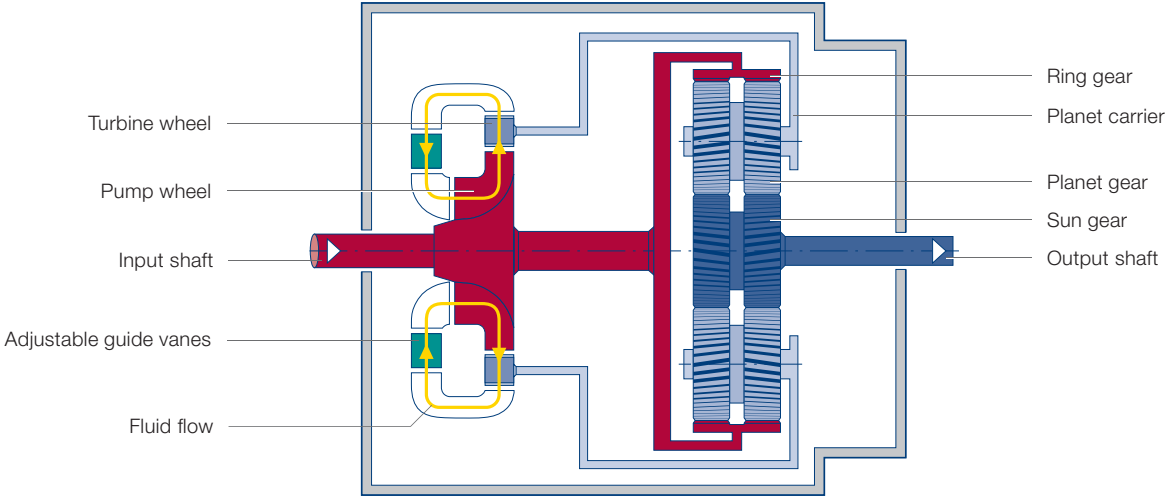
Function

The basic components of the Vorecon are a hydrodynamic torque converter coupled with a planetary gear. The planetary gear is designed as a superimposing gear. The torque converter acts as the control unit.

Design and function

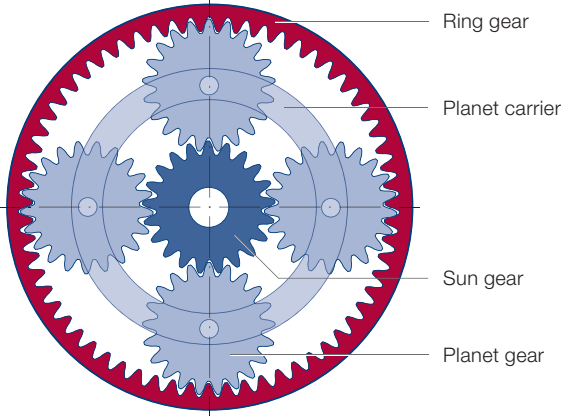
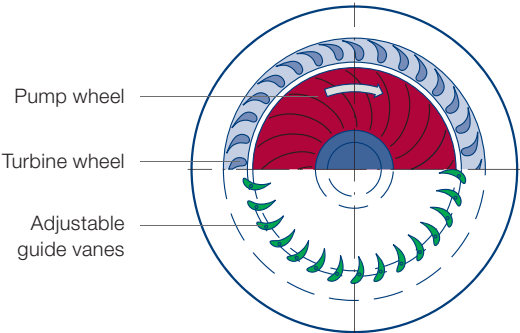
- In the driveline, the Vorecon is located between the drive motor and the driven machine.
- The input shaft is connected to the ring gear of the planetary gear.
- A large proportion of the input power is thus transmitted to the planetary gear directly, mechanically and almost loss-free.
- A hydrodynamic torque converter is also coupled with the input shaft.
- The pump wheel of the torque converter is linked to the input shaft and branches off just a small proportion of the input power.
- A flow of fluid transmits this power from the pump wheel to the turbine wheel of the torque converter (hydrodynamic power transmission).
- The power branched off is transmitted to the planet carrier of the planetary gear via the turbine wheel.
- The power from the ring gear and from the planet carrier are added together in the planetary gear.
- The planet gears transmit the accumulated power to the sun gear, the output shaft and, finally, to the driven machine.
- Adjustable guide vanes control the flow of fluid in the torque converter and determine the speed of the turbine wheel. This allows the speed of the driven machine to be infinitely adjusted.

Basic design of the Vorecon

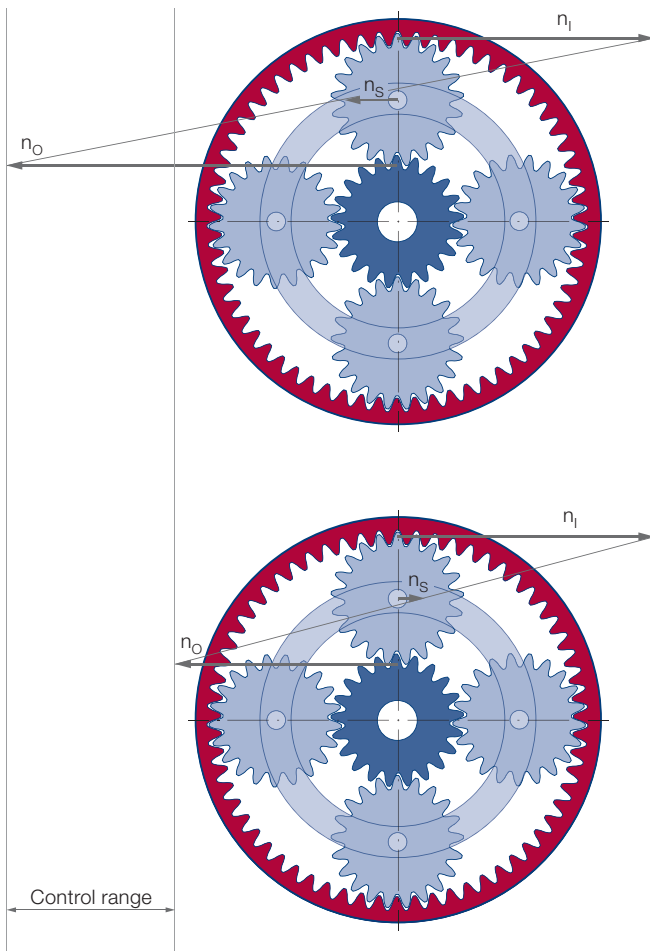


Hydrodynamic torque converter

Planetary gear



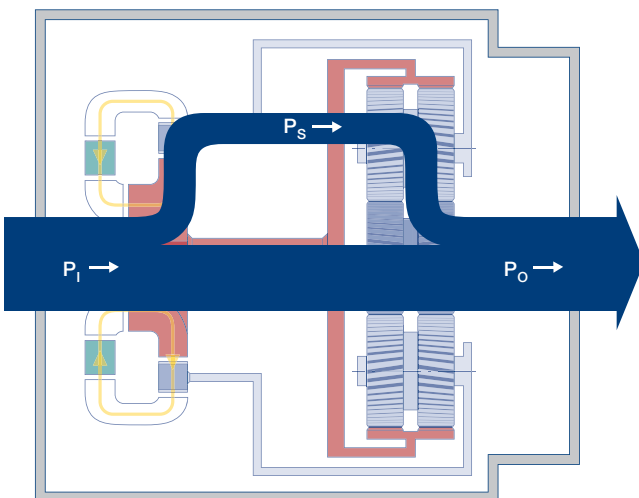
The superimposition principle



- The input speed corresponds with the motor speed and is constant.
- The continuously adjustable guide vanes in the hydrodynamic torque converter determine the variable superimposition speed.
- The output speed results from the vectorial addition of the input and superimposition speed.

n_i : Input speed
 n_s : Superimposition speed
 n_o : Output speed

The principle of power splitting in the Vorecon



- In the Vorecon, the largest proportion of the input power flows directly from the input shaft to the output shaft.
- The hydrodynamic torque converter branches off a small proportion of the input power.
- The power being branched off is then reapplied to the output shaft through the superimposing gear.
- The Vorecon achieves high efficiency thanks to the principle of power splitting.

P_i : Input power
 P_s : Superimposition power
 P_o : Output power

Finding the Best Solution.

Vorecon Product Range

The Vorecon product range comprises various types and configurations, enabling us to respond to your requirements. Together, we choose the Vorecon that best matches your drive and system.

Type	What it offers	Applications		
		Compressors	Pumps	Blowers
RWE	Economical and compact.	✓	✓	
RWC	For starting up the motor load-free.	✓	✓	
RW	For a wide control range.		✓	✓
RWE-M	Economical and modular.	✓	✓	
RWC-M	The economically-priced modular version for starting up the motor load-free.	✓	✓	
RWC-M-D	For high efficiency even down to the lower speed range.	✓	✓	

Type RWE – Economical and Compact

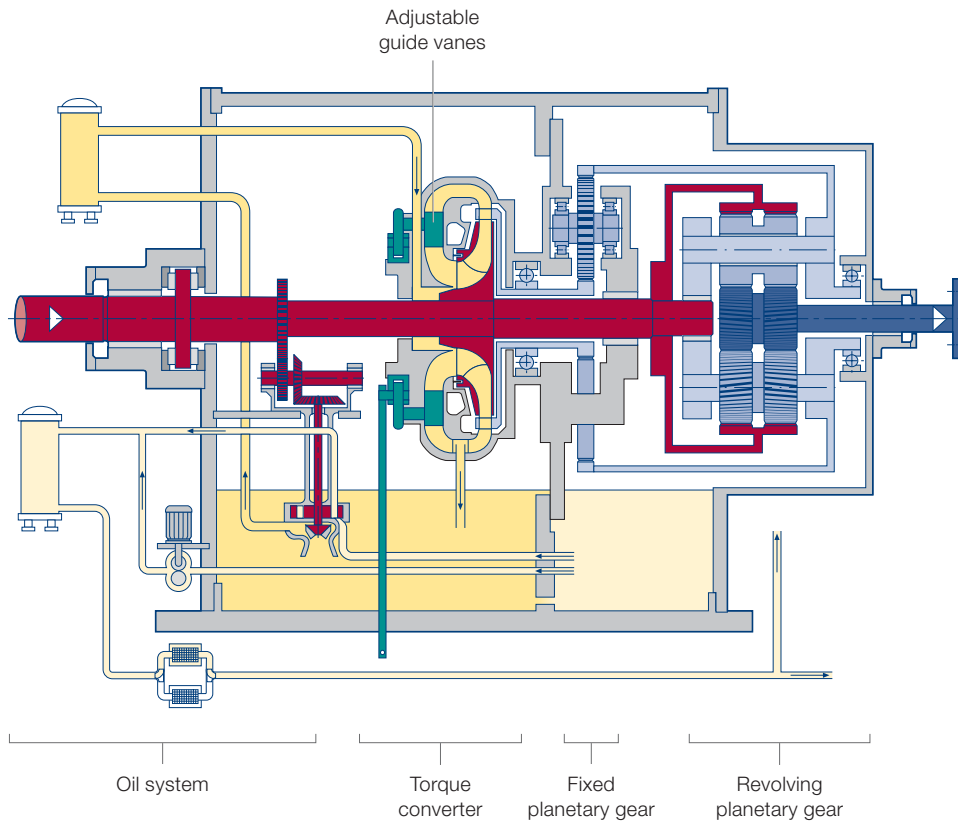
Function

- The torque converter fills immediately after starting the motor and branches off a small proportion of the input power.
- The driven machine is accelerated to minimum speed.
- A fixed planetary gear transmits the power branched-off to the revolving planetary gear (superimposing gear).
- The revolving planetary gear adds up the power again.
- Speed control is applied using the adjustable guide vanes in the torque converter.
- The integrated oil system fills the torque converter with operating oil. At the same time, the Vorecon supplies the drive motor and the driven machine with lubricating oil.

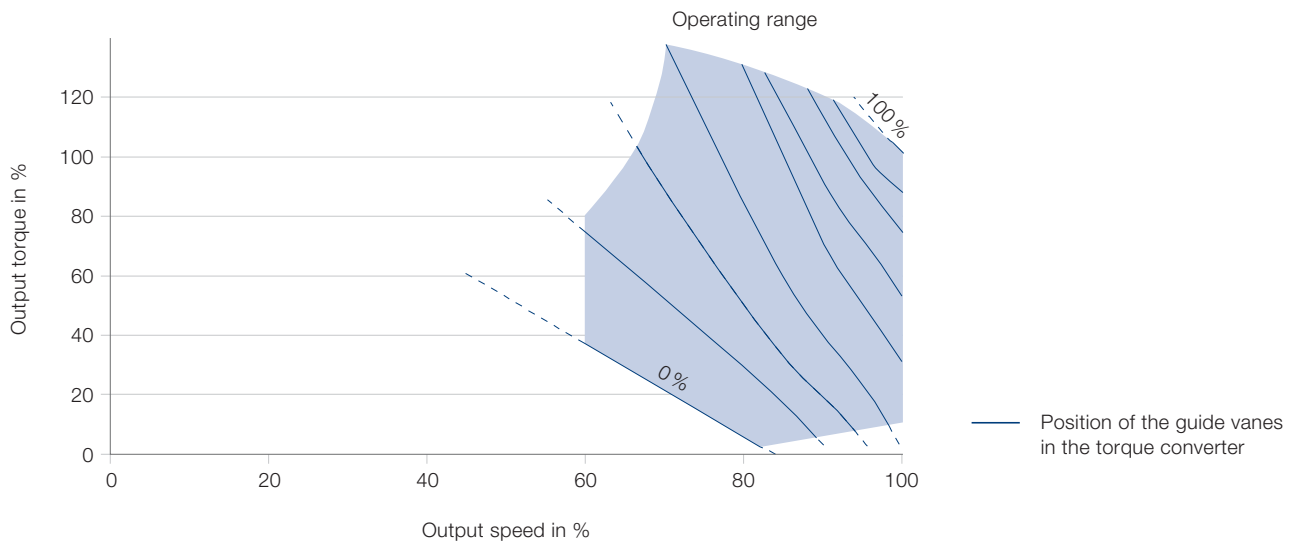
Special benefits

- + The Vorecon RWE is a cost-effective and simple solution for high-speed turbo compressors and boiler feed pumps with reduced control range.
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RWE sectional diagram



RWE characteristic curves



Type RWC – For Starting Up the Motor Load-Free

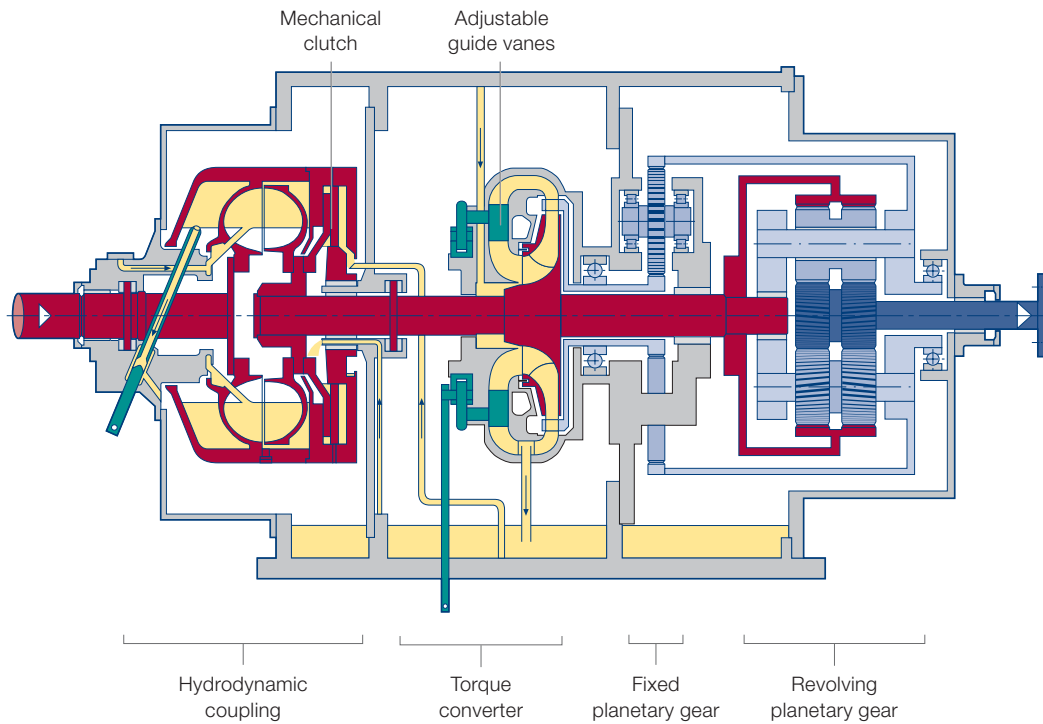
Function

- When starting the drive motor, the hydrodynamic coupling is emptied and the clutch is opened. Therefore, the drive motor and the driven machine are decoupled, with the motor started up essentially load-free.
- The hydrodynamic coupling is filled after the drive motor is running, and begins to transmit power. The driven machine is then gently accelerated to minimum speed.
- The clutch closes and bypasses the hydrodynamic coupling.
- From then on, the Vorecon RWC operates in the same way as the Vorecon RWE. The speed control of the driven machine is applied using the adjustable guide vanes in the torque converter.

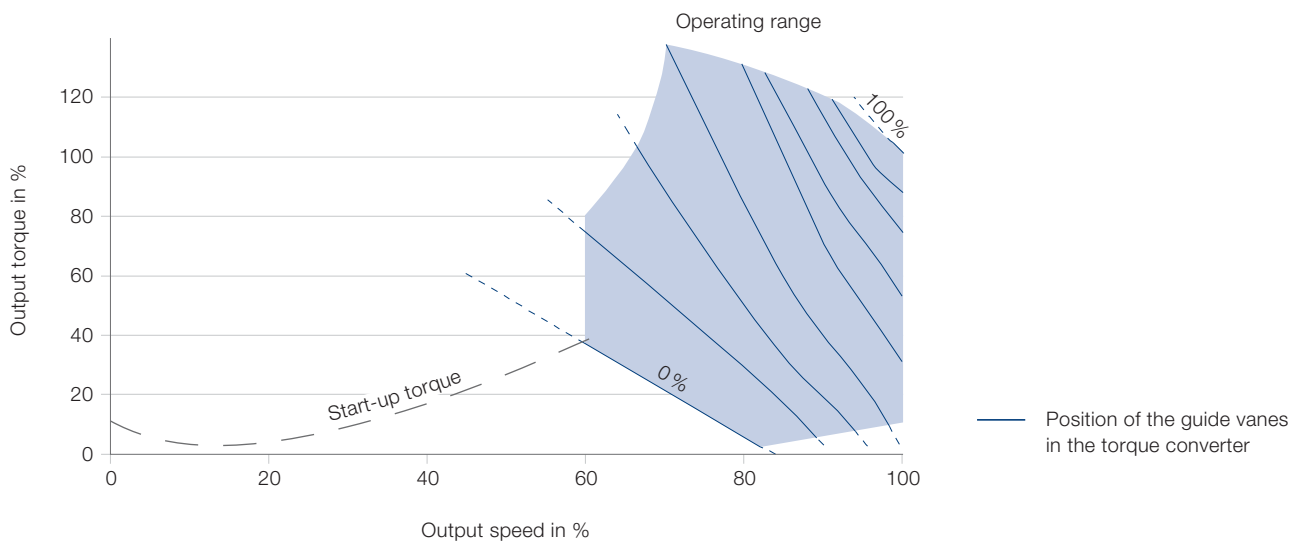
Special benefits

- + The drive motor starts unloaded. The driven machine can also be started under weak power grid conditions.
 - + Driven machines with a high mass moment of inertia are easier to start-up.
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RWC sectional diagram



RWC characteristic curves



Type RW – For a Wide Control Range

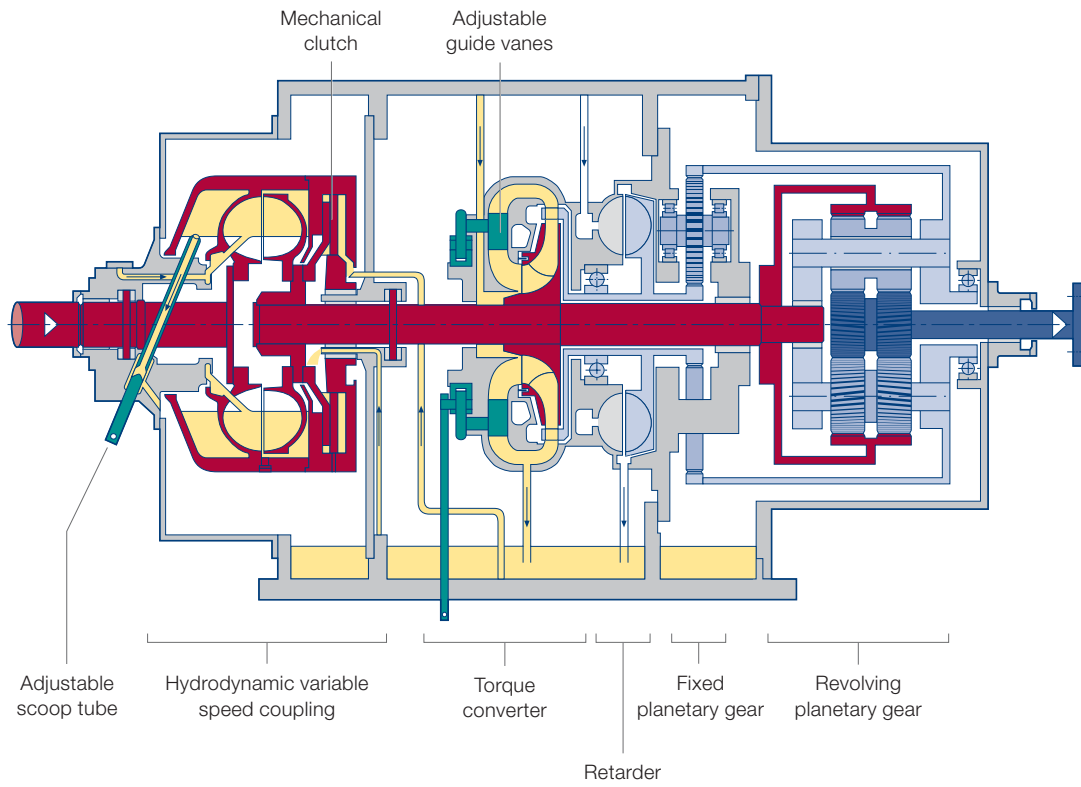
Function

- When starting up the drive motor, the hydrodynamic variable speed coupling is emptied and the clutch is opened. Therefore, the drive motor and the driven machine are decoupled, with the motor started up essentially load-free.
- In the lower control range, the hydrodynamic variable speed coupling is filled and transmits the power. The torque converter is emptied and thus is non-operational in this control range. The speed control of the driven machine is achieved via the adjustable scoop tube which determines the filling level of the operating oil in the coupling and therefore, the power transmitted.
- The retarder (hydrodynamic brake) is filled with oil and keeps the fixed planetary gear at a low speed.
- To achieve the upper speed range, the clutch closes and bypasses the variable speed coupling.
- The retarder is emptied and the torque converter is filled.
- From then on, the Vorecon RW operates in the same way as the Vorecon RWE. The speed control of the driven machine is applied using the adjustable guide vanes in the torque converter.

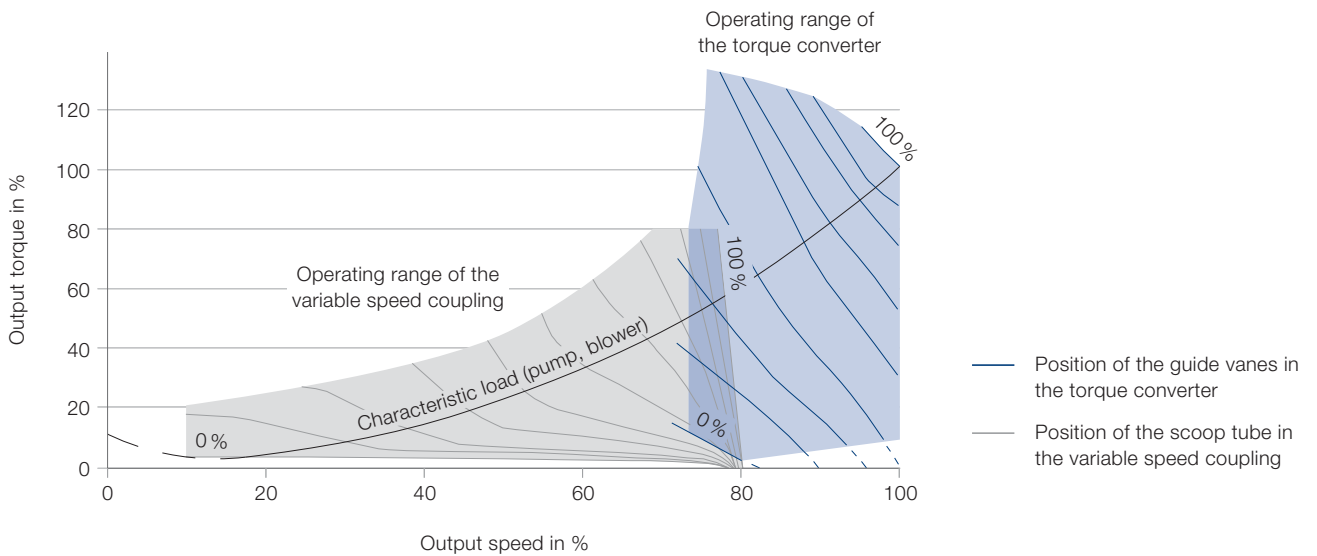
Special benefits

- + The Vorecon RW is the ideal control combination for driven machines with a wide control range – mainly pumps and blowers.
 - + In addition, the Vorecon RW offers the same advantages as the Vorecon RWC: no-load motor start-up and easy start-up of driven machines with a high mass moment of inertia.
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RW sectional diagram



RW characteristic curves



Type RWE-M – Economical and Modular

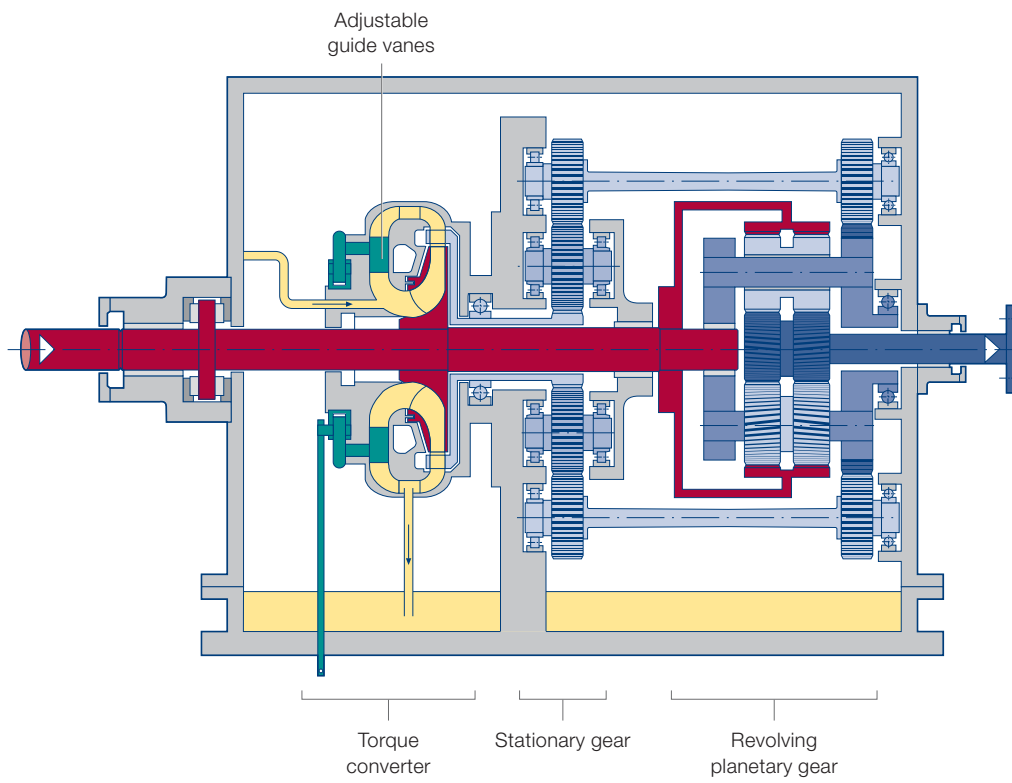
Function

- The torque converter fills immediately after starting the motor and branches off a small proportion of the input power.
- The driven machine is accelerated to minimum speed.
- A stationary gear transmits the power branched-off to the revolving planetary gear.
- The revolving planetary gear adds up the power again.
- The speed control is applied using the adjustable guide vanes in the torque converter.

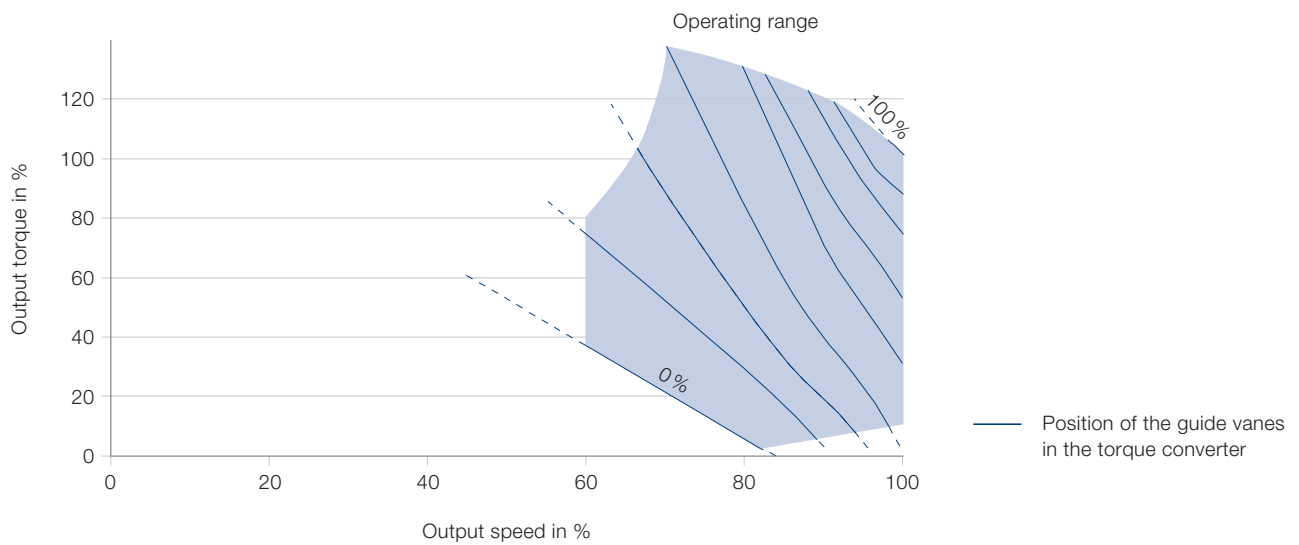
Special benefits

- + The Vorecon RWE-M is a cost-effective and simple solution for high-speed turbo compressors and boiler feed pumps with reduced control range.
 - + The modular design with horizontally split housing allows service work to be carried out quickly and effectively, which is an important aspect for offshore systems.
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RWE-M sectional diagram



RWE-M characteristic curves



Type RWC-M – The Economically-Priced Modular Version for Starting Up the Motor Load-Relieved

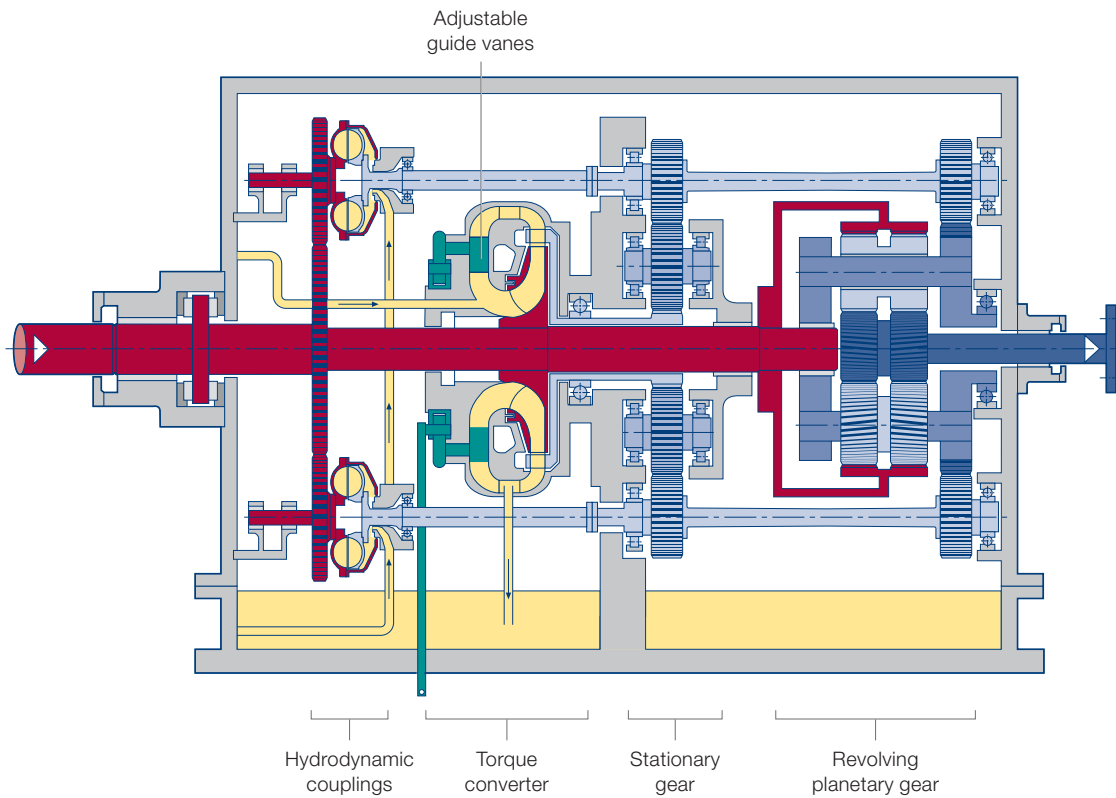
Function

- When starting the motor, the hydrodynamic couplings are filled and the torque converter is emptied. The hydrodynamic couplings thus connect the stationary gear with the input shaft. This results in a very low speed on the output shaft and the driven machine takes on a little power. This relieves the motor when starting up.
- After starting up the motor, the hydrodynamic couplings are emptied and the torque converter is filled. The driven machine is accelerated to minimum speed.
- From then on, the Vorecon RWC-M operates in the same way as the Vorecon RWE-M. The speed control of the driven machine is applied using the adjustable guide vanes in the torque converter.

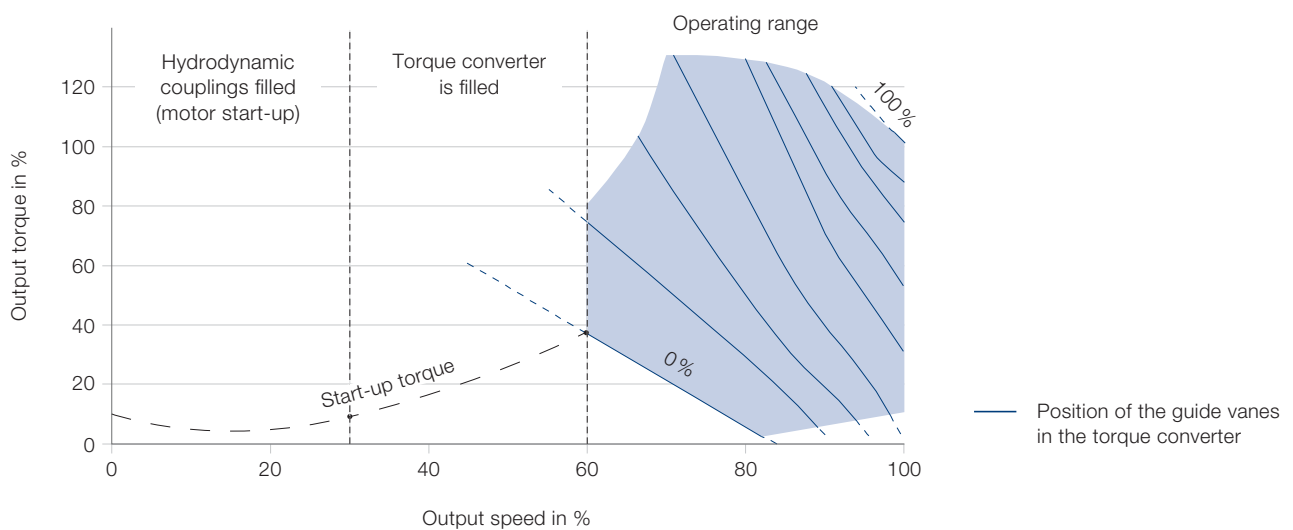
Special benefits

- + The drive motor starts unloaded. The driven machine can also be started under weak power grid conditions.
 - + Driven machines with a high mass moment of inertia are easier to start-up.
 - + The modular design with horizontally split housing allows service work to be carried out quickly and effectively, which is an important aspect for offshore systems.
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RWC-M sectional diagram



RWC-M characteristic curves



Type RWC-M-D – For High Efficiency even Down to the Lower Speed Range

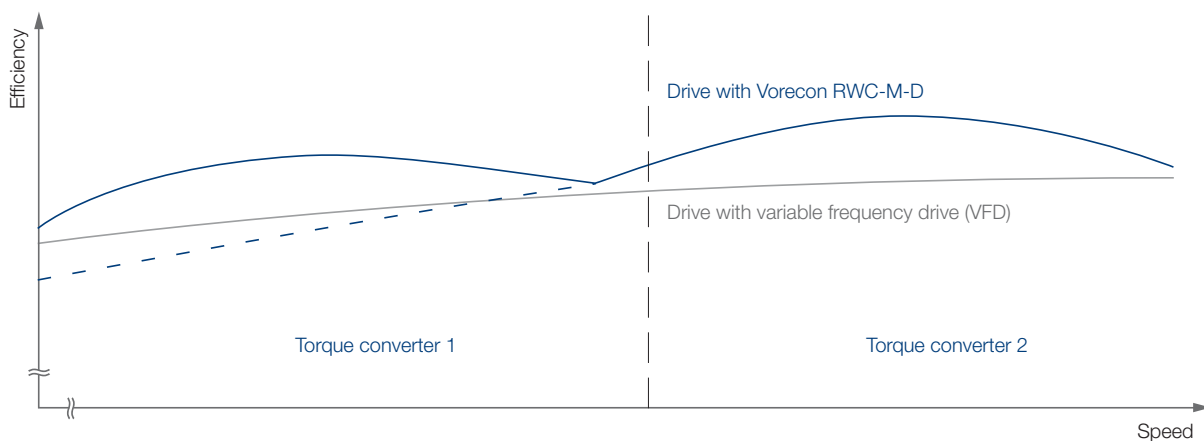
Function

- The drive motor starts up unloaded in the same way as with a drive system with the Vorecon RWC-M.
- After starting up the motor, the Vorecon RWC-M-D operates in principle in the same way as the RWC-M. The difference is that the speed control range is applied by using two separate torque converters, each with adjustable guide vanes.
- Torque converter 1 is filled in the lower speed range. It has the best possible efficiency for this range and controls the speed of the driven machine there.
- At a certain speed, torque converter 2 is filled and torque converter 1 is emptied. In the upper speed range, torque converter 2 has optimum efficiency and controls the speed of the driven machine there.

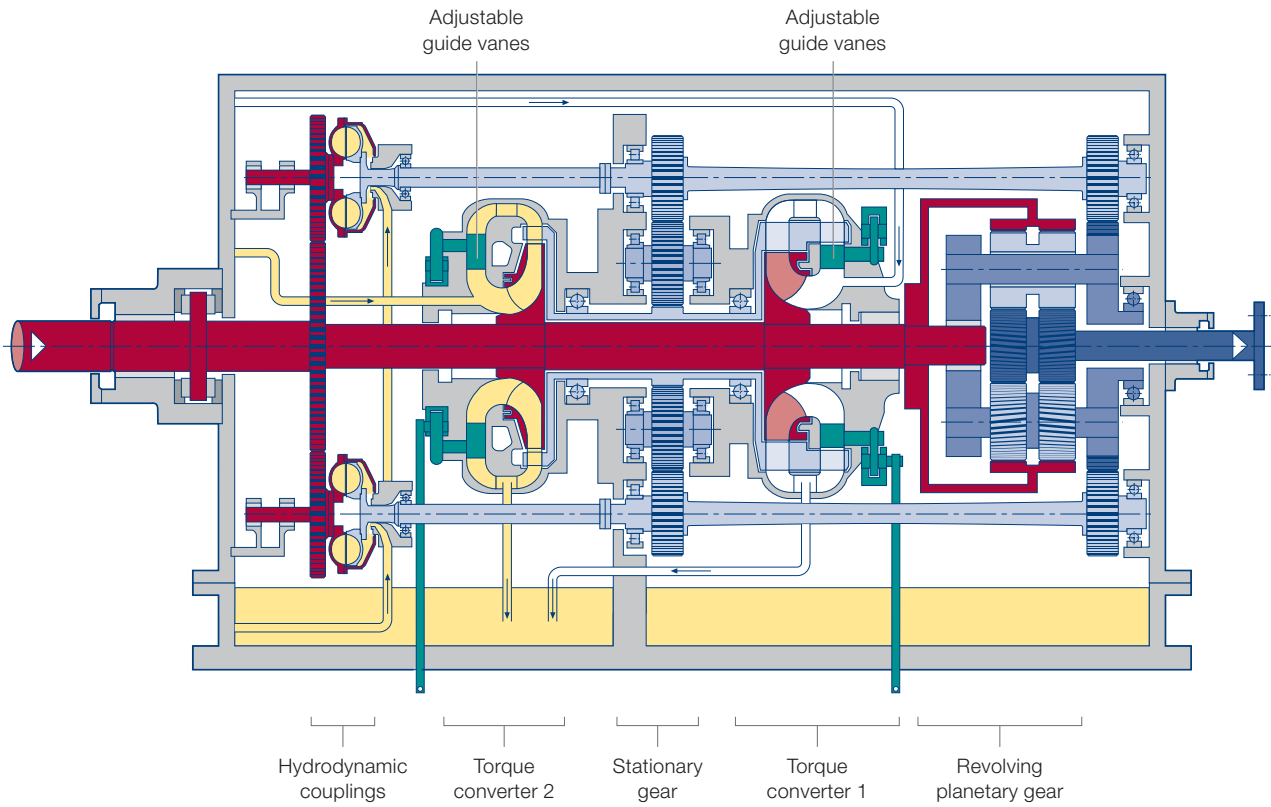
Special benefits

- + The Vorecon RWC-M-D offers very high efficiency over the entire control range.
- + In addition, the Vorecon RWC-M-D offers the same advantages as the Vorecon RWC-M: unloaded motor start-up and easy start-up of driven machines with a high mass moment of inertia.
- + The modular design with horizontally split housing allows service work to be carried out quickly and effectively, which is an important aspect for offshore systems.

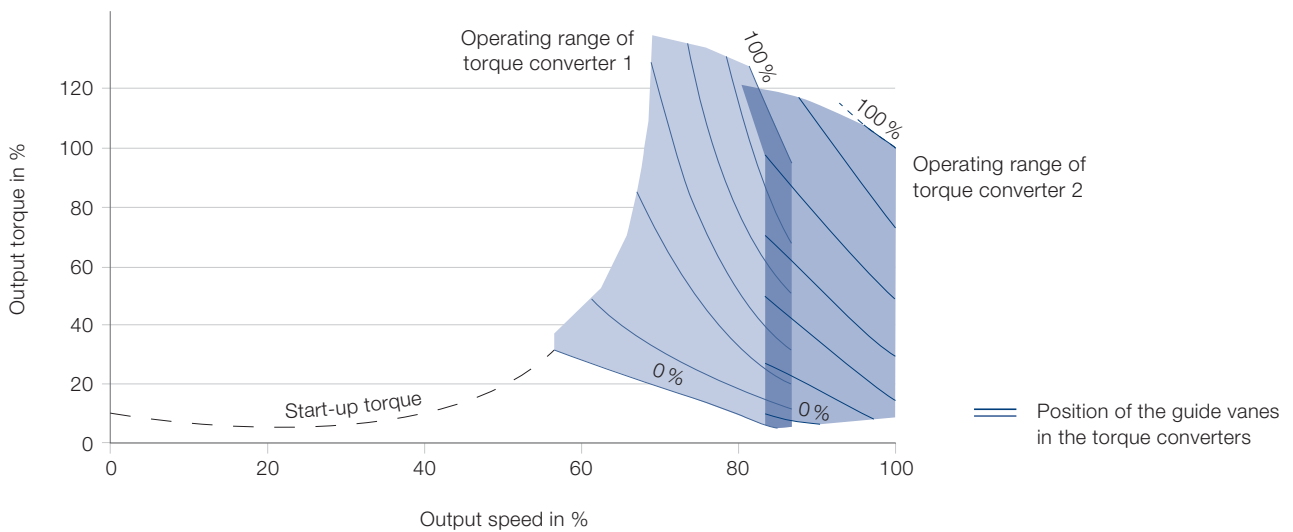
Comparison of overall efficiency



RWC-M-D sectional diagram



RWC-M-D characteristic curves





- 1 Type: RW 14-12 F 7
Driven machine: boiler feed pump
Country: Germany
- 2 Type: RWC 15-14.5 F 9
Driven machine: depletion compressor
Country: Oman



Drive Solutions that Inspire.

References

1 Almost forgotten already

These Vorecons are running in one of the largest and most modern coal-fired power plants in Germany. All this without drawing any attention to them doing so, for more than 20 years, simply operating according to plan. The Vorecons control the speed of the boiler feed pumps.

The Vorecon had convinced our customer right from the very beginning. In those days, a comparative study with variable frequency drives had already shown that when considering the overall life-cycle costs, the variable speed planetary gear scored considerably better.

2 Defying the desert conditions

Searing daytime heat with temperatures exceeding 50 °C, sandstorms, no enclosed building, and as if that weren't enough, potentially explosive environment. None of these are a special challenge for the Vorecon. What other drive system could make such a claim?

Our customer uses this Vorecon to control a turbo compressor in their gas production facility. They have been trusting Voith drive solutions for decades with more than 30 hydrodynamic variable speed drives are in use in oil and gas production throughout Oman.



- 3 Type: RWE 12 F 7
Driven machine: pipeline compressor
Country: Thailand
- 4 Type: RWE 7 F 5
Driven machine: process gas compressor
Country: Sweden
- 5 Type: RWE 12 F 6
Driven machine: refrigerating compressor
Country: China

3 Withstanding tropical environments

High temperatures combined with high humidity are typical of tropical climates. In electronic devices, this leads to a significantly increased failure rate and to reduced service life. Consequently, electronic variable speed drives using VFD require an enclosed building with expensive air conditioning that results in high energy costs.

The operator of this natural gas processing plant put their faith in the Vorecon. They rely on the benefits of the hydrodynamic power transmission: long-lasting, robust and, on top of that, low investment and operating costs. They were particularly impressed with the possibility to simply install the Vorecons outdoors in a harsh and potentially explosive environment.

4 Keeping up with time

This driveline with Vorecon is a retrofit solution. A simple and robust drive was needed to replace an outdated steam turbine drive. The customer considered both an electronic variable speed drive with variable frequency drive (VFD) and a solution with variable speed planetary gear from Voith. Voith soon proved to be the solution of choice. The exceptional high availability and minimum installation space turned out to be the decisive criteria.

Our customer operates refineries that are among the most modern and environmentally-friendly worldwide. The environmental compatibility of the products being manufactured are also exemplary. For example, the refineries were the first in the world to produce unleaded petrol. In doing so, the Vorecon has been found to be highly available and efficient when in operation.

5 Safe liquefaction of natural gas

Liquid natural gas (LNG) is an ideal supplement to pipeline gas. Smaller and medium-sized liquefaction plants are gaining increasing significance in regional gas supply. The demands on the technologies of these plants are the same as for larger plants: safe production, reliable components, sturdy engineering and efficient operation.

A speed controlled refrigerating compressor is used for the processing of the gas liquefaction. Our customer had compared electric solutions for speed control with the hydrodynamic solution from Voith. The high and verifiable availability, robust mechanics and explosion protection of the Vorecon served as very convincing arguments. The low operating and maintenance costs were the final points supporting the Voith solution.

6 Putting a package together

Our customer is an energy company involved in the entire value-added chain of the oil industry. The company operates a number of refineries in Spain with a processing capacity of more than a half a million barrels of oil a day. Since the 1980s, hydrodynamic variable speed drives from Voith have been used at the refineries.

As a recycle gas compressor was being upgraded for a number of years, we received an inquiry concerning the drive system. Our customer placed great value on the fact that the entire drive was supplied by a single source. They wanted a „Plug & Play“ solution and that is exactly what we were able to offer them; Vorecon plus an electric motor mounted on a base frame. Our customer has not regretted their decision to opt for the Vorecon at any time since. This is due in large part to the fact that everything ran smoothly from the start.

7 47 000 horses strutting out

Power is what they need here! This pipeline compressor station pumps gas through one of the largest pipelines in North America: 16 900 km long and with capacity of almost 100 billion cubic meters per year. This amount of gas would be enough to meet the needs of 20 million households.

As the capacity of the pipeline was about to be expanded over the next few years, this compressor station needed to be modernized and upgraded. Up until then, four reciprocating compressors and a turbo compressor had been operated in the station. A high-speed electric motor with magnetic bearings had driven the turbo compressor and a VFD had controlled the speed. Now everything is a lot simpler and more reliable: an electric motor, a Vorecon and a compressor do the whole job.

8 Delivering natural gas to the "Sunshine State"

Bright sunshine and fantastic beaches – this is how we all imagine Florida to be. Natural gas is the primary source of energy for this wonderful state. A large pipeline system brings the gas to Florida from the production areas in Texas, Louisiana, Mississippi and Alabama.

The Vorecon is also now installed here and was delivered as a package: motor and Vorecon mounted together on a base frame with integrated oil supply system. Our customer originally intended to use VFDs but at the last moment, discovered the Vorecon. The customer's initial thought was that the Vorecon would be too expensive and maintenance-intensive. We were delighted to disprove that thought and now have another satisfied Vorecon customer!



6



7



8

- 6 Type: RWE 12 F 6
Driven machine: recycle gas compressor
Country: Spain
- 7 Type: RWC 16-15 F 11
Driven machine: pipeline compressor
Country: USA
- 8 Type: RWC 710 M 9
Driven machine: pipeline compressor
Country: USA



9

- 9 Type: RWE
Driven machine: turbo compressor
Country: Brazil
- 10 Type: RWE 12 F 6
Driven machine: fuel gas booster compressor
Country: Argentina
- 11 Type: RWC 12-12 F 8
Driven machine: pipeline compressor
Country: USA

9 Exploiting offshore treasure

FSO, FPSO, FLNG, FSRU – These abbreviations stand for vessels that store, process and transship crude oil or natural gas on-location during offshore exploitation. On these vessels, the requirements of machines and systems are particularly demanding. The environment is potentially explosive and corrosive. The installation space on vessels is extremely valuable and the weight of the system must be kept as low as possible. Downtimes during production are extremely expensive which is why only machines are used that have a much higher verified availability.

Controlling offshore pumps and compressors – the Vorecon is just right for the job. For example, an operator of FPSO vessels off the coast of Brazil uses the Vorecon. Several dozen variable speed planetary gears are used there in the drivelines of compressors on various vessels.



10 Combining gas and steam

Combined cycle power plants are small wonders of efficiency. They achieve excellent efficiency of up to 60 %, an average of 20 % more than conventional power plants. Therefore, these combined cycle power plants are the most efficient power plants using fossil fuels.

Our customer, a large energy supply company in South America, was planning the construction of a combined cycle power plant. However, the pressure of the pipeline gas was insufficient for the operation of the gas turbine. This is why the fuel gas supply of the turbines was supported by a booster compressor. The original intention was to implement the pressure control of the booster as a simple throttle control. Our customer soon noticed the disadvantages: very high loss of energy and low overall efficiency of the power plant. In this case, they made the decision to install a speed control system for the compressors. Our customer chose the Vorecon as they wanted a power plant free of unscheduled downtime.

11 Playing a part in a success story

Natural gas is the cleanest fossil fuel. This source of energy is sufficiently available in North America. In the USA, an extensive pipeline system transports the gas from the production areas to the large consumption regions. The safe transport of the gases and reliable consumer supply is the main focus of the pipeline company.

The operators of the gas pipelines frequently choose the Vorecon as the drive solution in the pipeline compressor stations. Vorecon isn't just present in new stations. When retrofitting gas turbines and electronic variable speed drives, the Vorecon fares well with its significantly higher availability and low life-cycle costs.

Achieving Common Goals. Engineering

We don't just supply products, we also provide ideas. Voith products have been controlling the speed in drive systems for more than 60 years now. The benefit from this experience can be applied in planning, use and cost-optimized operation and maintenance.

System competence

The Vorecon can be found in more than 500 drives in the oil and gas industry, as well as in the chemical industry and thermal power plants.

Make the right decision to invest using our knowledge of systems and the applications in which they are employed. In this way, you can both increase your plant availability and lower your operating costs.

Partnership

Do you have questions concerning the equipment that is driving your rotating machines? Please consider turning to Voith and we would be happy to discuss your concerns together.

Our competences:

- Consultation in the planning of drive systems
- Torsional vibration calculation and analysis
- Strength calculations using FEM
- Run-up calculations
- Calculation of speed step responses
- Retrofitting of electric variable speed drives and turbine drives



Benefit from the Manufacturer's Knowledge. Service

Service by the manufacturer increases the efficiency, safety and availability of your system. The engineers and technicians of Voith's worldwide service network are there to assist you. We maintain sales and service facilities in all regions of the world.

Our services

- Installation, commissioning
- Training
- Maintenance and repair
- Original spare parts
- Modernization, retrofits
- Service contracts

The benefits for your system

- Improved operational reliability
- Increased service life
- Assured productivity
- Optimized maintenance costs
- Plannable life-cycle costs

Locations worldwide





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VOITH
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