

## Reliable Speed Control. Geared Variable Speed Couplings





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

Founded in 1867, Voith employs more than 39,000 people, generates Euro 5.3 billion in sales, operates in over 50 countries around the world and is today one of the largest family-owned companies in Europe.

# Writing a Success Story.

## The Geared Variable Speed Coupling

It has been around for seven decades – the Voith geared variable speed coupling. More than 500 customers in 83 countries trust this type of speed control. Over 10,000 geared variable speed couplings contribute to saving innumerable kilowatt hours of energy. All of this happens quietly.

### The principle

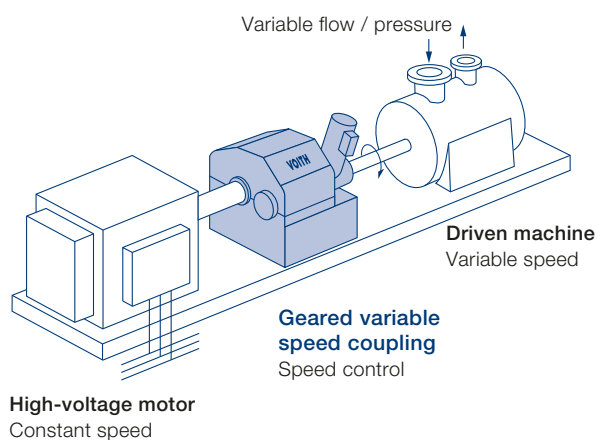
- The geared variable speed coupling combines a hydrodynamic variable speed coupling and a mechanical gearbox in one compact unit. Input powers from 1 to 30 MW and output speeds of up to 20,000 rpm are possible.
- The geared variable speed coupling controls the speed of the driven machine precisely, quickly and repeatably within the required control range.

### Unique characteristics

- The reliability of the geared variable speed coupling is 99.97 %.
- Hydrodynamic power transmission is wear-free.
- The compact driveline with the geared variable speed coupling is suited to both harsh ambient conditions and potentially explosive atmospheres.
- The geared variable speed coupling provides three functions in one machine: Speed control, transmission for speed conversion, and integrated oil supply that delivers oil to the entire driveline.
- The lifetime exceeds 30 years. The supply of spare parts is guaranteed over the entire lifetime.

### Driveline with a geared variable speed coupling

Power transmission up to 30 MW





# Controlling Drives Reliably.

## Applications

Variable speed drives using a Voith geared variable speed coupling are compact, efficient and offer unbeatable reliability. The reliability of the couplings is 99.97%. The range of application includes powers up to 30 MW and output speeds up to 20,000 rpm. The standard motor and the geared variable speed coupling form a strong pairing in thermal power plants and in oil and gas industry applications.

### **Power plants**

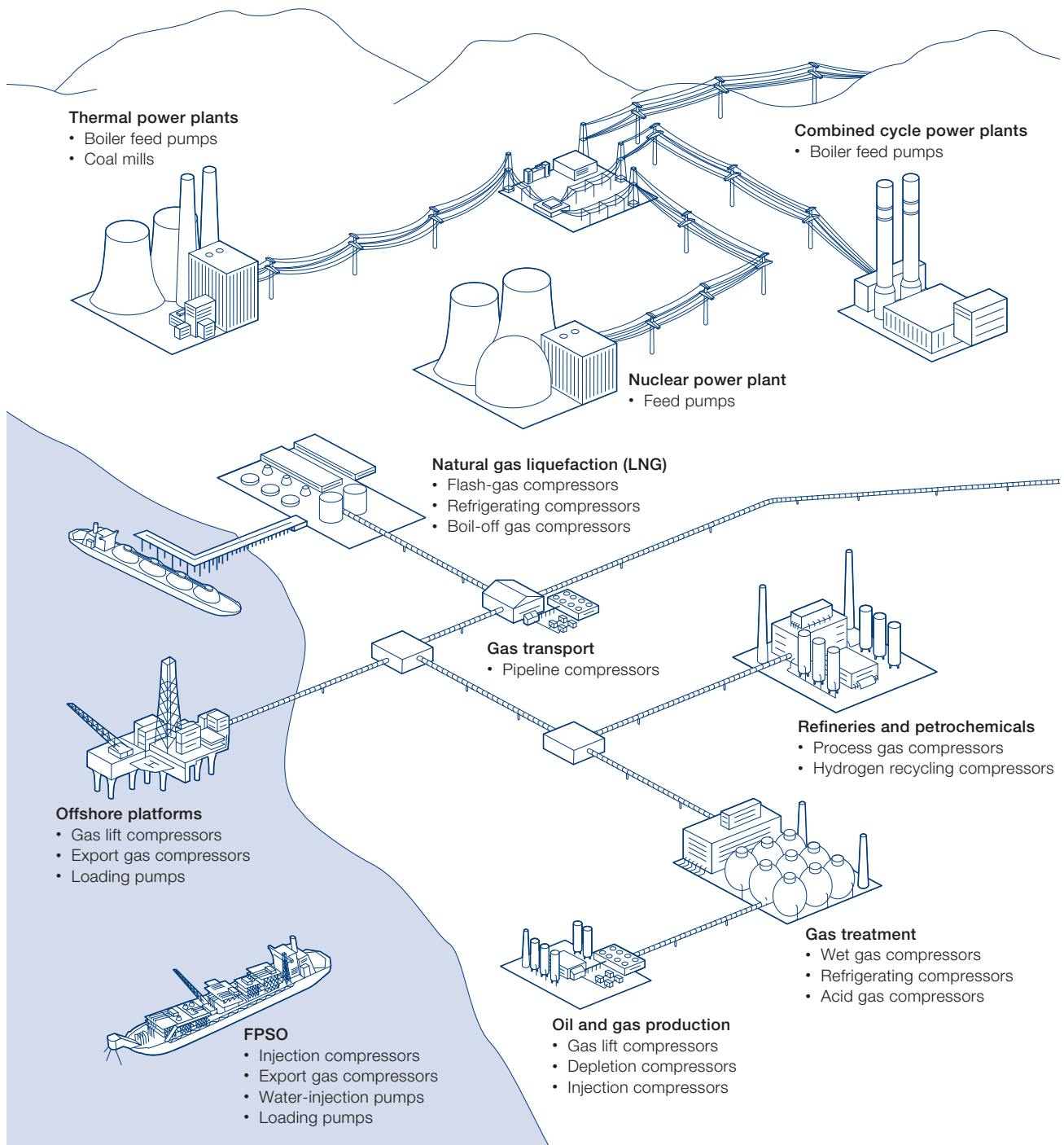
The geared variable speed coupling is indispensable to thermal power plants. It is used as a continuous boiler feed pump drive (for example, in a 3 x 50% configuration) with the best balance of energy. It is also used in start-up and stand-by solutions in conjunction with steam turbines. In these cases, it ensures a controlled, smooth and fast startup even in difficult situations.

### **Oil and gas**

With their unbeatable reliability, the Voith geared variable speed coupling easily convinces both onshore and offshore customers. One particular key use is in drives for pumps and compressors in up-stream, midstream and downstream applications where there is typically no backup. Designs according to DIN, API and AGMA are available.

## The geared variable speed coupling and possible applications

in the oil & gas industry, thermal power plants and nuclear power plants.



# Achieve Success on Schedule.

## Advantages and Benefits

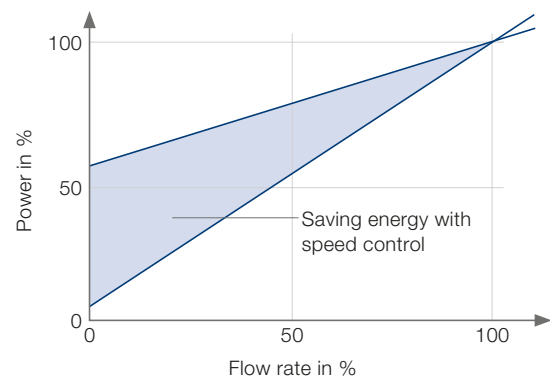
Increase the productivity of your operation utilizing the flexibility of the hydrodynamic geared variable speed coupling for speed control of your processes. You will also benefit from a compact, robust machine requiring very low maintenance effort.

### Productivity

- + Speed control reduces the energy required. This increases the efficiency of your driveline.

How? The hydrodynamic variable speed coupling varies the speed of the driven machine precisely, quickly and repeatably within the required control range. The motor only supplies the power that the process needs. With speed control, you save a considerable amount of energy over throttle control.

#### Increase productivity of your plant

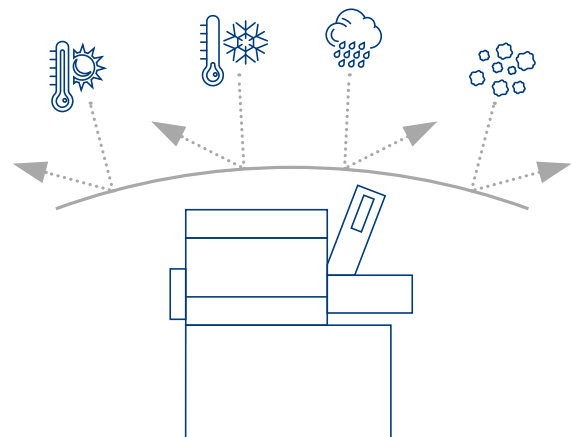


### Robustness

- + Integrate the coupling into the drive system without the costs of additional infrastructure measures. Prepare your schedule independent of extreme environmental conditions.

How? The robust design ensures that the geared variable speed coupling is less sensitive to environmental effects. Heat, cold, moisture, dust and dirt present no particular challenges to the unit. It can also be used in potentially explosive atmospheres.

#### Keep your infrastructure costs low

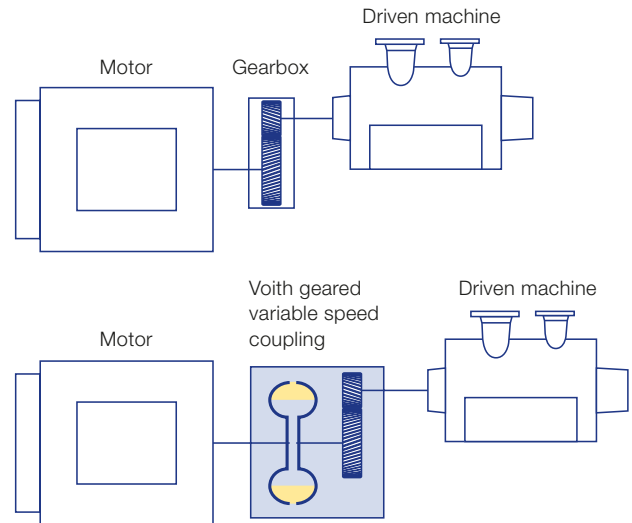


# Motor Start

+ Start your motor under virtually no-load conditions and smoothly accelerate even those driven machines with a large mass moment of inertia.

How? The hydrodynamic coupling is empty during motor starting, separating the motor from the driven machine. In this way, a motor start under no-load conditions is possible without any additional measures or equipment. Starting the motor under no-load conditions is particularly important for weak power grid conditions, with driven machines having a large mass moment of inertia or in the case of processes with an initially large load torque. Standby drives for boiler feed pumps can be started quickly and safely using the geared variable speed coupling.

## Start the motor under no-load conditions

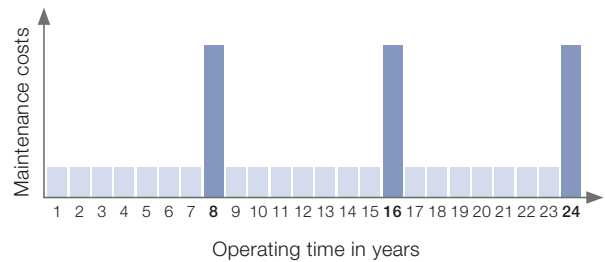


# Maintenance and Repair

+ Avoid unscheduled downtimes. Assure reliable planning of maintenance and reduce costs and operational downtimes.

How? We combine wear-free hydrodynamic power transmission with mechanical components that are designed for a lifetime of at least 30 years. The recommended overhaul interval is 8 years and can be planned well in advance.

## Minimize your maintenance effort

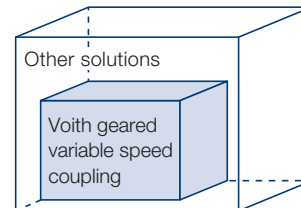


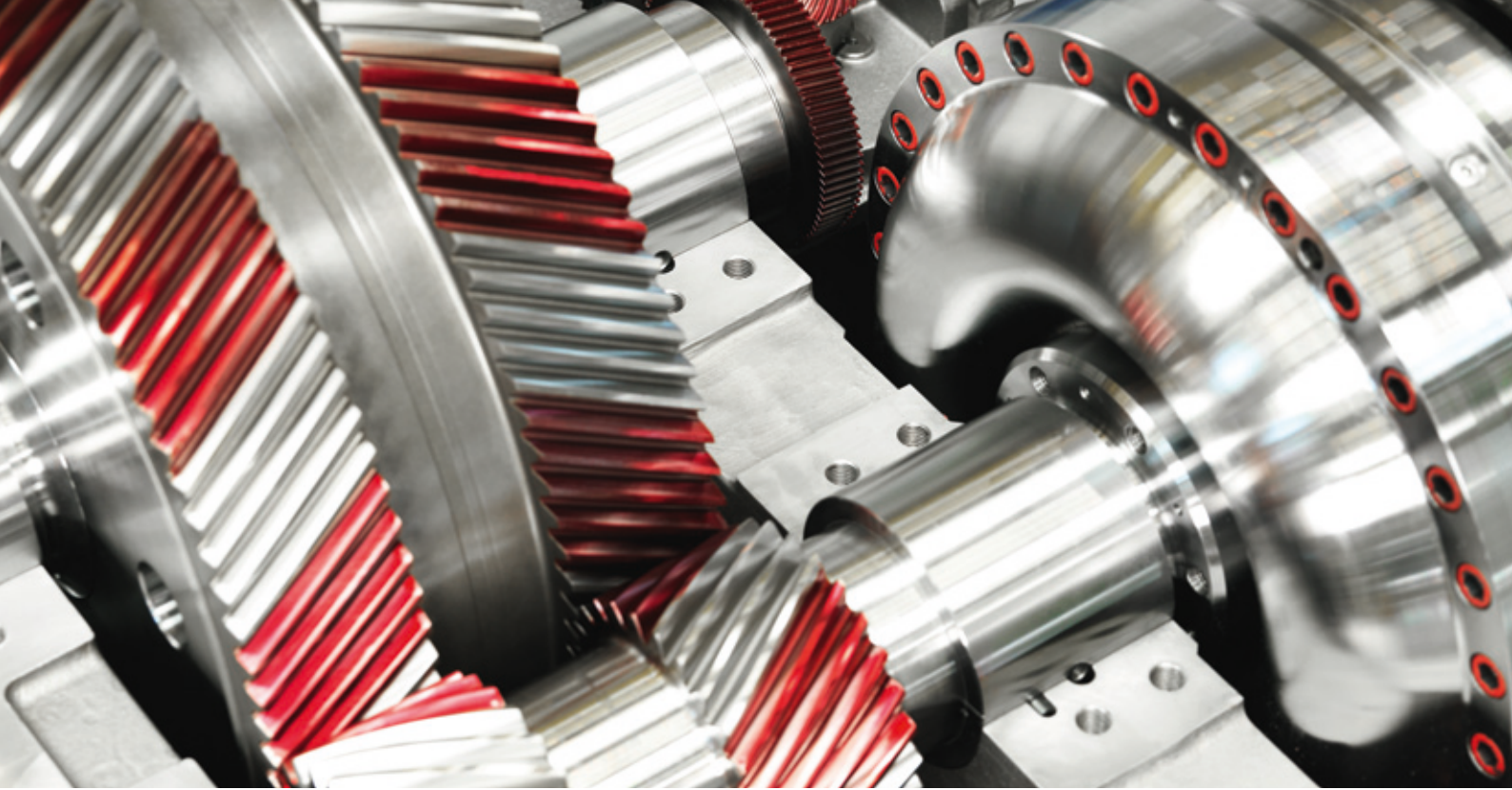
# Design

+ Compared to other types of speed control, you save up to 70% on the installation space.

How? The geared variable speed coupling consists of simple mechanical components. A hydrodynamic coupling, a gear stage and the oil system are integrated into a single housing.

## Reduce the installation space you need





# Reliably Combining Hydrodynamics and Mechanics. Function

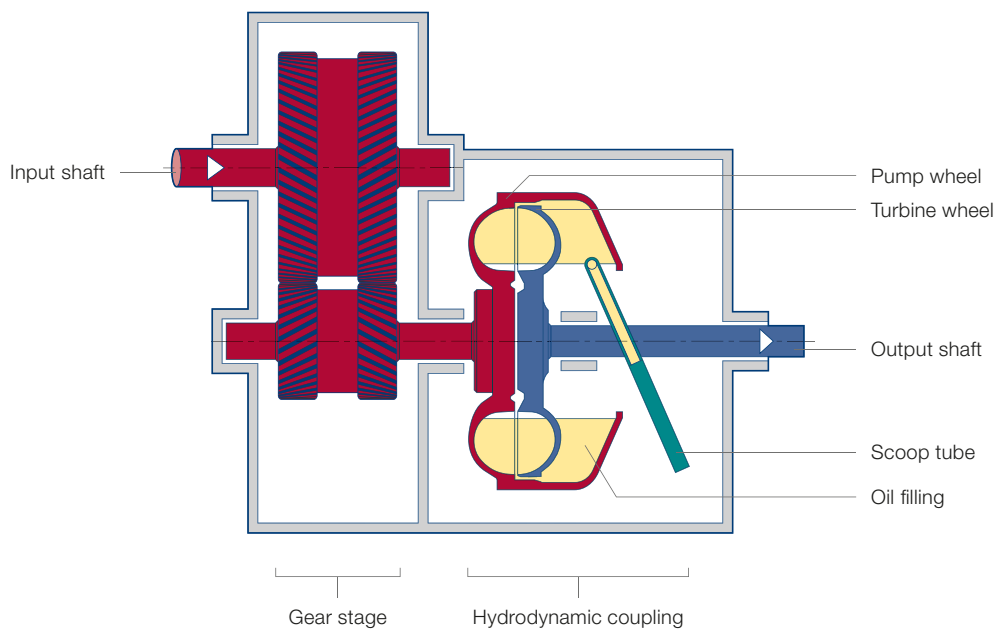
The core components of the geared variable speed coupling are a hydrodynamic variable speed coupling combined with a mechanical gear stage. The gear stage is designed for the initial increase or decrease of the input driver speed. The variable speed coupling then varies the speed of the driven machine within the required range.

## Design and function

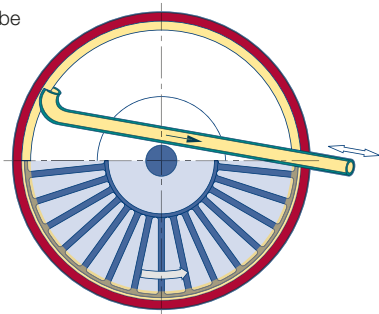
- The hydrodynamic variable speed coupling and the mechanical gear with double helical design are integrated into an enclosed housing with a horizontal split.
- The gearbox is located before or after the variable speed coupling depending on the customer's application.
- Using the hydrodynamic power transmission principle, a fluid flow transmits the power from the pump wheel to the turbine wheel.
- The pump wheel rotates at a constant input speed and the turbine wheel at variable output speed.
- The scoop tube varies the coupling filling. The filling amount determines the power transmitted and consequently the speed of the driven machine.
- An actuator varies the position of the scoop tube. In this way, the speed can be controlled in a stepless manner over a wide operating range.
- Working and lube oil are supplied to the geared variable speed coupling from the integrated oil tank. The working and lube oil circuits are separate.
- The integrated lube oil supply system can supply lube oil to the motor and the driven machine. A separate lube oil supply system is not required.



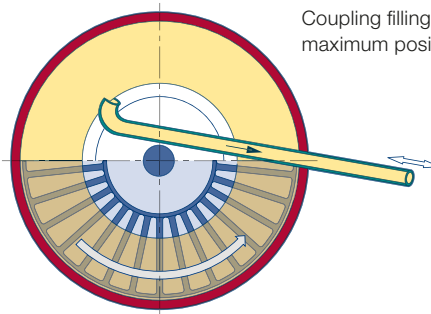
## Principal design of the geared variable speed coupling (type R..K)



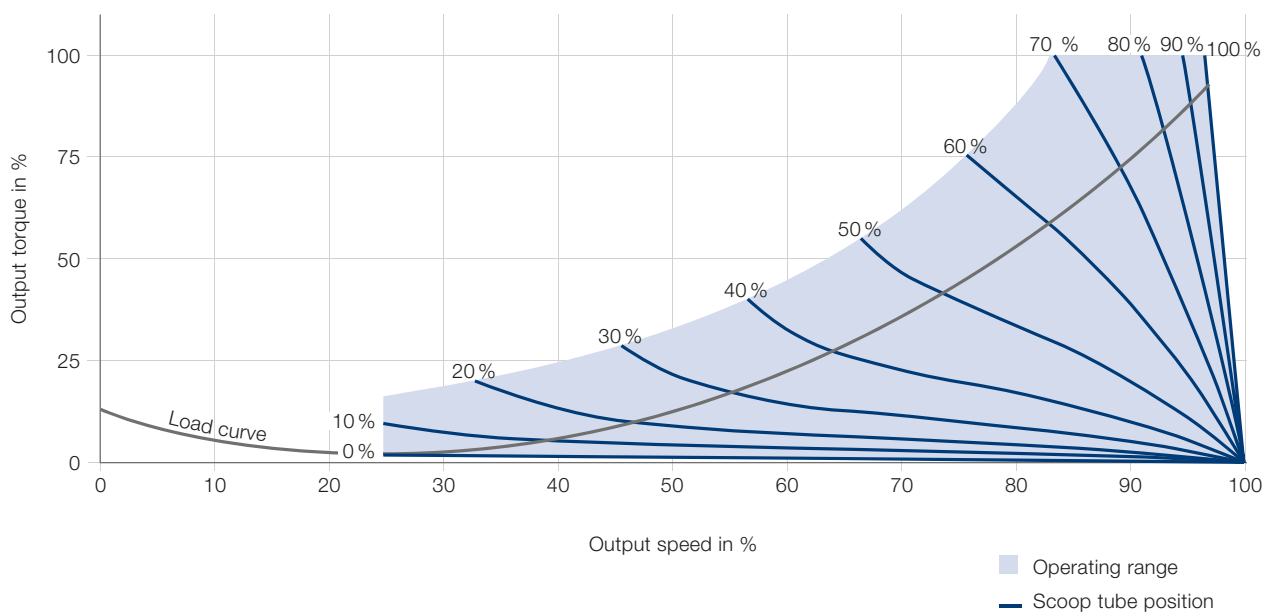
Coupling filling at scoop tube minimum position (0%)



Coupling filling at scoop tube maximum position (100%)



## Operating map



# Precisely Adjust the Speed. Actuator

The Voith VEHS electrohydraulic actuator positions the scoop tube fast and in a stepless manner at high precision. The short reaction time and the high position accuracy adapt the operating behavior of the driven machine to the process conditions exactly.

## Function

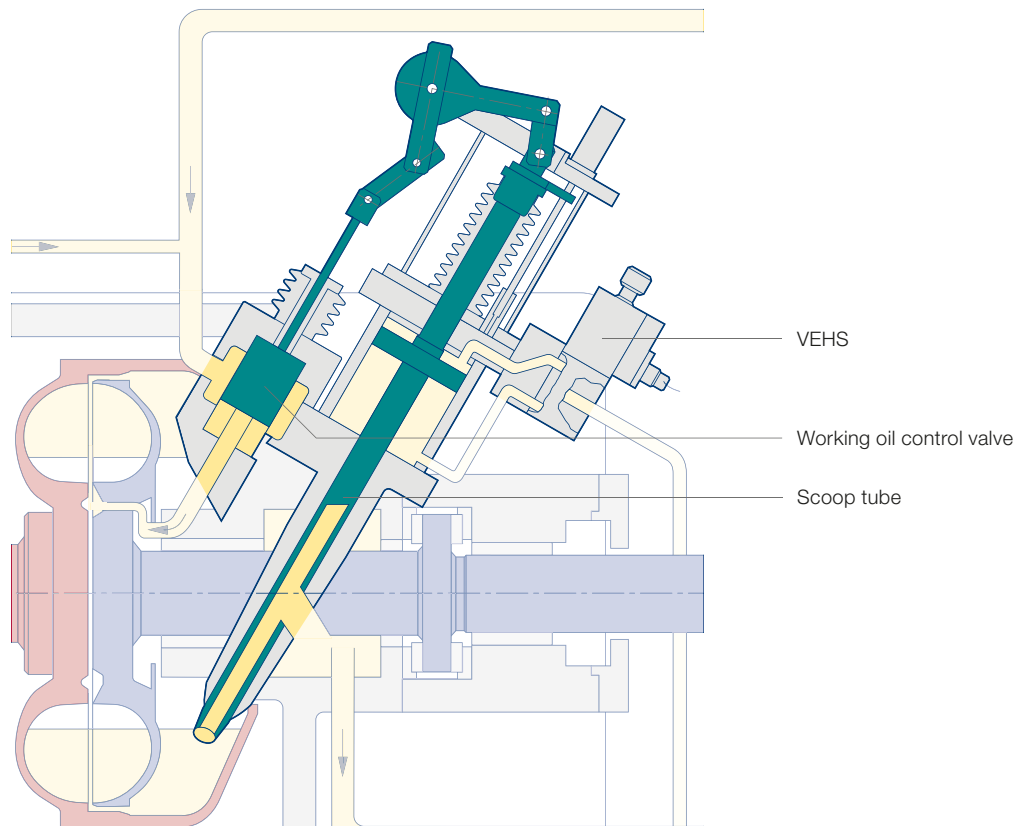
- The hydrodynamic variable speed coupling is filled via the working oil control valve.
- The oil filling in the variable speed coupling is varied using the scoop tube depending upon the speed required of the driven machine.
- The Voith VEHS electrohydraulic actuator ensures that the scoop tube is set fast and in a stepless manner.
- A simple 4 – 20 mA standard signal is required to control the scoop tube position.

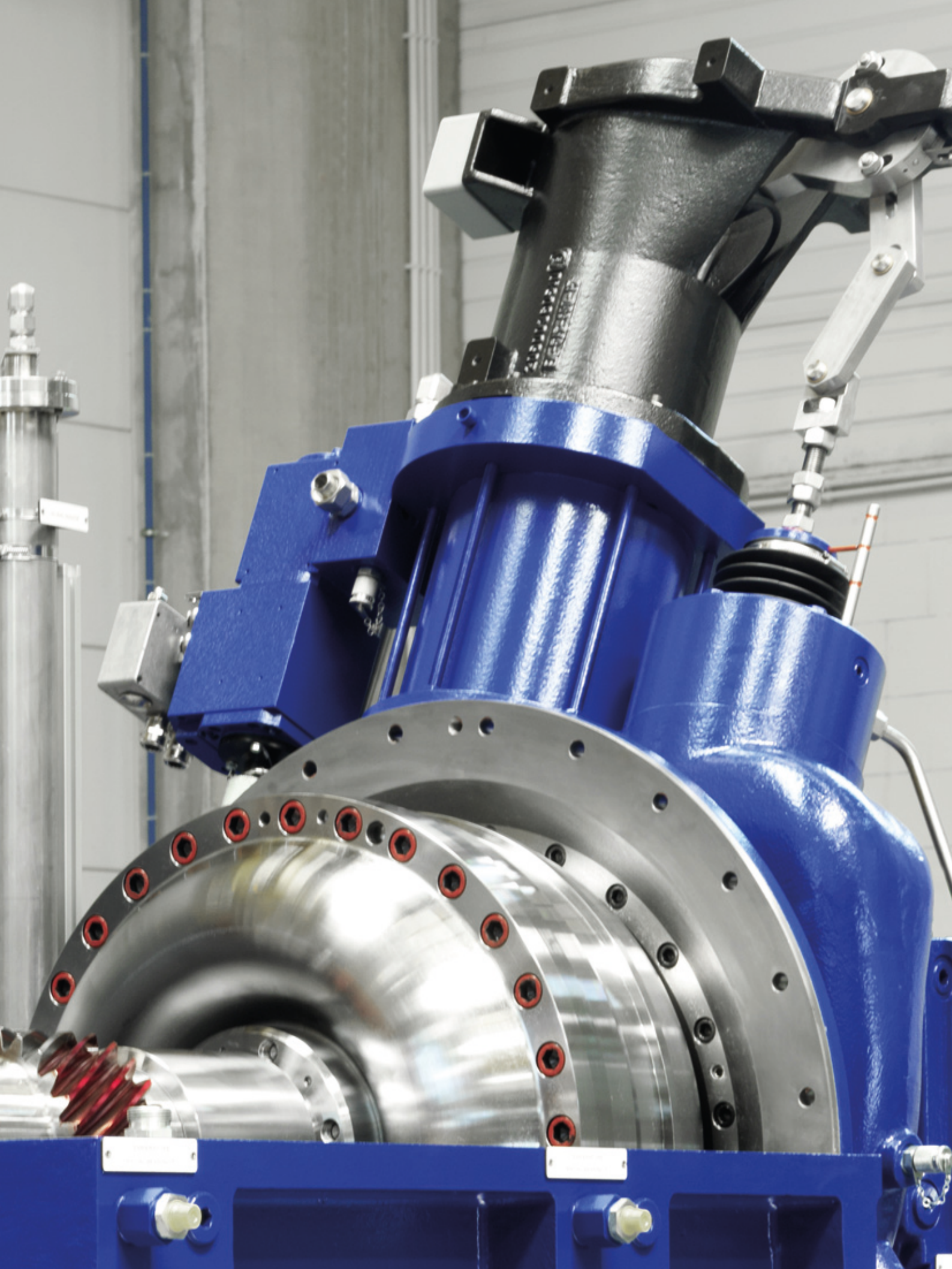
## Advantages

- The scoop tube is positioned with maximum precision through the simple and reliable combination of electronics and hydraulics. Additional intermediate electromechanical components are unnecessary.
- The short control time of the VEHS makes it possible to adjust the speed of the driven machine quickly and precisely for the process.
- The working oil control valve optimizes the flow in the oil circuit and improves the overall efficiency of the system.

## Scoop tube positioning using the Voith VEHS electrohydraulic actuator

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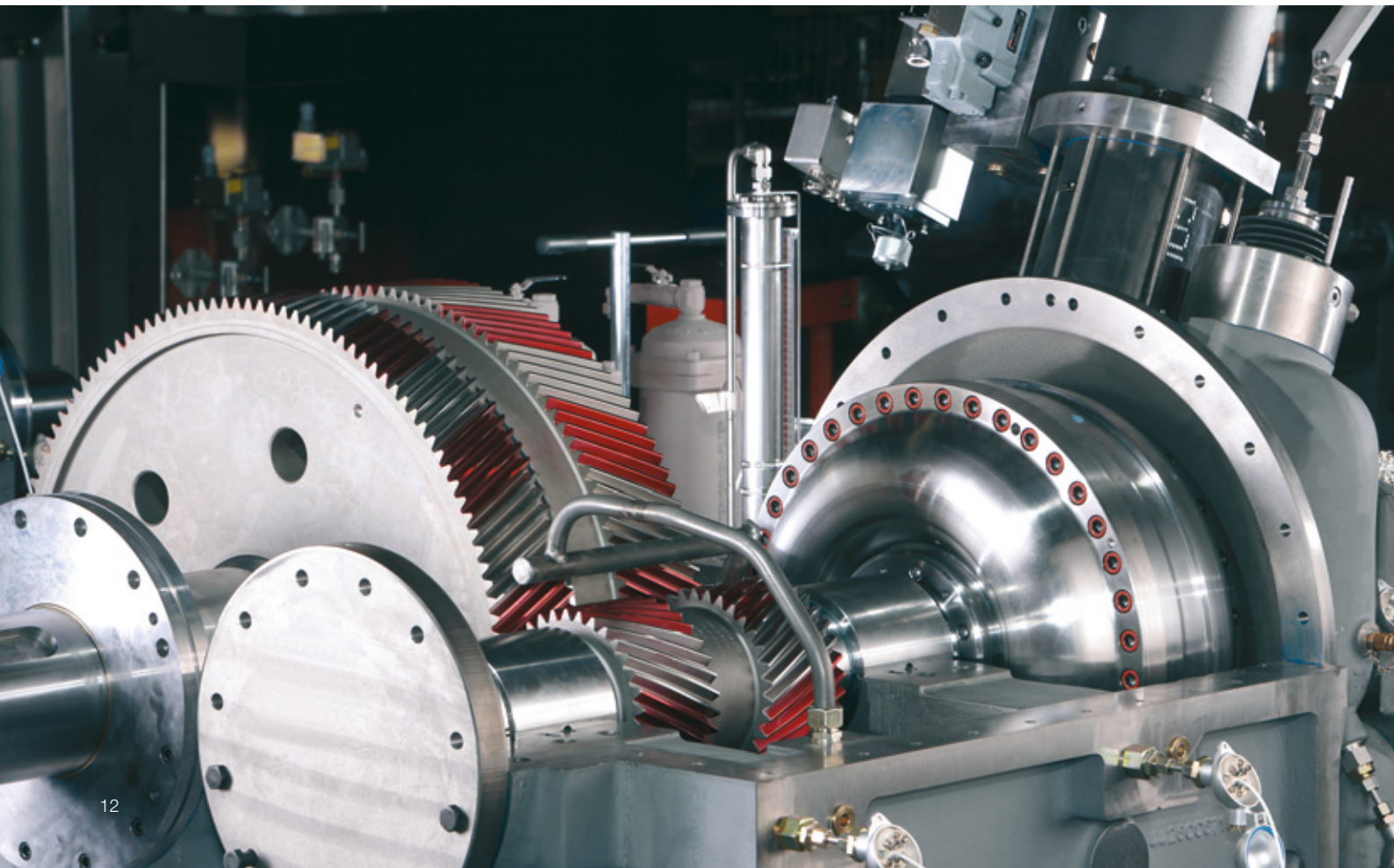


# Find the Best Solution.

## Product Family

The geared variable speed coupling product family always has an answer for your requirements. Together, we will choose the geared variable speed coupling that best suits your drive and your system.

Type	What it offers	Applications		
		Compressors	Pumps	Coal mills
R..K..M	The standard	✓	✓	
R..KGS	The strong one	✓	✓	
R..GS..M	The fast one	✓		
R..A	The slow one			✓
R..B	Turns the corner			✓

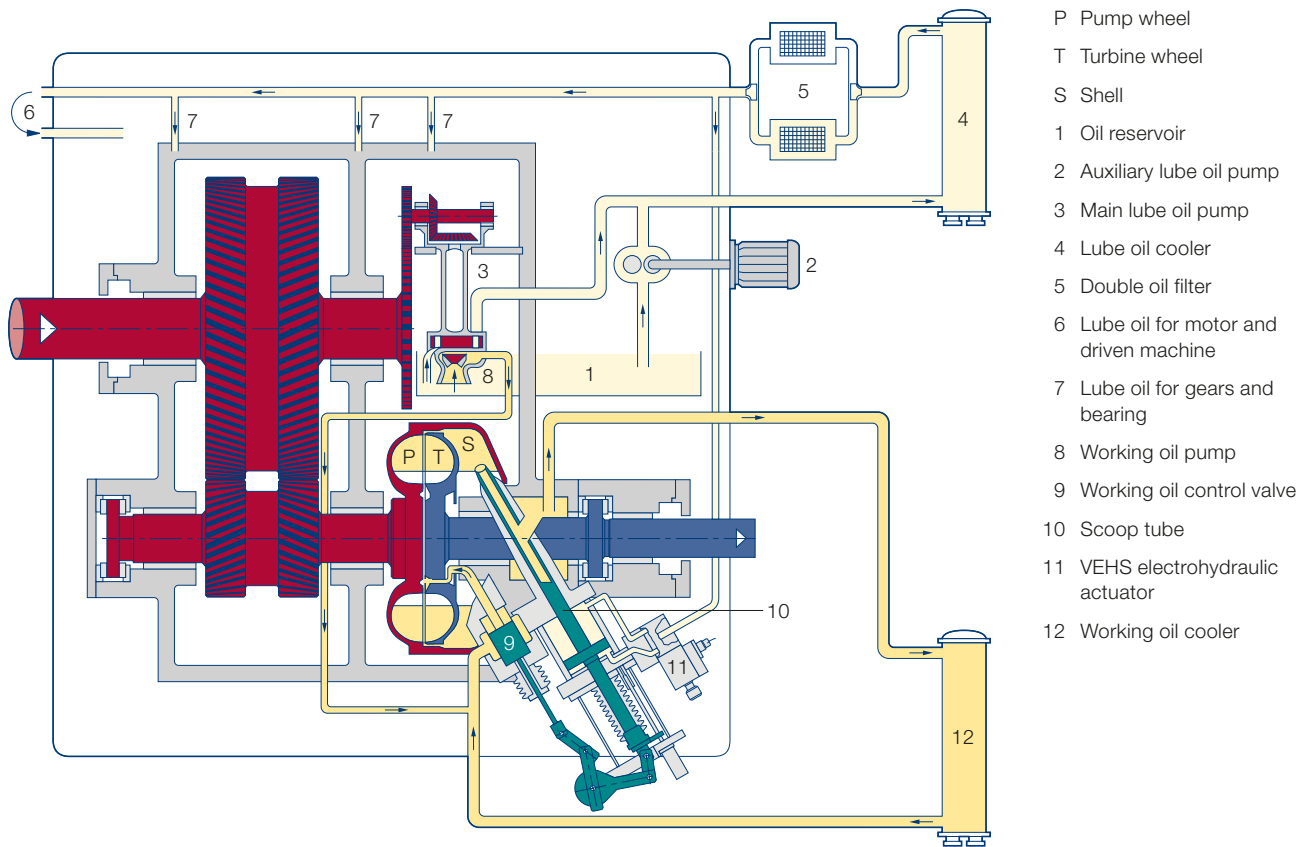


# Type R..K..M – The Standard

## Function – high power density at medium speeds

- The input shaft is connected to the gear stage.  
The input speed is converted up to the higher speed.
- The gear stage accelerates the pump wheel of the hydrodynamic variable speed coupling.
- When the motor starts, the hydrodynamic variable speed coupling is empty. The drive motor and the driven machine are decoupled. The motor starts up under virtually no-load conditions.
- The hydrodynamic coupling is filled after the motor has started and smoothly accelerates the driven machine to the minimum speed.
- The speed of the driven machine is controlled by the stepless positioning of the scoop tube.
- The scoop tube changes the oil filling in the variable speed coupling and thus changes the power transmission.
- Using the hydrodynamic principle, a fluid flow transmits the power from the pump wheel to the turbine wheel.
- The turbine wheel is connected to the driven machine via the output shaft.
- The integrated oil system fills the hydrodynamic variable speed coupling with the working oil. At the same time, the geared variable speed coupling, the drive motor and the driven machine are supplied with lube oil.

## R..K..M sectional diagram



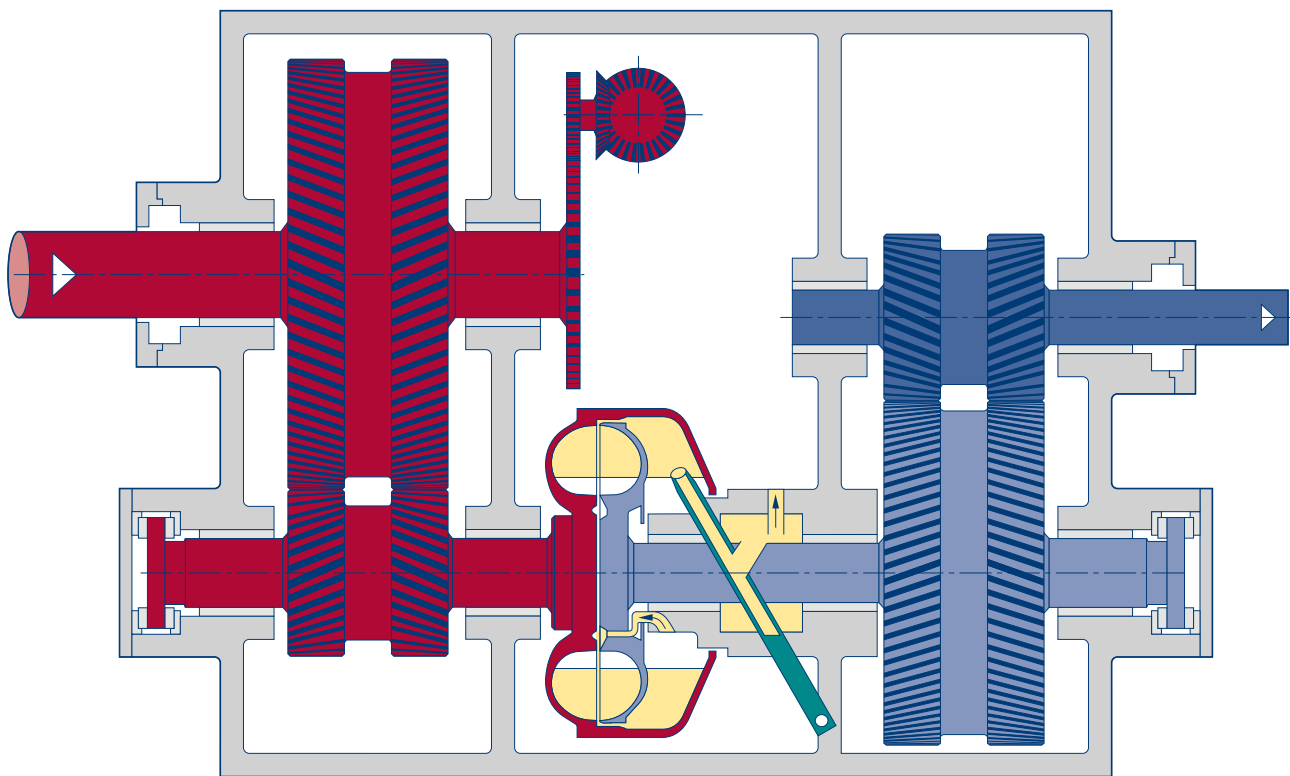
# Type R..KGS – The Strong One

**Function – high power transmission at high output speeds**

- The R..KGS geared variable speed coupling adds an additional gear stage on the output side of the design of the R..K..M type.
- The second gear stage provides an even higher output speed than in the type R..K..M.

R..KGS sectional diagram

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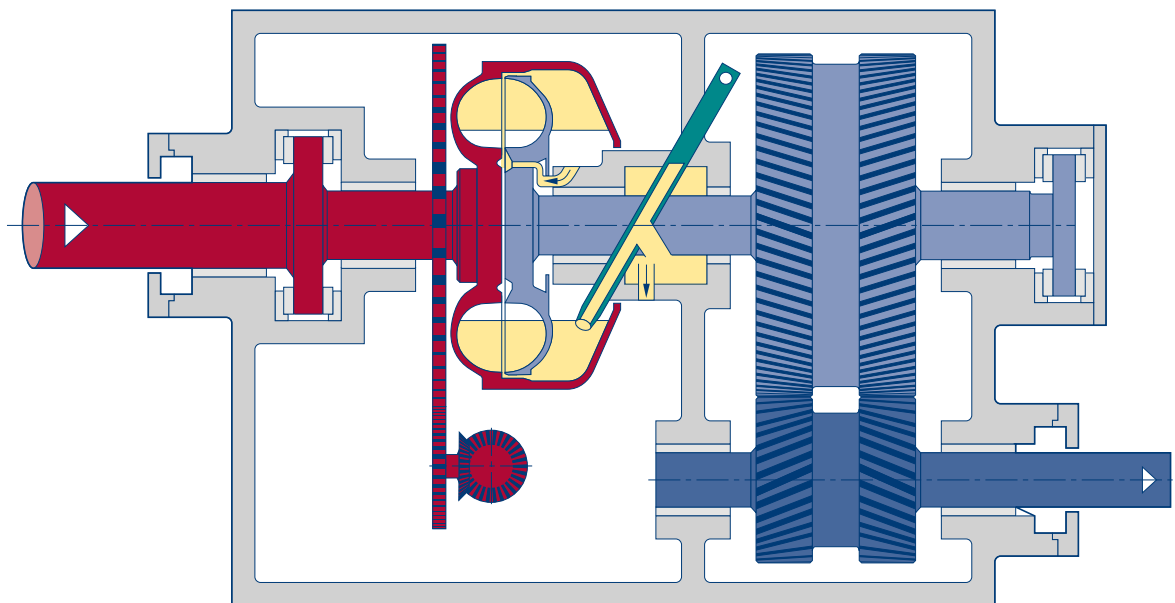
# Type R..GS..M – The Fast One

## Function – high output speeds

- The R..GS..M geared variable speed coupling is used in conjunction with 2-pole standard motors. It converts the fast input speed into an even higher output speed.
- The design of the R..GS..M type is based on the proven principle of operation of the R..K..M geared variable speed coupling. The hydrodynamic variable speed coupling is arranged before the gear stage, however.

## R..GS..M sectional diagram

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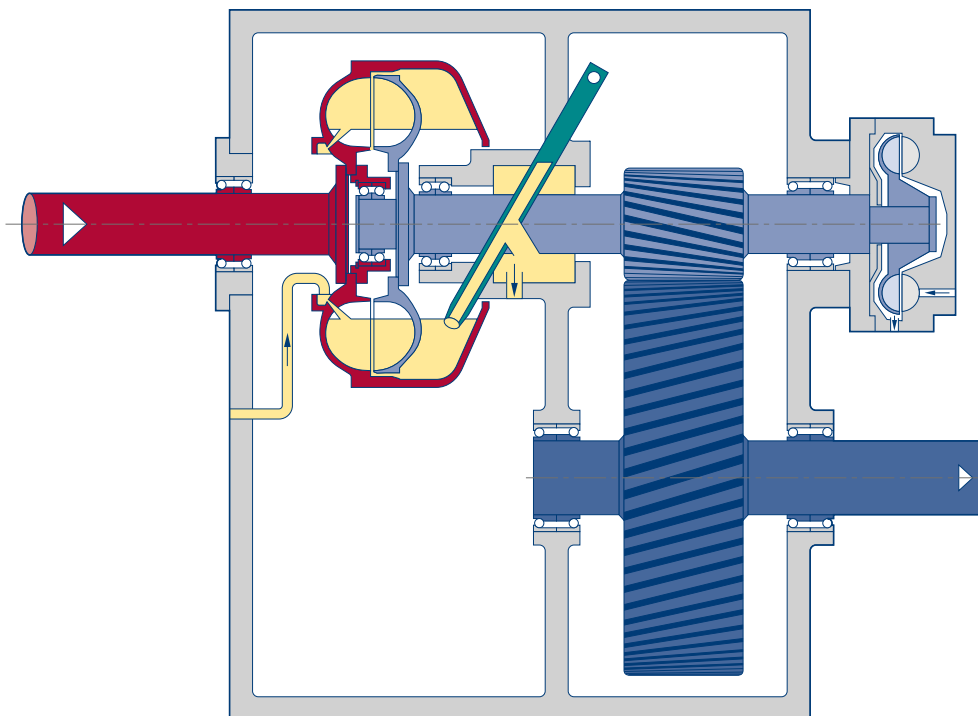
# Type R..A – The Slow One

## Function – low output speeds

- The gear stage converts the motor speed into a lower output speed.
- The hydrodynamic variable speed coupling and the gear stage are arranged in the R..A type in the same order as for the R..GS type.
- Mounting a hydrodynamic brake is possible as an option.

## R..A sectional diagram

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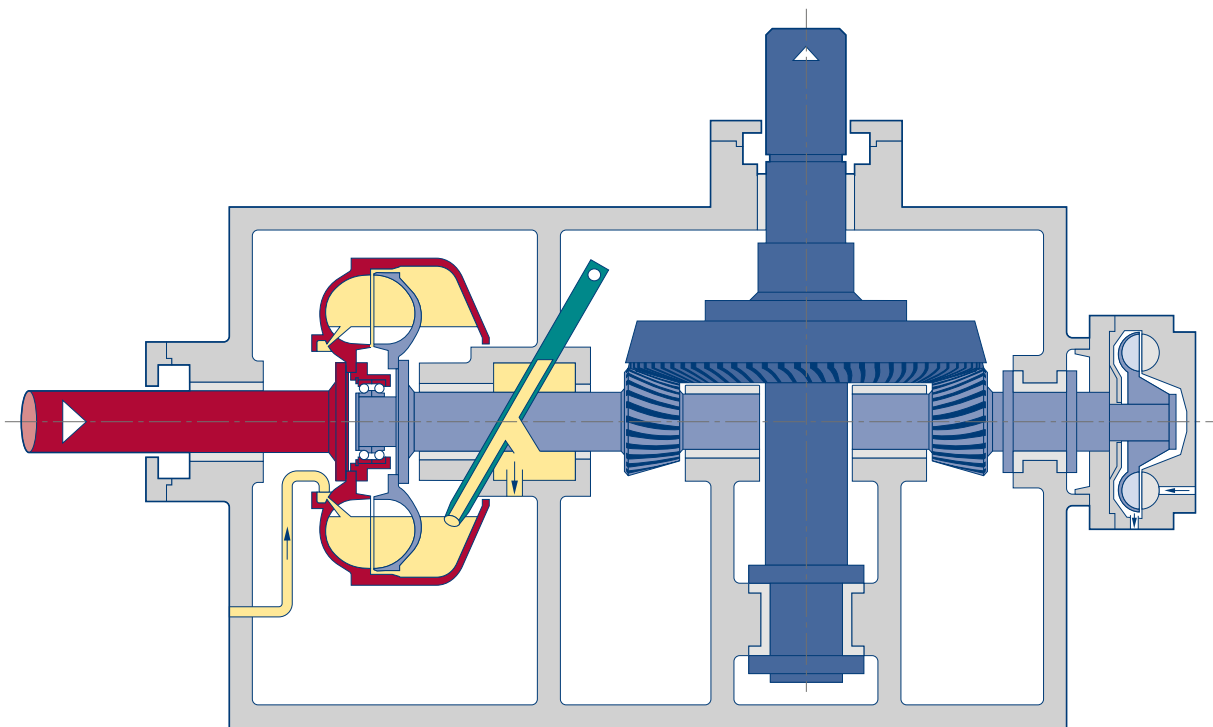
# Type R..B – Turns the Corner

## Function – low output speeds

- The R..B geared variable speed coupling serves to convert the motor speed to a lower output speed just like the R..A type.
- A bevel-gear is located at the output of the hydrodynamic variable speed coupling.
- The driven machine is arranged at a 90° angle from the drive motor.
- Mounting a hydrodynamic brake is possible as an option.

## R..B sectional diagram

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# Drive Solutions That are Convincing References.

Geared variable speed couplings meet all challenges: High speeds, special drive motors, heavy loads and harsh ambient conditions.





## Operating Around the Clock.

One of the leading companies in the German energy sector has put its trust in the hydrodynamic drive solutions from Voith for many decades now. In this case, our couplings control the speed of the boiler feed pumps in the second largest lignite-fired power plant in Europe. The base load power plant is designed for round-the-clock operation spanning decades. The requirements of the geared variable speed coupling with regard to lifetime and reliability are correspondingly high. For this reason, our customer considered only Voith as a potential supplier.

Incidentally, the two most modern units of this power plant have a gross power of 1,100 MW each and the considerable efficiency of > 43%. The efficiency of older lignite-fired power plants is between 30% and 35%. Accordingly, the CO<sub>2</sub> emission while producing the same amount of power can be reduced by six million metric tons per year. The flexibility of the new units is also remarkable: Each unit can change its power output by 500 MW in 15 minutes.

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• Type:	R 18 K 550 M
• Application:	Lignite-fired power plant
• Country:	Germany
• Driven machine:	Boiler feed pump
• Input power:	11.9 MW
• Maximum output speed:	5,660 rpm

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# Robust Machines for Demanding Processes.

Oil and gas will remain an indispensable part of the global energy mix for decades to come. Consequently, oil producers are intensifying their search for techniques that provide improved yields from oil fields. Using primary and secondary extraction methods, a yield of 30% to 40% can usually be achieved; with tertiary methods, an increase to 40% to 60% is possible. The technical term for these tertiary methods is "Enhanced Oil Recovery" or "EOR." In this project, our customer uses a very demanding EOR method known as polymer flooding. High-pressure pumps inject water, to which organic polymers have been added, below ground. The additives increase the viscosity of the water, which releases heavy crude oil more easily from the reservoir rock.

Our robust geared variable speed couplings reliably control the speed of the injection pumps during this process – whether outdoors in hot desert climate, in hazardous areas, and even during powerful sandstorms.

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• Type:	R 17 K
• Application:	Oil extraction
• Country:	Oman
• Driven machine:	Water injection pump
• Input power:	4 MW
• Maximum output speed:	4,700 rpm

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## Successful over Decades.

China, with its approximately 1.4 billion inhabitants, is the world's largest energy producer. In 2013, electricity production was an unimaginable 5.4 TWh and the installed power plant capacity was a considerable 1,260 GW. Experts predict a doubling of installed capacity by the year 2040. Currently, the lion's share of the power is generated from fossil fuels. Thermal power plants that use coal as a fuel produce about three-fourths of the electricity. Power plant operators are increasingly using variable speed drives to save energy and further increase the overall efficiency of power plants.

We have been keeping pace with this development for more than 30 years by supplying geared variable speed couplings to power plants throughout the country. More than 1,000 geared variable speed couplings are running in the drives of boiler feed pumps. The customers are very satisfied with Voith couplings. Their quality, performance and, last but not least, unbeatable reliability provide convincing arguments again and again.

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• Type:	R 17 K 500 M
• Application:	Coal-fired power plant
• Country:	China
• Driven machine:	Boiler feed pump
• Input power:	8 MW
• Maximum output speed:	5,500 rpm

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# Reliable Technology Pays for Itself.

Our customer operates the largest power plant in the country. This plant uses lignite to produce electricity and district heating. A newly erected power plant unit has replaced four units that are reaching the end of their service lives. The new unit is considerably more efficient. Using the same amount of coal, it produces 30% more electricity. After being commissioned, the power plant generates one-third of the power being used throughout the country.

Eight Voith geared variable speed couplings are used in the new Power Plant. They control the speed of the coal mills that are located around the boiler in very constrained spaces. The couplings have an integrated bevel-gear drive boasting a space-saving design. In addition, the coupling very effectively dampens vibrations and torque shocks in the driveline with hydrodynamic power transmission. The lifetime of all drive components is thus extended considerably. Our couplings were not unknown to the power plant operator. Voith supplied variable speed fluid couplings for the old units that ran for a possibly record-breaking 58 years without noteworthy failures – what more convincing reasons could you need?

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• Type:	R 866 B 4 G
• Application:	Lignite-fired power plant
• Country:	Slovenia
• Driven machine:	Coal mill
• Input power:	1.2 MW
• Maximum output speed:	500 rpm

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# Expensive Shutdowns to be Avoided.

This oil refinery has a long and eventful history. It was the first refinery in the country and started operation in 1950. Initially, it processed 2,500 barrels per day while today it handles a respectable 323,000 barrels. With 26 process units, 31 different products are made. These range from the usual fuels to paraffin for manufacturing chewing gum.

Refineries are exceedingly complex large-scale systems. Usually, the maintenance intervals are five to six years. In the meantime, the systems run without interruption, every day, around the clock. Shutdowns during operating times are extremely expensive. The costs resulting from an unplanned shutdown are almost always in the single-digit to double-digit million dollar range. This fact caused our customer to consider early a Voith geared variable speed coupling for the speed control of a hydrogen recycle compressor. Several hundred references in similar applications quickly convinced him to use the Voith solution.

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- |                         |                        |
|-------------------------|------------------------|
| • Type:                 | R 16 GS 360 M          |
| • Application:          | Refinery               |
| • Country:              | Brazil                 |
| • Driven machine:       | Process-gas compressor |
| • Input power:          | 1 MW                   |
| • Maximum output speed: | 16,000 rpm             |
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# A Profitable Partnership.

Actually, the history of this power plant extends back to 1953. At that time, a very large lignite deposit was discovered in the north of the country. Coal mining started in 1955. Following the oil price crisis of 1973, it was decided to build a power plant in the immediate vicinity of the coal mine. The country wanted to use lignite to supply electricity so that it would be less dependent on imported oil. Finally, two units with a power of 75 MW each went on line in 1978.

From the outset, the operator of the power plant used Voith geared variable speed couplings in the drives of the boiler feed pumps. Reliable operation, low maintenance costs and, last but not least, a promised lifetime of 30 years were the deciding factors for our customer. Over the years, 11 additional units were added – each time with our geared variable speed couplings for controlling the boiler feed pumps. Today, 10 units are still operating with an installed total power of 2,400 MW. In the coming years, the plan is to replace 4 units with a single state-of-the-art unit of 600 MW. Following cooperative negotiations, one thing quickly became obvious: Voith geared variable speed coupling will again play a role.

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• Type:	R 18 K 600 M
• Application:	Lignite-fired power plant
• Country:	Thailand
• Driven machine:	Boiler feed pump
• Input power:	15 MW
• Maximum output speed:	5,630 rpm

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# 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. You benefit from this experience in planning, use and the development of cost-optimized operation and maintenance.

## **System competence**

You can find thousands of Voith geared variable speed couplings in thermal power plants, the oil and gas industry and the chemicals sector.

Make the right investment decision using our knowledge of systems and the applications in which they are employed. In this way, you increase the availability of your system while reducing the operating costs, too.

## **Partnership**

If you have any questions concerning the drivers of your driven machines, please don't hesitate to contact Voith and we will be delighted to discuss all of your questions.

## **Our areas of expertise:**

- Consultation in the planning of drive systems
- Torsional vibration calculation and analysis
- Strength calculations using FEM
- Run-up calculations
- Calculation of speed step responses
- Retrofit of electronic variable speed drives (VFD)

# Take advantage of the manufacturer's knowledge.

## Service

You benefit from our system and sector competence. Service from the manufacturer increases the efficiency, safety and availability of your system. The engineers and technicians of Voith's service network are available worldwide. 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 and upgrades
- Service contracts

### The advantages for your system

- Improved operational reliability
- Increased service life
- Assured productivity
- Optimized maintenance costs
- Life-cycle costs you can plan on

### Offices worldwide

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