RENK MAAG

Innovative Power Transmission

RENK-MAAG

Integral Gear Unit MULTICOM®

The heart of multi-tiered compressor systems!

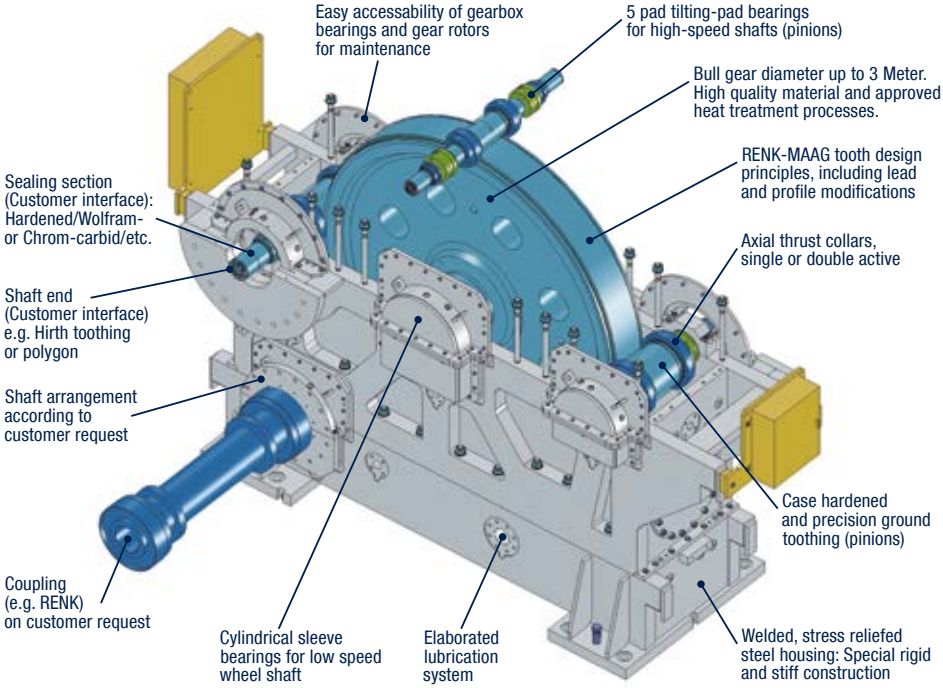
Integral Gear Unit MULTICOM® – for great performance and high speeds

MULTICOM® gearboxes GMX are designed and built according to the latest findings and processes in gearbox technology. As the heart of a multi-shaft compressor system, RENK-MAAG MULTICOM® gearbox GMX drives up to 10 compressor stages with speeds up to 63 000 rpm.

Multi-shaft integrally geared compressors are used in applications involving air, nitrogen, oxygen and other gases.

Applications

- Air and other gas **compression** trains used in petroleum, chemical and gas industries, either gas/steam turbine or E-motor driven
- Power recovery with **expander** MULTICOM® e.g. in combination with RENK-MAAG Synchronous Clutch Coupling MS/HS
- Air separation



The impellers are connected directly to the individual pinion shafts by a special toothing (e.g. Hirth) or polygon and are sealed in the casing by a special sliding ring seal on the pinion shafts. The compressor casings are directly mounted to the gearbox casing. The gearbox casing therefore has to absorb these additional weights and forces.

The wheelset with thrust collar generally features single-helical toothing, making the fast-running axial bearing on the pinion shaft redundant. The axial thrust of the impellers is absorbed by the slow wheel shaft by means of the thrust collar. RENK-MAAG has calculated, analysed and optimised the dynamic behaviour of the entire compressor system in relation to bearing damping and vibrations using special computer programs. Since delivering the first integral gearbox in 1969, the proven design has been continuously optimised. Smoothness, efficiency and service life are on exceptionally high levels in todays GMX.

Design characteristics

Casing

The casing is manufactured from welded steel plates. It is of a particularly rigid and stiff design comprising at least two main sections (upper part and lower part), thus avoiding possible distortions due to heavy impeller casings mounted directly on the gear casing.

Aerodynamic package

An optional package to reduce the ventilation losses thus increasing efficiency is available.

Bull Gear and Pinion Shafts

The teeth of the pinions are case-hardened. The bull gear teeth are either nitrided, through hardened or case-hardened depending on wheel size. All are precision-ground. The tooth flanks of the

Technical date

Power transmission	0,2–50 MW
Speeds	up to 63 000 rpm
Efficiency	up to 99,1 %
Gear ratios	up to 1:16
Compressor stages	1–10
Housing design	welded
Toothing	ISO 1328/AGMA 2015 accuracy grade 3 or better

The gearbox is available for compressors as well as for expander processes.

GMX stands for
G = gearbox
M = multi-shaft
X = thrust collar

Designed according to API 617 and/or API 672.

pinions are provided with the necessary profile and lead modifications to ensure smooth tooth meshing and a correct tooth contact pattern under full load conditions.

Thrust Collars
The axial forces developed by the helical teeth and the radial compressor are absorbed by thrust collars preferably located on the cold side of the rotors. The faces of the thrust collars are slightly tapered, surface-hardened and ground. The required lube oil is supplied by the gear mesh lubricating system.

Bearings
Pressure-lubricated sleeve bearings are provided for the bull gear. One of the bull-shaft bearings includes a thrust bearing to hold the complete gear train in the correct position. Direct-lubricated tilting pad radial bearings are used for the pinion shafts.

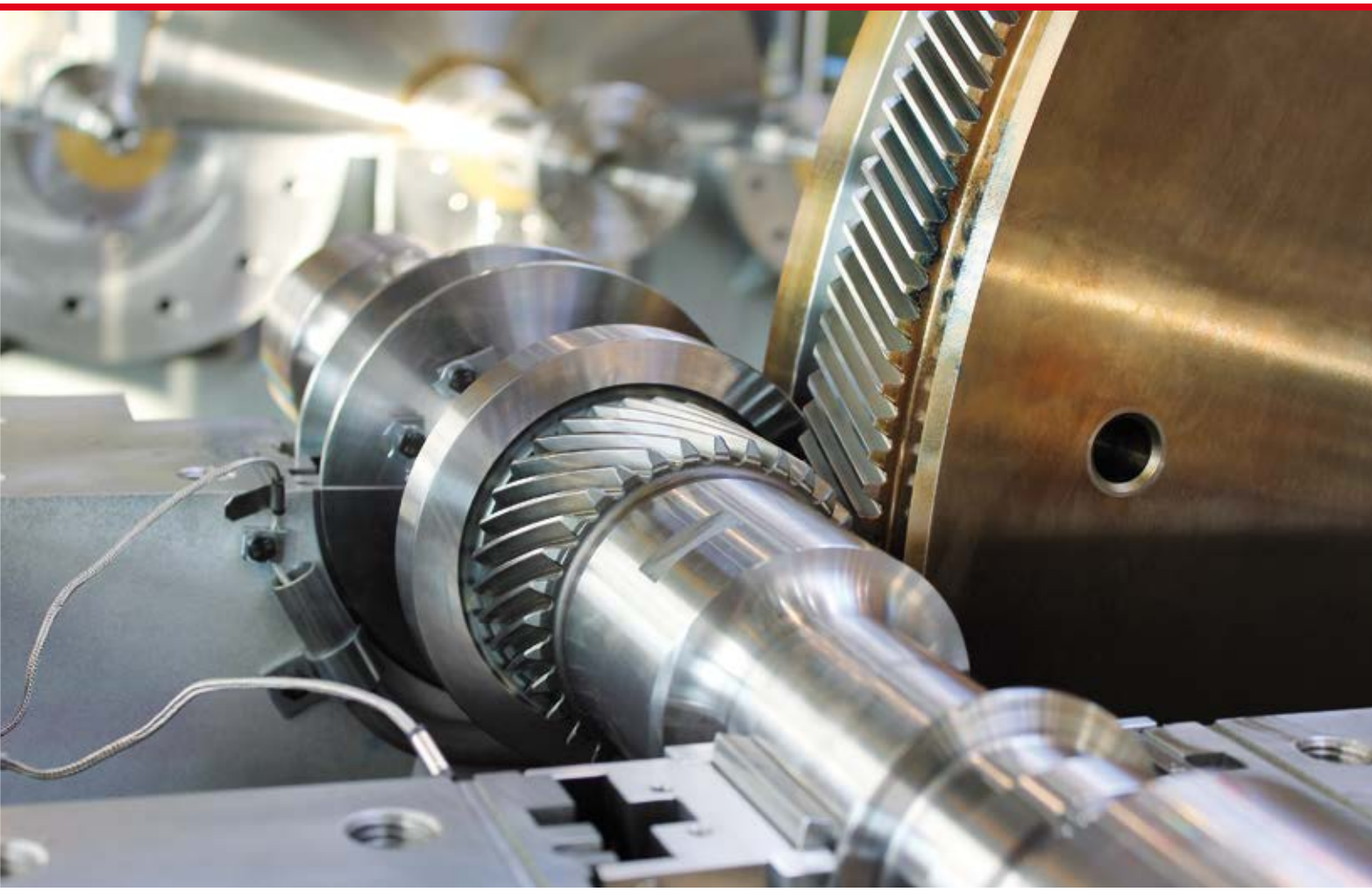
Seals
Special shaft seals combined with carbon rings are usually mounted on all pinion shafts. These seals are designed and built for a pressure of up to 80 bar. Standard oil seals are used for the bull gear shaft.

Pressure Lubrication
The gears and the bearings are pressure-lubricated. The required lube oil could be supplied by a built-on gear-driven lube oil pump with an attached valve system ensuring oil supply to the gearbox in case of reverse turning of the lube oil pump (backflow of process gases).

Accessibility for Maintenance
MULTICOM® gearboxes are designed for optimum accessibility to internal parts and instrumentation.

Gearbox monitoring system

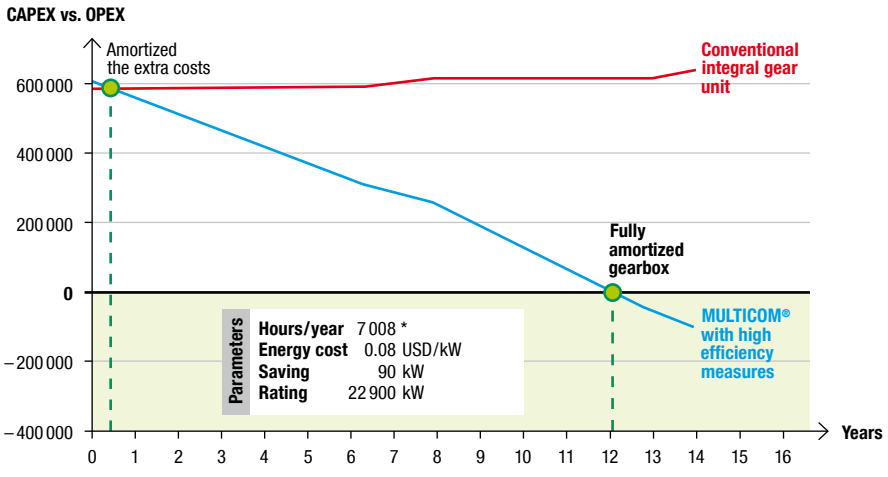
- **Instrumentation according to customer specifications**
- **Bearing temperatures**
  - Radial and axial bearings
  - Embedded platinum resistance thermometer devices (RTD PT-100 simplex or duplex)
- **Rotor vibrations**
  - Radial and axial vibration
  - Bently Nevada vibration probes, Series 3300 or similar
- **Keyphaser**
  - Wheel (optional also pinions possible)
  - Bently Nevada vibration probe, Series 3300 or similar
- **Accelerometers on casing**
- **ATEX if requested** (ATmosphère EXplosives)



Features of MULTICOM®

- Single helical gears with hardened and ground toothing
- Thrust collars arranged on the cold side of the rotors, but acting in both directions
- Special rigid and stiff construction of main casing
- Optional aerodynamic package for higher efficiency
- Low noise levels
- 1 to 10 pinion-shaft-mounted impellers
- Easy accessibility of gearbox bearings and gear rotors for maintenance
- Mounting of compressor housings, impellers and gas sealings according to customer request.
- Gearbox size and arrangement of pinions adapted to diameter of compressor/expander volutes.
- Built-on oil pump at bull gear if required.
- Buffer air if requested.

Daily operating costs savings with additional high efficiency measures



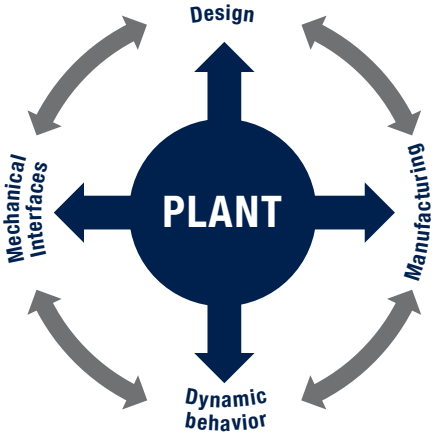
*In common plant is 80% of time in production.

In less than 160 days, the higher investment costs for the high efficiency measures have paid off. From this point on, the use of the MULTICOM® is highly profitable thanks to a 11% reduction in power loss at 100% speed.

Engineering, design, manufacturing, test – a one-stop service package

RENK-MAAG is your one-stop partner beginning with the concept development through design and manufacturing, mechanical test run leading to the installation in the field. The specific customer requirements will be considered and reflected at anytime.

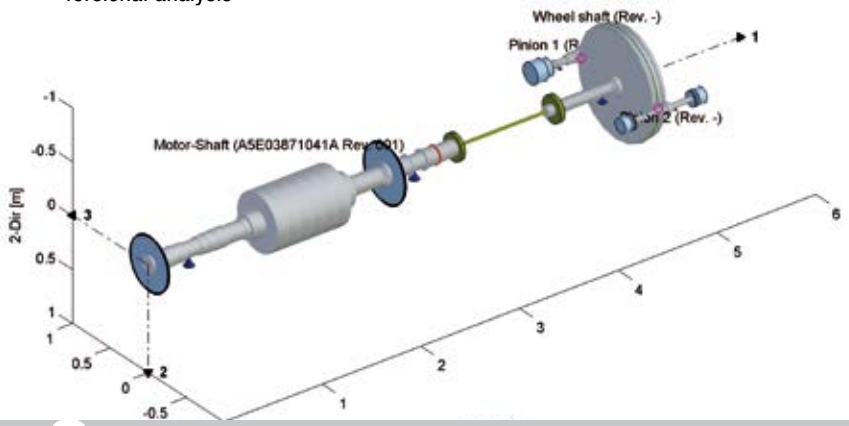
The detail engineering and sizing of the gearbox is often in parallel to the development of the complete plant and its processes. RENK-MAAG works in close cooperation with customers and engineering offices to optimize performance, layout and cost. During the manufacturing phase numerous quality checks – including ultrasonic, barkhausen noise, paint penetration and geometry – are carried out to insure the proverbial SWISS quality. The result will be mechanically tested and fully documented at our works before sent to the customer.

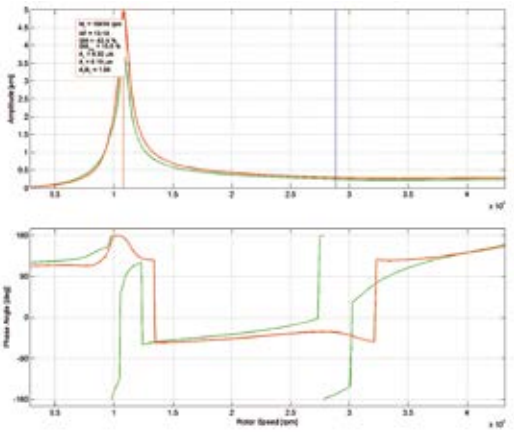


Rotordynamics

The following services are available

- Undamped lateral analysis (critical speed map)
- Damped lateral analysis (unbalance response analysis)
- Stability analysis
- Hot spot analysis
- Torsional analysis





Partner and software
MADYN 2000

DELTA JS AG

Summary

RENK-MAAG has a wide range of experience with different types of multi-shaft gearbox-designs since 1960 right up today!

- Thrust collars design
- Optional: aerodynamic package for higher efficiency
- Gearbox design for up to 10 flanged compressors
- Transmitted power up to 50 MW realized
- Pinion speeds up to 63 000 rpm realized
- Low noise and vibration levels
- Buffer air design available
- Other devices on customer request

Product portfolio

RENK-MAAG provides new products, services, inspections, repairs and spare parts (incl. complete gearboxes) for all types of MAAG/RENK-MAAG gearboxes.

Turbo Gearboxes

Parallel Shaft Gearbox

Developed for applications in generator, compressor and pump drive markets.

Applications/Industries
- Oil and gas
- Power generation
- Petrochemical industry
- Steel production
- Paper industry
- Energy recovery systems
- Testbeds

Features
- Since 1915 over 11 000 gearboxes supplied
- Partnership with various companies for tailor made gearbox designs
- Power range up to 180 000 kW
- Gear ratio single stage: $i \leq 10$ double stage: $i \leq 50$
- Speeds up to 63 000 rpm

HET Gear® (Vacuum Gearbox)

For highest efficiency where it is needed – world's most efficient turbo gear.

Applications/Industries
- Power generation
- Compressor drives
- Energy recovery
- Combined Cycle Power Plant (CCPP)
- Combined Heat and Power (CHP) plants

Features
- Highest efficiency
- Up to 99.3 % at 90 MW
- Power range 15 MW to 120 000 kW
- Viable at pitchline velocity > 120 m/s

Integral Gearbox MULTICOM®

The heart of a multi-tiered gearbox compressor and/or expander.

Applications/Industries
- Gas compression trains used in petroleum, chemical and gas industries
- Air separation
- Oil and gas
- Power recovery (in combination with RENK-MAAG Synchronous Clutch Coupling)

Features
- 1 to 10 stages
- Radial Compressors
- Up to 63 000 rpm
- First 10 stage integrally geared compressor gearbox ever built
- Toothing (e.g. Hirth) or polygon
- Up to 50 MW

High-Speed Epicyclic Gear

A simple, efficient principle when space is at a premium – plant cost (CAPEX) can be reduced.

Applications/Industries
- Power generation
- Compressor drive
- Pump drives
- Marine applications
- Paper industrie
- Hydroelectric

Features
- Over 1000 gearboxes installed in more than 55 years
- Ongoing GT-Generator drive program with more than 70 units running
- Partnership with various companies for tailor made gearbox design
- Power range up to 45 000 kW
- Gear ratio single stage: $1.6 \leq i \leq 13$ double stage: $12 \leq i \leq 45$
- Speeds up to 36 000 rpm

Special Gears [1] e.g. clutch gearboxes

Recovered energy in modern power recovery processes is automatically and directly fed back to the train.

Applications/Industries
- Between expander and blower as an increasing gear "BPRT" [2] for steel works
- Between steam turbine and fan as a reduction gear "SHRT" [3] for steel works

Features
- Integrated RENK-MAAG Synchronous Clutch Coupling type MS
- Over 125 BPRTs installed
- Power range 1000 to 100 000 kW
- Gear ratio single stage: $i \leq 8$
- Speeds up to ≤ 10 000 rpm

All RENK-MAAG gearboxes are according to DIN/ISO, AGMA or API (other norms or special design upon request).
Ask also for RENK-MAAG gear couplings (such as automatically synchronizing, engaging on demand or completely disengageable).

[1] RENK-MAAG develops and manufactures special gears for an enormously wide range of applications. The clear strength lies in the close technical cooperation with customers. A detailed specification and required gearbox design for optimum solutions are discussed and developed in person with the customer.

[2] BPRT = Blast Furnace Power Recovery Turbine

[3] SHRT = Sintering Heat Recovery Turbine

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Our manufacturing and other operational activities are implemented in accordance with our internal quality assurance system and in strict compliance with ISO 9001:2008, ISO 14001:2004 and OHSAS 18001:2007.

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