MECOS
Magnetic Bearing Technology
for Turbomachinery in Oil & Gas Applications

Engineering the Future – since 1758.
MAN Diesel & Turbo
Modern turbomachinery for oil & gas applications, such as sealed compressors with direct motor or turboexpander drives, requires the use of magnetic bearing systems.

With MECOS, MAN Diesel & Turbo provides state-of-the-art magnetic bearing solutions for oil & gas applications.

MECOS has extensive experience with digitally controlled magnetic bearing systems. Our experience with leading OEMs in the oil & gas and other markets (such as semiconductor industry, high-power lasers), enables us to understand today’s requirements and to provide solutions for tomorrow. Whether superior digital control, proven upstream gas technology or leading user interfaces, MECOS can provide the perfect magnetic bearing solution.

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<th>Main Features of MECOS AMB Technology</th>
<th>Main Advantages of MECOS AMB Technology</th>
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<td>Modular control cabinet architecture</td>
<td>Supports systems with up to 9 axes from a single cabinet</td>
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<td>Advanced amplifier control</td>
<td>High dynamic control</td>
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<td>Most advanced processor board, high computation power, sophisticated control algorithms</td>
<td>Stable rotor system under surge conditions</td>
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<td>Remote monitoring support capability</td>
<td>Low noise, stable systems</td>
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<td>Fully integrated robustness assessment capability according to ISO 14839</td>
<td>Enables preventative maintenance</td>
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<td>Software tool for field balancing of completely assembled machines</td>
<td>Short response time for first level trouble shooting</td>
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<td>Fully digital signal processing and control</td>
<td>No additional measurement equipment required, short commissioning and down time</td>
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<td>Superior PC-Tools for online measurement and postprocessing</td>
<td>Reduces pre-balancing requirements</td>
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<td>Increases quality of balancing</td>
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<td>High flexibility, easy adaptation to changing turbomachinery duties</td>
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<td>All sensor parameters are adjusted/optimized by means of the digital controller, no hardware adaptations necessary</td>
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<td>Massively reduced commissioning time</td>
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Application Examples

Compressor

Large Gas Compressors for Pipeline and Storage Application:

All power level classes of HOFIM®/MOPICO® compressor types

- Multistage compressors
- AMB systems for control of up to 9 axes
- Typical rotor weights between 2 and 3.5 tons
- Rotational speed up to 12'000 rpm

Tandem HOFIM® for gas storage

Turboexpander

Large Turboexpanders for the Oil & Gas and Petrochemical Industry:

Designed typically for natural gas treatment or pressure-let-down (PLD) applications in configurations such as expander/compressor, expander/generator or expander/brake.

- Power range of up to 10 MW
- High compressor/expander system power densities
- Compact design

Compressor/expander with AMB for cryogenic applications, including natural gas, petrochemical, and air separation
The MBX10/20 is a high-power, state-of-the-art control system cabinet designed for turbomachinery magnetic bearing systems. With its high supply voltage and advanced digital control architecture, it is the industry’s most dynamic control cabinet in this class.

In the basic configuration, the MBX10/20 controls standard 5-axes machines. Due to its modular design it can easily be extended to 7- or to full 9-axes control and therefore drive turbomachines with up to 4 radial and one thrust bearing.

**Advanced Controller Functions**

**Fully Digital Controller**

The MBX10/20 features a very powerful, digital multi-core control system. For high robustness and ultra low noise, the sensor signals are processed fully digitally. As a result, the MBX10/20 is highly insensitive to external electrical disturbances.

To provide the best dynamics, the power amplifiers are also controlled by the digital controller and thus allows for compensation of bearing non-linearity.

**Superior Vibration Reduction**

The main source of machine vibration and noise is the residual unbalance of the rotor as well as higher harmonic sensor disturbances induced e.g. by scratches on the sensor targets. The MBX10/20 offers different control strategies to reduce such machine vibration.

- Adaptive tracking filters minimize synchronous forces due to unbalance (UFRC).
- Unbalance force counteracting control (UFCC) is essential for crossing bending criticals.
- Open-loop runout compensation filters are used to cancel out higher harmonic disturbances and to avoid potential amplifier saturation.

**Industry’s most dynamic cabinet in its class**

- Reactive power of 20 kVA per channel, maximum 18 channels
- Recommended for machinery up to 20 MW
- Flexible system interface options: PROFINET, Modbus RTU/TCP, etc.
- Remote access via Ethernet
- Sensor interface: Inductive or eddy current position probes, current sensors, voltage measurement

**Monitoring and Supervision**

The MBX10/20 features versatile monitoring and supervision capabilities to protect the machine and the control cabinet from excessive load and damage.

- Supervision limit values are set according to customer requirements.
- Advanced trip data logging. Each trip event triggers not only the storage of the current system state but also data recorders at different sampling rates.

- Supervision of rotor elongation caused by thermal expansion (redundant axial position sensor).

**Highly Efficient Service Interface**

The key to short commissioning times and unmatched dynamic identification capabilities, is the service and measurement interface to the MBX10/20. Installed on a remote PC, it allows for multi-variable transfer function and signal spectra measurements.

Furthermore, these functions allow the system dynamics to be identified, compared with previous rotordynamic modeling and optimized prior to rotation as well as during rotational testing. These capabilities eliminate the need for bulky dynamic signal analysis equipment on site. The robustness assessment of the control system according to ISO 14839 is virtually built into the system.
Magnetic Bearing System

Bearing Components

MECOS offers a very robust magnetic bearing design. Based on our extensive experience with high-volume applications in many different fields, MECOS can provide bearing components in standard, moulded or liquid proof technology.

- FE-optimized magnetic design and minimized eddy currents.
- High-load capacity up to 30 kN (radial) and 80 kN (thrust).
- Validated by force measurements.
- No use of non-ferrous metals in order to increase insensitivity to gas residues in pipelines (e.g. glycol).
- Vacuum pressure impregnation (VPI) for use in harsh environments (e.g. sour gas environment).

Sensors

Reliable sensor technology is fundamental to Active Magnetic Bearing systems. Accurate and highly dynamic sensors are the basis for position control. Measurement of the rotational speed is needed to implement speed dependent control parameters and supervision limits.

- Inductive or eddy current type.
- Four sensed channels in one sensor unit (3 displacements, 1 rotation), spare pulse sensor.
- Low noise, high resolution design. Integrated shielding against external magnetic fields.
- Signal quality is independent of cable length. Cable lengths up to 300 m and more. No impedance conversion necessary.
- Rugged design, scalable in size. Qualified for harsh environments (such as sour gas environment).

Sour Gas Proven Technology

Based on thousands of hours of industrial operational experience with the materials used in our bearings, MECOS can offer active magnetic bearings for wet and sour gas applications. The selected bearing materials thus complement compressor, expander, and/or motor materials for integrated wet and sour gas rotating equipment solutions.