



HOFIM™ Technology

Oil-free compression systems

Engineering the Future – since 1758.

MAN Diesel & Turbo



HOFIM™ Sealed – the result of a decade of technology pioneering

For more than a decade, MAN Diesel & Turbo has pioneered the development of turbocompressor systems using high-frequency motor drives and magnetic bearings. Starting with the dedicated pipeliner MOPICO® (Motor Pipeline Compressor) in the early 90's, the use of these state-of-the-art technologies has been further applied to process compressors for use in a wide range of applications in the oil, gas and process industries.

A consequent and logical ongoing development

The technologies applied to the unique, hermetically sealed MOPICO® concept were further developed into the HOFIM™, a non integrated motor/compressor unit, offering a wide capacity range for all types of process applications. The advantages of these two concepts have now been integrated into the HOFIM™ Sealed, the ultimate in process compressor technology.

- Simple, robust, wear-free design
- High efficiency, low energy consumption over a wide operating range
- Discharge pressures up to 300 bar
- Oil-free, emissionless (HOFIM Sealed)
- Minimised footprint and weight
- Unattended remote operation
- Minimum maintenance

Oil-free compression

Oil-free compression systems can offer the user considerable advantages compared with conventional compression systems. Conditional upon the availability of an adequate and secure power supply, the electric drive is always more efficient than an equivalent combustion engine driver. Due to the inherent sim-

plicity of the electric motor, especially in combination with magnetic suspension, maintenance costs become insignificant. The undisputed reliability of state-of-the-art magnetic bearings and solid state frequency converters ensure reliability and availability levels which are unachievable with conventional systems.

Remote control of an electric system is much simpler and requires significantly less local manning than a system with a combustion engine driver.

Technical features

- Fully integrated, skid-mounted high-frequency motor/compressor system
- Motor power range from 3 to 25 MW
- Wide operating range
- "Soft start" via variable frequency drive
- Unrestricted number of starts
- Immediate availability, no warm-up required
- Minimum footprint, minimum weight
- Oil-free
- Lowest noise levels
- Largely wear-free requiring minimum maintenance

Integration technology

The development of integrated, hermetically sealed, electric compression systems presented the development team with completely new, multi-discipline technical challenges.

- Dynamics of large, magnetically levitated rotating elements at the rotational speeds required by high-pressure process compressors
- Cooling of power-intensive high-frequency motors with high-pressure hydrocarbon gases
- The further development of solid state frequency converters for the combination of power and frequencies required

These challenges were successfully overcome by a multi-company team of engineers with intimate knowledge of their respective disciplines, as well as a clear understanding of the complexities of integrating multiple technologies into a single system in compliance with market requirements.

Magnetic bearings

Thanks to the use of active magnetic bearing systems supplied by Société Mécanique Magnétique (S2M), complex

and space consuming oil systems have been eliminated. Magnetic bearings provide contact and wear-free operation over a wide speed range.

High-frequency motors

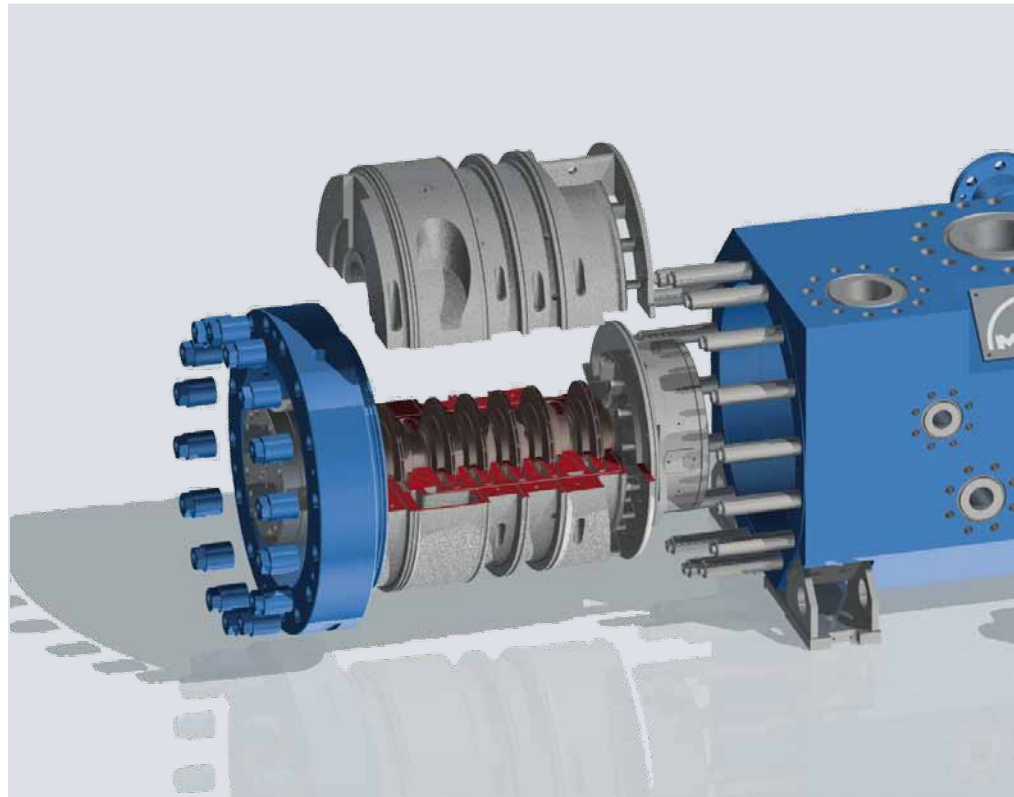
The high-frequency motor is a squirrel-cage, induction machine with a laminated rotor design. In the HOFIM™ Sealed version, the motor is cooled by filtered, high-pressure working gas which provides intensive cooling and enhanced efficiency levels. In the stand-alone version, cooling is from an external source (air, nitrogen, etc.) at a pressure slightly above atmospheric. This type of motor design results in a high power density and correspondingly reduced weight and space requirements.

Variable frequency drive

The frequency converter takes power from the grid at a standard frequency and provides the motor with a controlled variable frequency supply via a unit input transformer and a solid state rectifier/inverter system. Alternative systems can be supplied according to specific customer requirements.

HOFIM™

The HOFIM™ concept is conventional in so far as the high-frequency motor and the compressor are separate stand-alone units, coupled together with a conventional dry coupling. Both motor and compressor are fitted with magnetic bearings and the compressor has conventional dry gas shaft seals. Motor



cooling is an external system using optional cooling media (air, nitrogen, etc.) at a pressure slightly above atmospheric for enhanced cooling. The conventional HOFIM™ can be supplied in single or tandem compressor casing configurations. This is the solution of choice when the quality of the gas under compression is not acceptable as a cooling medium for the motor.

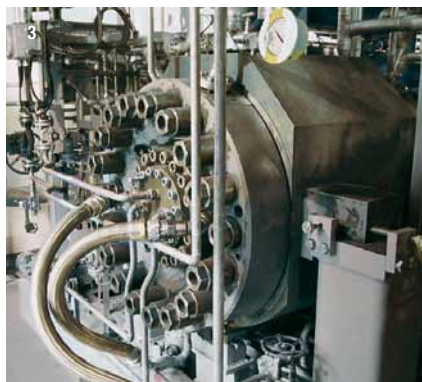
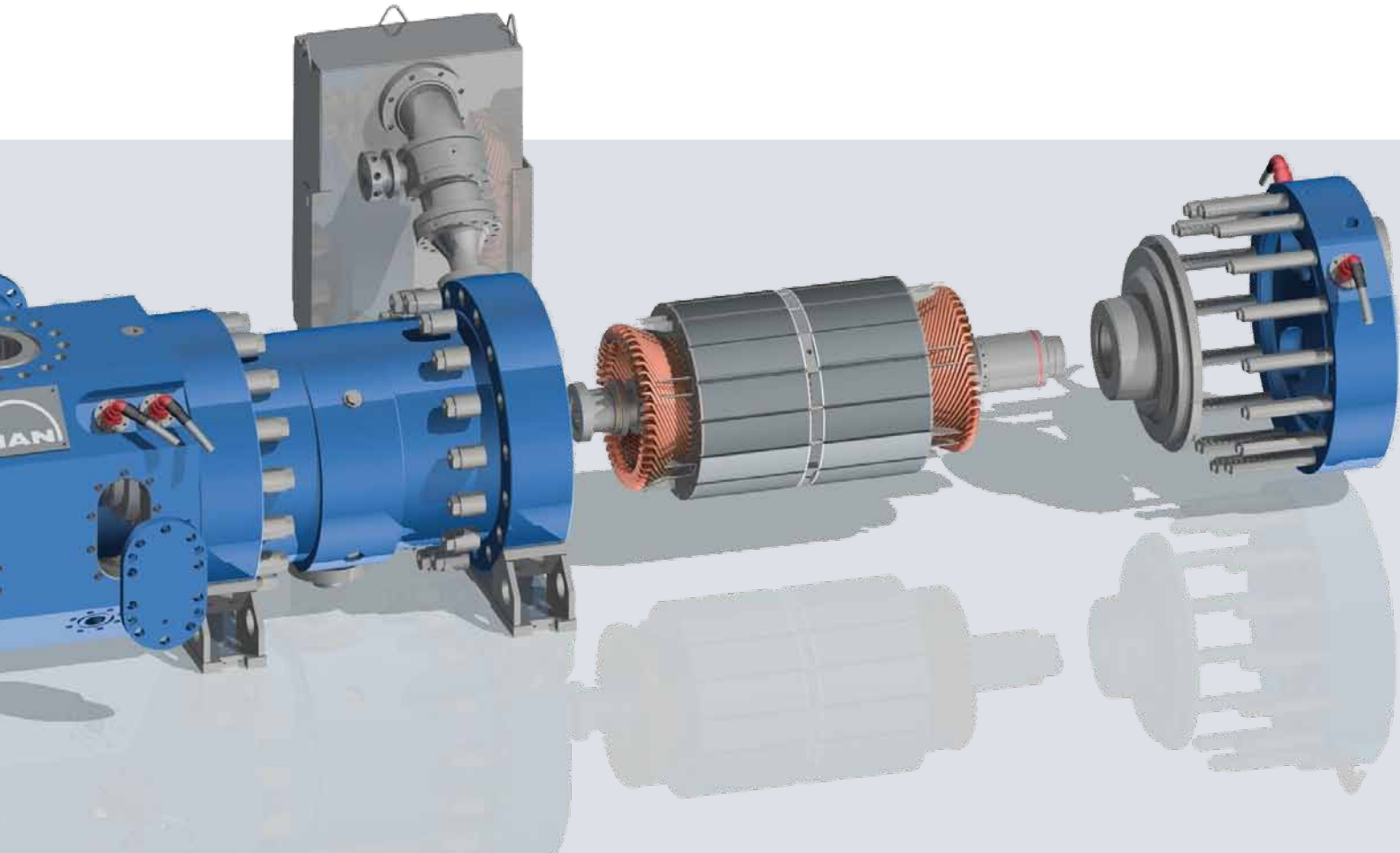
Advantages of HOFIM™

- Small footprint and low weight due to high motor power density
- Minimum service and maintenance requirements due to largely wear-free concept

- Ideally suitable for remote control and reduced plant manning requirements
- Simplified plant layout thanks to oil-free concept

Typical applications

- Oil and gas production and processing
- Gas transport
- Gas storage



1 A single HOFIM™ in a gas depletion duty in the Netherlands. The motor is rated at 4.7 MW and 14,700 rpm. In the initial layout, the system comprised a single compressor casing, taking gas from approximately 40 to 97 bar. In the meantime, the system has been converted into a tandem to accommodate suction pressures down to 13 bar.

2 A tandem HOFIM™ system for gas injection duty in a Natural Gas Liquids Plant on the Alaskan North Slope. **3** The motor is rated at approximately 7 MW at 14,000 rpm and gas is compressed from 17 to 280 bar.

HOFIM™ Sealed

The HOFIM™ Sealed combines the advantages of the MOPICO® and the HOFIM™ in an hermetically sealed, environmentally neutral motor compressor system, suitable for use in a wide range of process compression applications. Due to the sealed concept, the motor is cooled by process gas bled from the compressor and then returned into the suction header.

With this unique concept, most of the traditional sources of turbomachinery failures, namely gear boxes, couplings, shaft seals and lube oil systems, have been completely eliminated. The system can be supplied either in the single casing or the twin casing tandem HOFIM™ Sealed version.

The HOFIM™ Sealed offers an even smaller footprint and lower weight than the conventional HOFIM™. The elimination of the dry gas shaft seal systems significantly simplifies the overall system and is a major contributory factor to the enhanced reliability and reduced service and maintenance requirements offered by the HOFIM™ Sealed.

Advantages of HOFIM™ Sealed

- Smallest footprint and lowest weight due to high motor power density and integrated system
- Simplified plant layout thanks to oil-free concept without shaft seals
- Emissionless, environmentally neutral system
- Minimum service and maintenance requirements due to the wear-free concept
- Ideally suitable for remote control and reduced plant manning requirements

Typical applications

- Oil and gas production and processing
- Gas transport
- Gas storage
- Subsea



4 The first three HOFIM™ Sealed units operating in a gas storage facility in the USA. The plant layout allows the three units to operate in parallel, but also two units in parallel, feeding the third unit in series for high-pressure ratio requirements. Each motor is rated at approximately 7 MW. Gas can be compressed from 55 up to maximum 220 bar.



5 The tandem HOFIM™, both conventional and Sealed versions, offers the added capability of operating the two casings either in the series or in the parallel modes. This allows the operator to cover the widest possible duty range at highest efficiencies. Switching from one mode to the other can be effected during operation without shutdown.

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