

HOFIM™ for Upstream Gas

Compact compression solutions



Engineering the Future – since 1758.

MAN Diesel & Turbo



Hermetically-Sealed Compression

Two decades of technology leadership



For the past 20 years, MAN Diesel & Turbo has pioneered the development of integrated turbo-compression systems using high-frequency motor drives and magnetic bearings. The early recognition of the concept potential and the subsequent development of these systems resulted in MAN Diesel & Turbo's recognized market leadership and unsurpassed field experience.

Built upon the foundation of MAN know-how in the design of integrated compression systems over the past 20 years, combined with unsurpassed field operating experience, MAN Diesel & Turbo advanced the concept to accommodate wet and sour gases and for subsea compression applications.

The MOPICO®, the unique pipeline compression system introduced in 1989, was the world's first fully integrated, oil-free natural gas compressor using magnetic bearings, high-frequency motors, and solid state drives. These state-of-the-art technologies were further developed and applied to process

gas compressors designed for higher pressure ratios and higher compression ratios for use in a wide range of applications in the oil, gas, and process industries. This development is known as HOFIM™ technology.

Since the early introduction in 1989, the product family MOPICO® and HOFIM™ has been enhanced, proven and demonstrated to be competitive in an open market environment.

Advantages of the integrated compressor concept



- 1 1989 First MOPICO®
- 1991 First HOFIM™
- 1997 First tandem HOFIM™
- 2000 First HOFIM™ Offshore
- 2 2000 First integrated single HOFIM™
- 3 2002 First integrated tandem HOFIM™
- 4 2007 Successful testing of enhanced motor for wet and sour gas, subsea
- 5 2009 Upstream qualification programme completed

Health, safety & environment mindset

- Safer design with all shaft seals eliminated; no potential for gas blow-out
- Minimum number of casing seals
- No dry gas seals
- No CO₂ or other exhaust emissions
- Low noise signature
- The absence of a lube oil system eliminates all lube oil requirements: purchase, storage, disposal, filtration, heating, cooling, circulation, spillage, and records

Operation

- Cold start to full power in less than 5 minutes
- Unlimited start/stop cycle frequency
- 0 –100 % speed range flexibility
- Contact- and wear-free operation
- High reliability
- Low component number means reduced spare parts requirement
- Each HOFIM™ is powered by a variable frequency drive offering significant efficiency advantages when operating at part load and minimal impact to the grid when starting under a heavy load

Economics: low installation cost

- High power density
- Compact design
- Minimum on-site connections
- Maximum modularization
- Smaller foundation

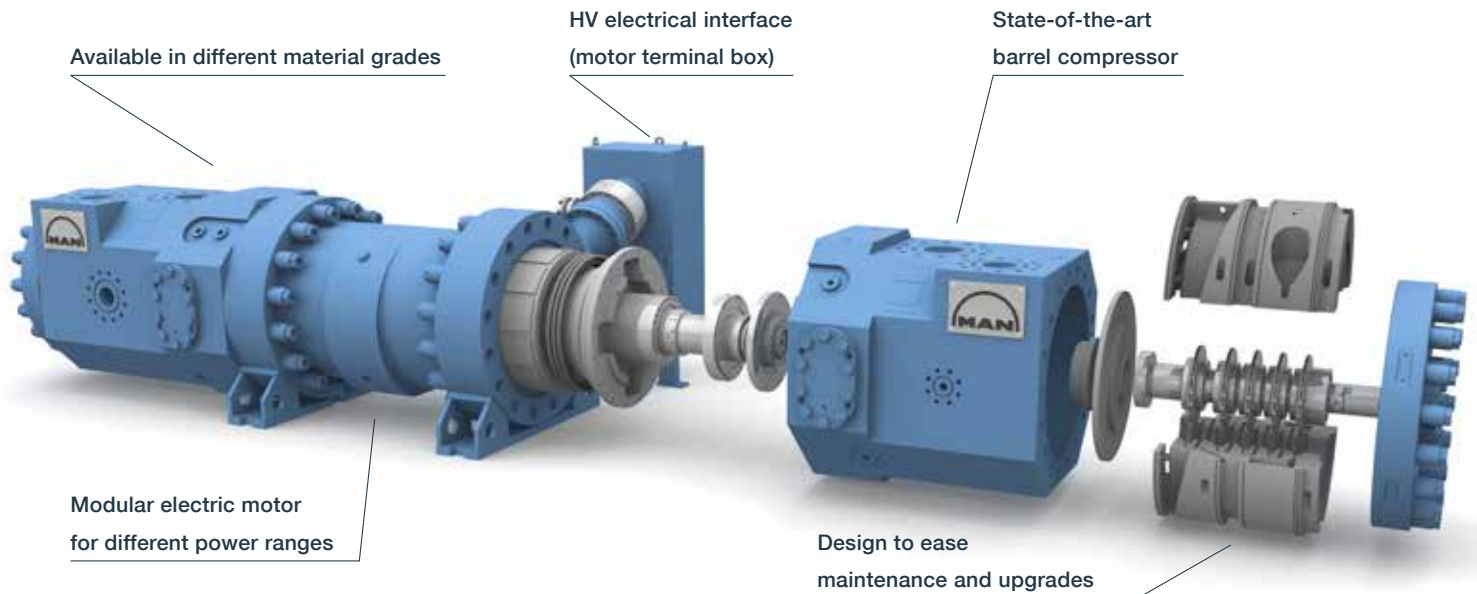
Economics: low operating cost

- Efficient motor and compressor
- Maximum flexibility
- Unmanned operation
- Minimum sparing required
- Minimal maintenance
- Low life-cycle cost

MAN technology for a safer and cleaner environment.

Modular Concept for Maximum Process Design Flexibility

Design reflects two decades of operating experience

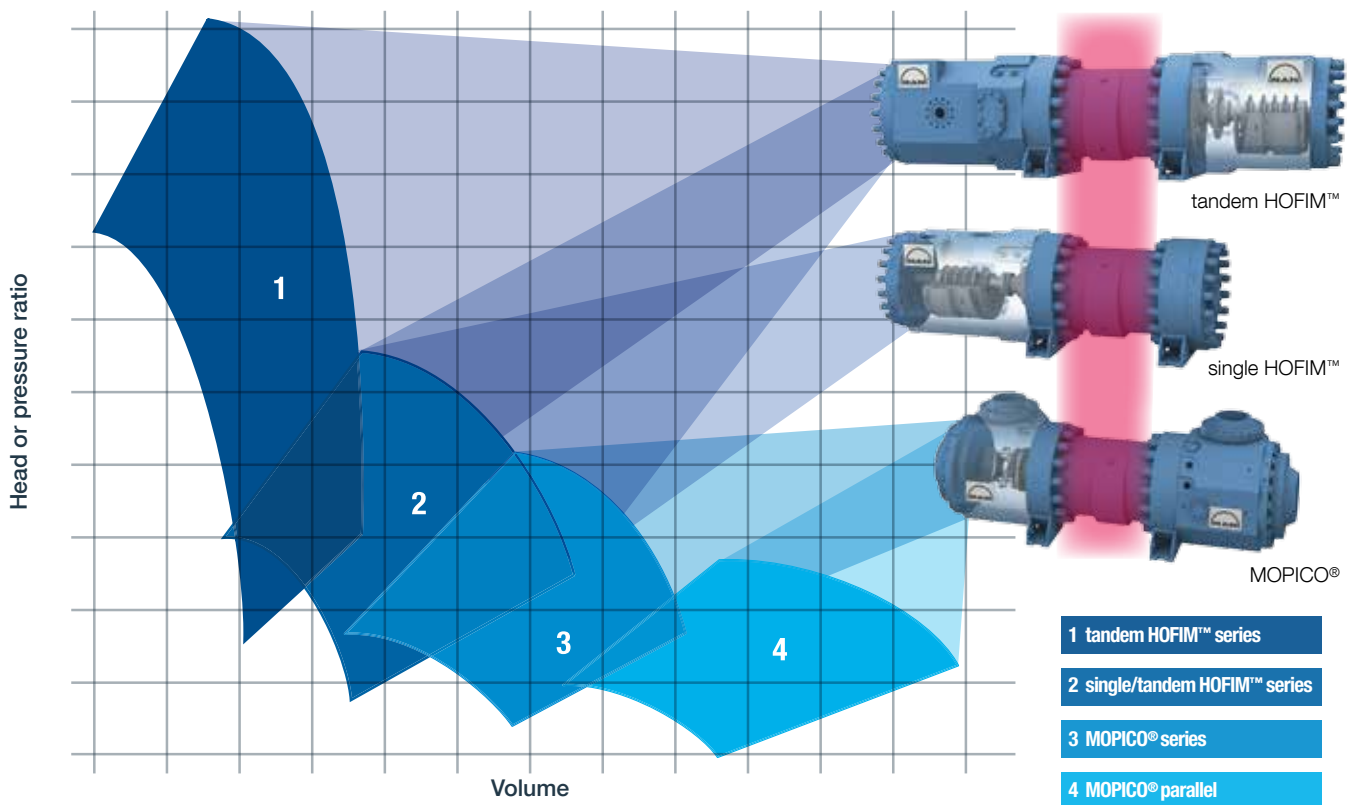


The compression concept is modular, which provides flexibility in component configuration. Standard components facilitate easy matching of the machinery boundary to the plant requirements. Wet and sour gases were given particular attention in material selection and detail design features, including a new motor design representing state-of-the-art technology. A team of engineers comprised of designers, suppliers, users, and university researchers contributed to this product redesign, setting a new standard in gas compression and enabling the first-ever subsea compression system. Mastering the subsea challenge provides assurance that all other applications may be installed with utmost confidence.

Design aspects: component designs providing higher reliability

- Tolerant for wet process gas
- Solid core non-laminated electric motor rotor
- Motor rotor and stator tolerant of rapid gas decompression
- NACE compliant
- Protected copper materials
- Non-canned motor stator protection
- Patented solid axial thrust disc between motor and compressor shafts for high thrust loads and safety during transient operation
- Proven bearing technology
- Highly effective symmetrical internal motor cooling system
- Minimum interfaces
- Suitable for use with most high-speed VFDs
- Negligible utility consumption

For series and/or parallel operation



The motor design concept incorporates three frame sizes from 4,000 HP (3 MW) to 24,000 HP (18 MW).

The modular program allows for maximum compressor design flexibility and short delivery times.

- MOPICO® motor-compressors incorporate overhung impellers and compress large volume flows with high-efficiency impellers.
- Single and tandem HOFIM™ arrangements for multi-stage compression are capable of generating the high polytropic heads required for high-pressure ratio applications.

Markets

One product for different applications



Oil and Gas market segments create different functional specifications for compressor design. Application requirements vary significantly in gas data, operations, and boundary conditions. The hermetically sealed, compact concept has been demonstrated to be competitive to the satisfaction of many clients.

The evaluation and implementation of HOFIM™ or MOPICO® systems demonstrate favorable system operating flexibility and efficiency, with low life-cycle costs and a positive impact on the environment.

Subsea

Subsea compression requires a remotely operated and reliable compressor installed on the sea floor. The core unit is integrated into the overall subsea module architecture.

Thanks to the simplicity of the modular compressor concept, only a few interfaces have to be connected to the subsea master module. If maintenance is required, the compressor module can be independently retrieved. The overall unit design is simple and offers a greatly reduced total system complexity.

Platform / FPSO

Available space and weight factors often determine design options, in particular in brown field applications with installation space constraints. HOFIM™ units occupy a small footprint and weigh a fraction of conventional compressor packages. Since the compressor casing is hermetically sealed, risks due to gas leaks are minimized. The HOFIM™ operates without dry gas seals. Lubrication oil systems are avoided and the number of auxiliary systems and components in the hazardous zone is significantly reduced. This leads to a minimum number of interfaces and ultimately results in a low failure rate.



Export terminals

HOFIM™ and MOPICO® compressors are particularly suited in sensitive areas where zero emissions and visibility are key issues in the project specification. As the machine is not emitting local emissions (e.g. drive exhaust gases or vents) and thanks due to its conceptual design it has very moderate sound pressure levels. In cases with very low noise requirements, the acoustics can be controlled by simple enclosure designs.

The machinery response is flexible, and low load up to peak load are simply controlled by speed variation. The system accepts load commands from standby (pressurized mode) to load operation within minutes without any restrictions.

Electrical system & controls

Variable speed drives (frequency converters) power the motor of the HOFIM™ and control the shaft speed according to the speed controller's set point. Variable speed drive convince with following system aspects:

- No inrush current and voltage drop at start-up of the system
- No limitations of number of starts per hour
- The $\cos\phi$ of the motor is compensated by the drive, therefore no reactive power on the primary line side.
- The input transformer can be matched to any line voltage, allowing simplifying the electrical network.

Frequency converters are made for installation into a safe and climate-controlled area.

The overall control of the compressor system can be integrated into the plant DCS system or it can be delivered with a specific unit control panel. The active magnetic bearings of the compact compressor are controlled by separate AMB control panels.

1 The compressor package occupies little space and has only a few interfaces and literally no auxiliary systems. (illustration shows a 6 MW / 8,000 HP installation)

2 Typical variable speed layout for installation in a safe area

3 Typical active magnetic bearing controller cabinet for installation in a control room

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