

# HV-TURBO® centrifugal turbo compressor

Single-stage integrally geared



**Revolving Around You™**

# Howden designs and manufactures high performance aeration technology for municipal wastewater treatment and industrial applications

## Highlights

Highest efficiency is automatically and continuously maintained over the entire turndown range, including off-design ambient temperatures and pressures where units most often operate.

Turndown to 45% (or less) at constant speed.

Variable flow by means of variable vane diffusers, pre-rotational inlet guide vanes or a combination of both systems, the DUAL POINT CONTROL™.

High-quality bearing construction results in exceptionally long life with minimal maintenance.

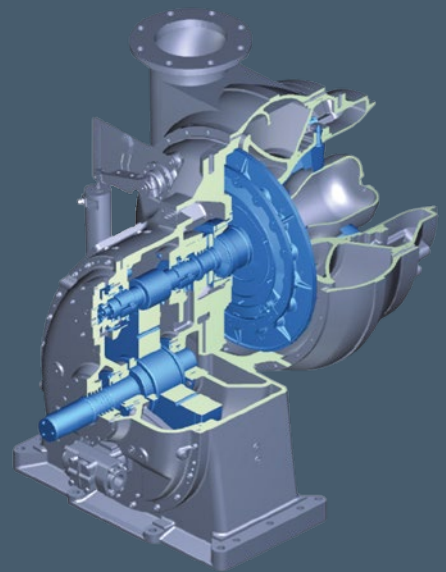
Guaranteed oil-free air delivery.

Compact design saves floor space and facilitates the replacement of older, less efficient compressors.

Standard or tailor made instrumentation and control for compressor operation compressor operation.

Low noise level with no pressure pulsation.

Low operating and maintenance costs.







## Highest efficiency, compact design

The HV-TURBO compressors are made uniquely according to plant specifications, thereby consuming significantly less energy compared to other compressor designs. The high quality compressor components, and the conformity with technical standards for a broad range of applications, ensure long-term reliability and minimum maintenance.

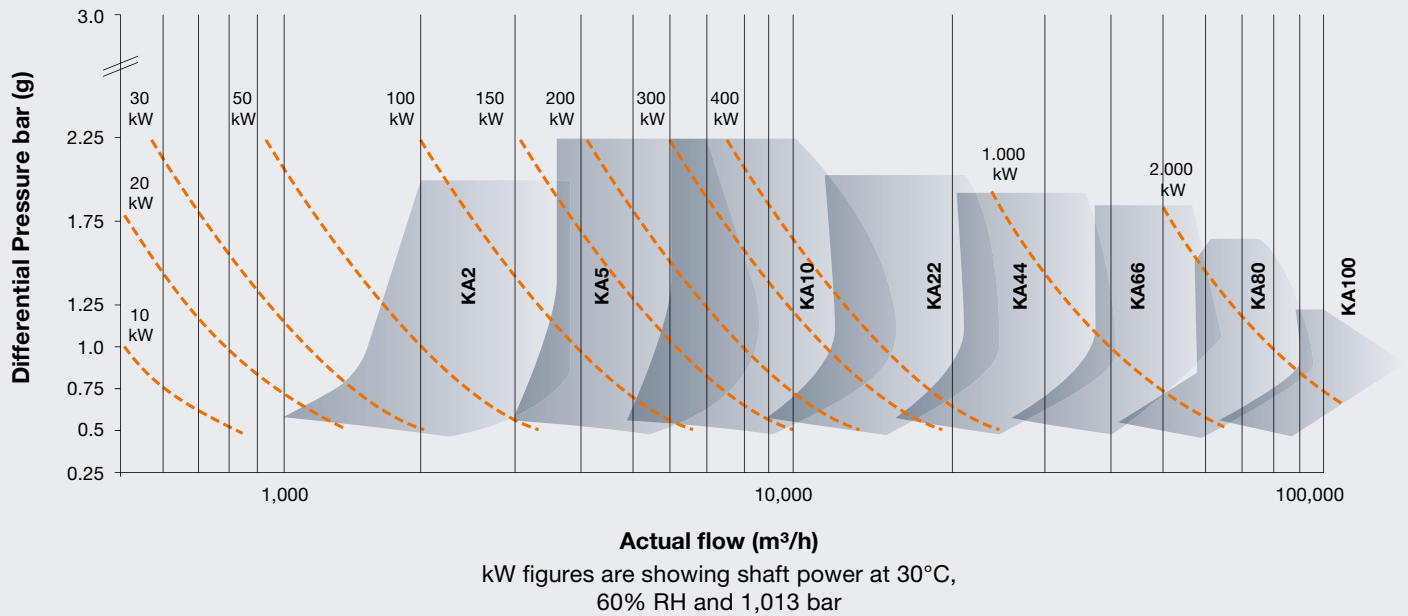
With more than 9,000 of units operating worldwide, Howden has become the market leader within its specific application areas.

The HV-TURBO competence centre is located in Helsingør/Denmark. Here our highly skilled experts and dedicated engineers are constantly improving compressor technologies, while keeping their main focus on optimised efficiency and continued reduction of energy consumption.



# Fields of application

## HV-TURBO compressor portfolio



### Wastewater treatment

Biological treatment of effluent in:  
Municipal sewage

Industrial sewage

### Flue gas desulphurisation

Oxidation air blowers associated with the cleaning of flue gases produced within power and heavy industry.

### Fermentation and enzyme production

Biochemical treatment within pharmaceutical and yeast production industry and similar biological processes

### Pulp and paper processes

#### Furnaces and smelters

Air blowers providing combustion or reaction air primarily for the petrochemical and metals industries.

#### Sulphur recovery

Air blowers providing reaction air for the catalytic recovery of sulphur within the petrochemical industry.

### Compressor flow and pressure range

Flow and pressure range from 1,000 to 125,000 m³/hour. Differential pressure up to 2.25 bar (g) (up to 4 bar possible with two stage design).

The HV-TURBO compressor series for municipal and industrial applications is comprised of different sizes. Howden offers a complete package consisting of an integrated gearbox, coupling, electric motor and lube oil system, all mounted on a common base frame.

### Efficiency by design

The HV-TURBO compressor has an advanced mechanical & aero-dynamical design and cutting edge control system. The air-end and integral gearbox have been developed and evolved during more than 30 years of manufacturing experience, creating the most high-efficient air compressor available in the market today.

A well designed compressor, is customised to site conditions, while requiring minimal power consumption. Compressors may be controlled by variable inlet guide vanes, variable diffusers, or both. The choice between the different control systems is based on variable flow rate demand, the discharge pressure and ambient conditions.

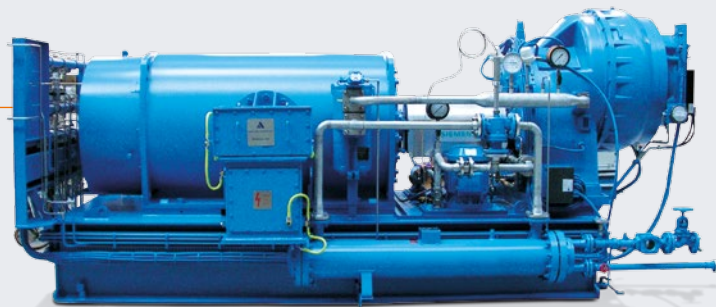
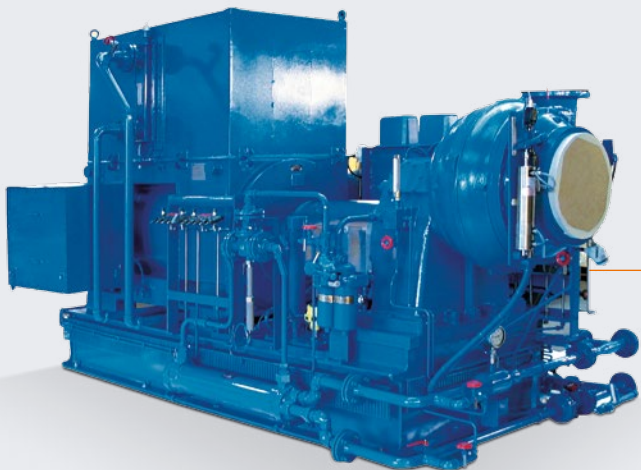


#### KA10 small-sized compressor

Inlet flow from ca. 6,000-17,000 Nm³/hour and differential pressure from 0.4–1.9 bar.

**KA22V-GL315 special application  
for sulphur recovery unit**

Mid-sized compressor unit KA22V-GL315 for  
constant flow of 19,190 m<sup>3</sup>/hour and up to 0,910 bar.



**KA10SV-GL285 special application**

For flue gas desulphurisation.  
Flow 11,300 m<sup>3</sup>/hour and up to 2,56 bar.



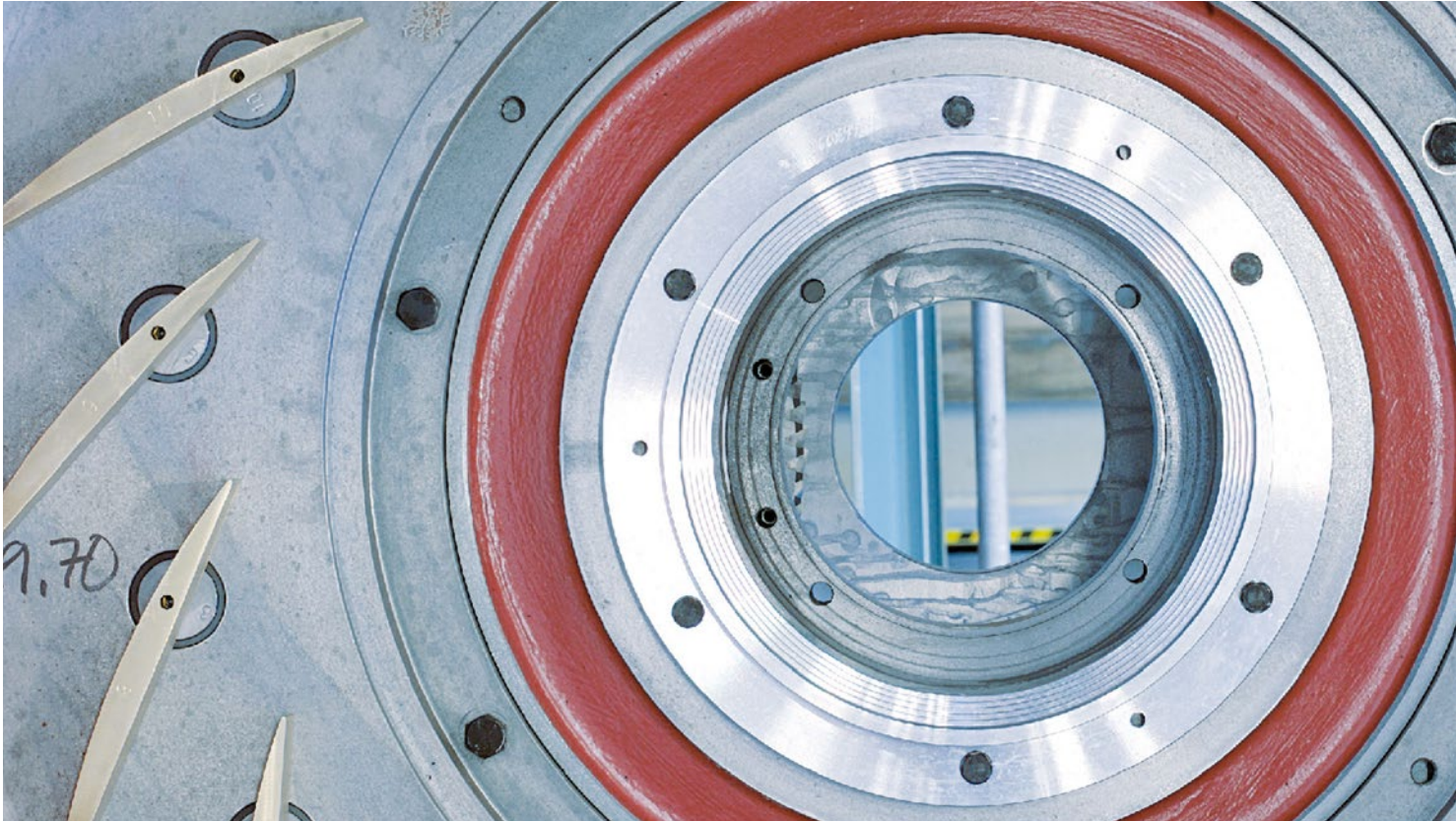
**Large sized compressor unit**

Inlet flow from 40,000-80,000 Nm<sup>3</sup>/hour and  
differential pressure from 0.4-1.5 bar.



# Aerodynamics & mechanical design

All components in the air stream are aerodynamically designed to minimise turbulence, thus streamlining flow through the compressor.



## Variable diffuser vane system

The Variable Diffuser Vane system (VDV) controls the flow by adjusting the angle of 17 to 20 diffuser vanes. The vanes are flow optimised, allowing adjustment of the nozzle area, while still maintaining an excellent efficiency throughout the entire operational range of the compressor. The vanes are arranged radially around the impeller.

## Inlet guide vane system

The Inlet Guide Vane system (IGV) controls the incidence angle of the inlet flow to the impeller, and thus influences the relative speed of the air. This allows the adjustment of the delivered head from the compressor and optimisation of power consumption according to changes in operational parameters such as inlet temperature, outlet pressure, etc.

Inlet air is continuously and automatically pre-rotated by 13-24 vanes, arranged radially around the concentric inlet, thus maximising efficiency throughout the operational range. The vanes are supported at both ends, an unusually strong and long-lasting configuration.

## The impeller

The core of the compressor is the impeller with backward leaning blades angled according to regulation and milled from a solid forged piece of high grade aluminium alloy (originating from the aircraft industry), with an optimal weight/strength ratio. Howden easily customise the design of the semi-open three-dimensional impeller by means of 3-dimensional simulation software Computer Fluid Dynamic simulation (CFD) to meet individual plant requirements. The impeller design is based on an extensive database comprising full factory tests of more than 9,000 compressors as well as full scale tests and finite element analysis.

**The KA turbo compressor series consist of single-stage compressors with integrated gearboxes. Compressor and gearbox are standard, fully integrated with vertical split and the pinion shaft above the drive shaft. The design is compact and easy to maintain. All gearwheels are customised according to compressor configuration.**

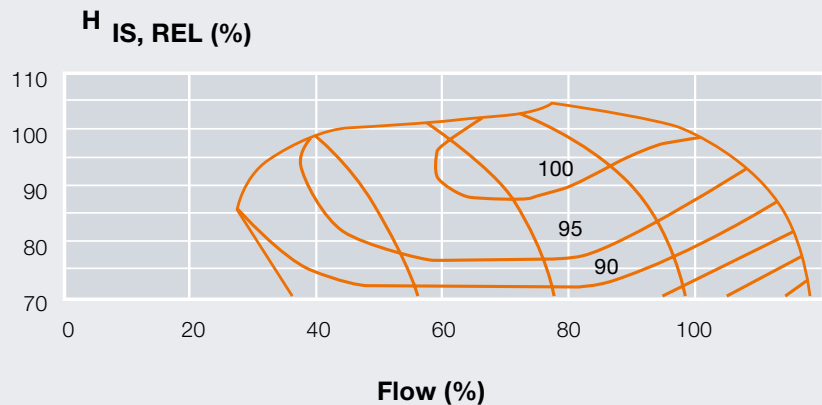
## Various gear types for different requirements

Howden offers several different combinations of air-ends and gearboxes. Selection depends on the capacity, required power and type of driver. All gearboxes share similar heavy duty design features for a long – low maintenance – operation.

## Various compressor control configurations:

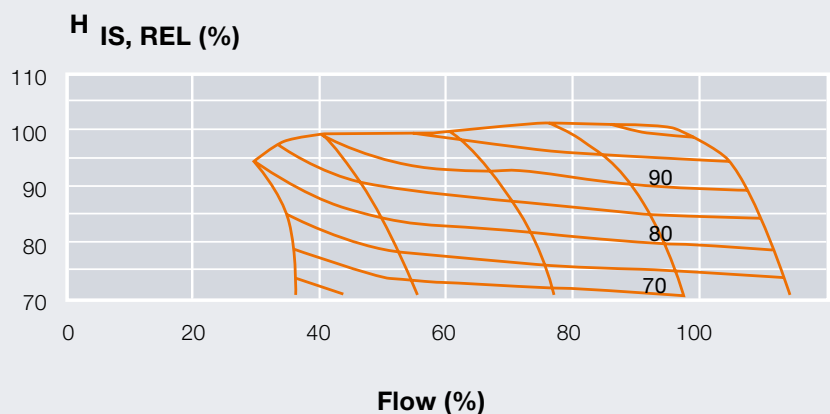
### Variable diffuser and inlet guide vane system

This design features the unique Howden DUAL POINT CONTROL™ with both inlet guide vanes and variable diffusers, which ensures high efficiency operation – even at off-design conditions. This makes the KA turbo compressors especially suitable when operating requirements are characterised by substantial fluctuation in inlet temperature, discharge pressure and flow.



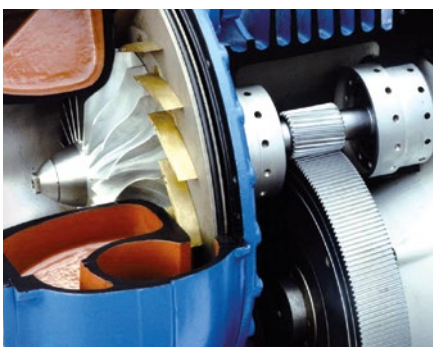
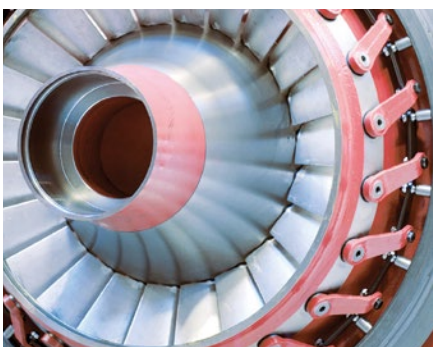
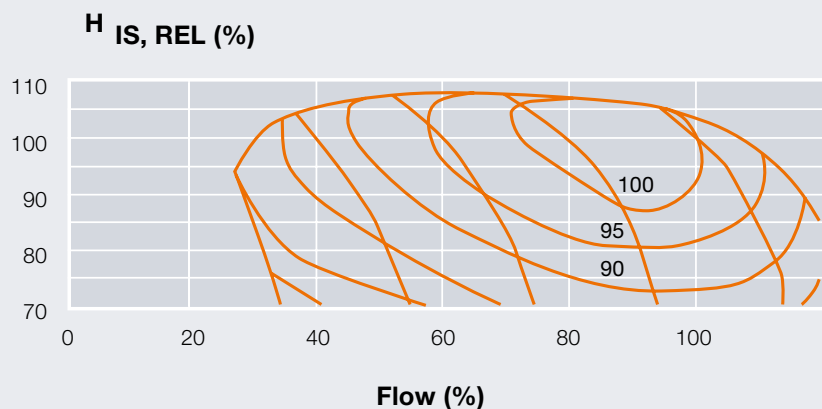
### Variable diffuser vane system

Equipped with a variable diffuser vane system, the KA turbo compressor has relatively steep performance curves and is thus particularly well suited for high efficiency operation at relatively constant discharge pressure and inlet temperature.



### Inlet guide vane system

Equipped with an inlet guide vane system, the KA turbo compressor is the most efficient solution for applications demanding high flow rates. This design also complies with API standards and is highly suitable for industrial applications.

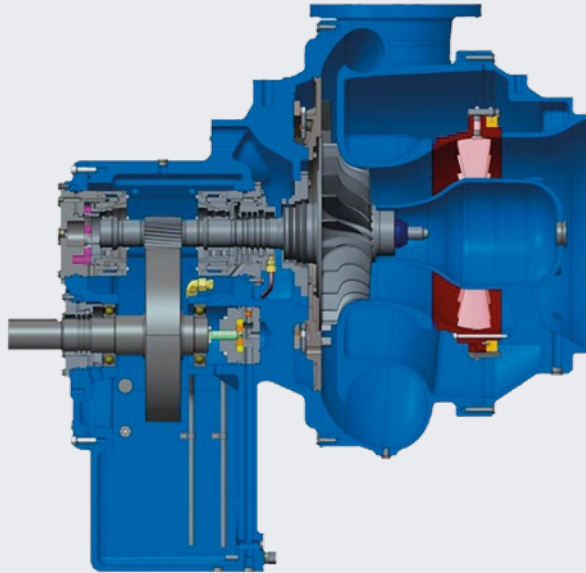


Ball bearing unit with helical gear and diffuser vanes for optimal efficiency.

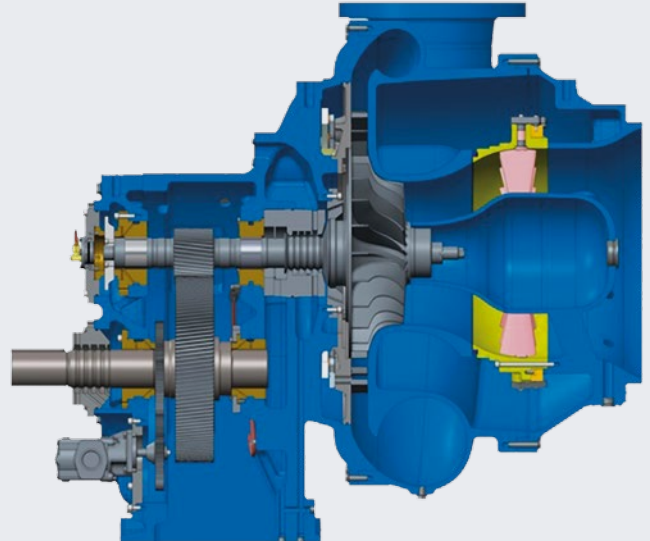


# Mechanical design & control

Model GK gearbox



Model GL gearbox



## GL and GB gear type series

The gears are helical cut from high grade steel alloy, case hardened and grinded to close tolerances. The bearings are hydrodynamic multi-pad bearings with forced oil lubrication. The designed bearing lifetime is 100,000 operational hours.

The design ensures easy access to vibration and temperature probes, which can be equipped optionally. The air and oil seals are non-contact labyrinth type. Gears and bearings are pressure lubricated by electrically and mechanically driven oil pumps.

The GL-gearboxes allows for higher flow and higher pressure within the range of HV-TURBO compressors and extend the maintenance intervals.

## GK-gear type series

Aeration installations in smaller decentralised wastewater treatment plants often require special needs as regards compressor design and performance. The GK series are ideal for small-scale plants, because they offer a particularly compact design, with an integrated gearbox equipped with ball bearings lubricated by an integrated oil pump.

## Special gear type series

The special GC-gear type is a planetary two stage co-axial gearbox for combustion engine drivers, well suited for applications such as methane recovery processes. This type of gearbox is designed for increased torsional forces originating from the driver.





## Efficiency by control

The efficiency of the aeration equipment ultimately depends on the control system.

The HV-TURBO compressors are provided with safeguards and monitors for long-term, trouble free operation. Other instruments are available to monitor compressor operation and include vibration and bearing temperature monitors that are generally used on larger units. Maintenance status monitors are available for inlet air filters, oil filters, oil reservoir level, and reverse rotation.



## Local Control

The Howden Local Control Panel (LCP) is specially designed for monitoring and controlling the HV-TURBO compressor with diffuser and inlet guide vanes.

### Standard features

- Control panel mounted off-skid.
- Control is provided by an internal Siemens PLC type S7-1500 with job customised software.
- Equipped with touch panel operator interface with colour screen.
- Emergency stop push button.
- Factory tested.
- Protection class IP54, colour RAL 7035.
- Power supply according to specific requirements.
- Industrial ethernet.
- Multi-language interface.

**The Local Control Panel is also provided with contactors for auxiliary equipment, such as:**

- Actuator for the blow-off valve.
- Electric motor for the lube oil pump.
- Electric motor for the air/oil cooler fan.

### Special features

**Systems may be designed to accommodate specific client needs, for instance:**

- Different PLC platforms.
- Other network communication available to DCS/SCADA: PROFIBUS DP, Ethernet, MODBUS TCP.
- Housing in EEx certified enclosures of IP65 for hazardous area applications.
- Modification for tropical environment.
- Remote connect online support via mobile network/local area network.
- Trending of operational data.

### Vibration and monitoring devices

- HV-TURBO compressors for municipal and industrial applications can be equipped with vibration detection and monitoring devices:
- Accelerometer offers vibration detection and monitoring, the analogue signal is connected directly to the PLC in the LCP.
- Proximity probes for radial and axial shaft vibration monitoring.

## Master control

The Master Control Panel (MCP) is designed for automatically controlling the air supply from a compressor group arrangement from 2 up to 15 HV-TURBO compressor units. With the MCP control using the highly efficient cascade control philosophy, the process is constantly provided with the right amount of oxygen.

### This kind of regulation ensures:

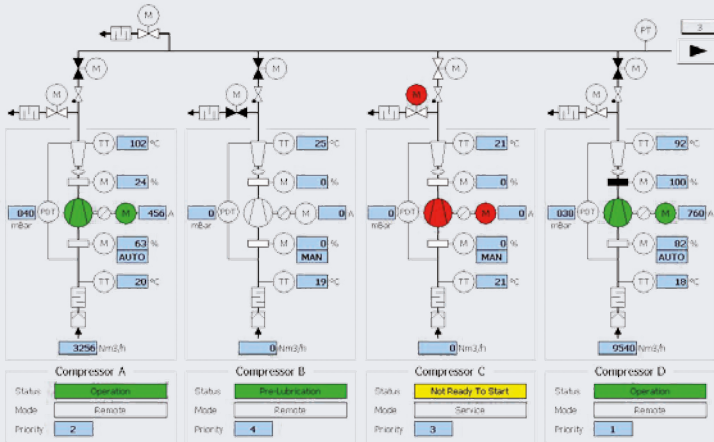
- Maximum efficiency and lower energy consumption.
- Accurate control – even under fluctuating conditions.
- Priority control allowing the turbo compressors to equalise their working hours.

### MCP single overview

- Easy overview of each compressor's operational status.
- Single overview for the operator on the complete compressor system showing all events and system messages.
- Direct indication of main discharge pipe pressure and set-point.
- All critical functions and settings are access protected.

# Control & testing

## Details compressor station



MCP single overview

## Standard features

- Control panel installed separately.
- Control by Siemens PLC S7-1500 system.
- Equipped with touch panel interface with colour screen.
- Factory tested before delivery.
- Protection class IP54.
- Power supply:  
According to customer requirements.
- Multi-language interface.
- Industrial ethernet or Profibus communication to DCS/SCADA system.

## Special features

- Systems can optionally be designed to accommodate specific client needs, like:
- Easy connection to DCS/SCADA systems via industrial Ethernet, Profibus DP, Modbus TCP or OPC-UA.
- System input/output for remote monitoring and control via DCS/SCADA.
- Different PLC platforms.
- Process trending.
- Redundancy requirements.
- Remote connect online support via mobile network /local area network.
- Different sizes and materials for special applications.
- Housing in EEx certified enclosures for hazardous area applications.
- Modification for tropical environment.

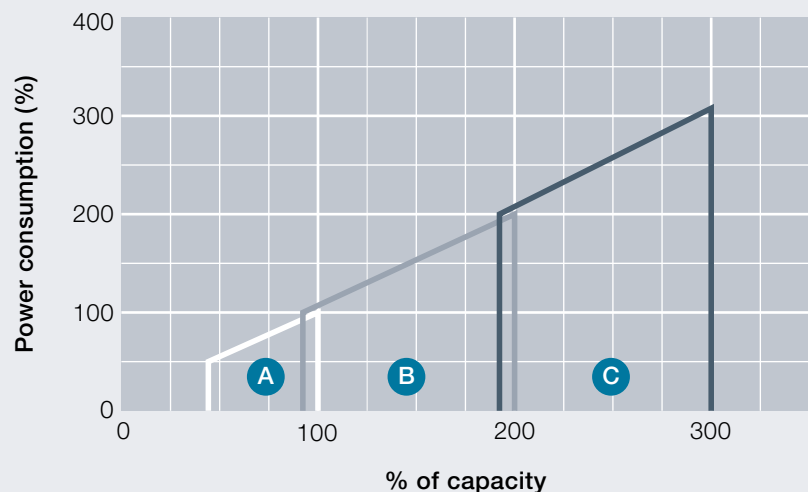
## Cascade control ensures

- Easy fine-tuning according to process requirements as only one compressor at the time is regulated. Parallel control will cause a more unstable ramp-up/down.
- Maximum number of compressors can be operated in optimum. Only one compressor is potentially operated at lower efficiencies. In parallel, every compressor can potentially be operated away from optimum.

## The prime advantages of the system solutions include:

- Single-source responsibility.
- System integration.
- Greater overall efficiency.
- Better control and smoother operation.
- Avoiding interface issues.
- Start-up and fine tuning.
- Greater system reliability.
- On-line support via VPN (mobile network or LAN).

## Cascade control





# Testing

## Standard Shop Test

Each compressor core unit is tested in our advanced test-rigs in accordance with our Standard Shop Test specification. The test-rigs are certified every year according to ISO 9001 and the calibration procedures are conducted at regular intervals according to ASME, ISO and API international standards.

During the Standard Shop Test, each compressor is operated at maximum design load for 3–10 operating hours, depending on the compressor type.

## The test procedures have been developed during decades of testing thousands of turbo-compressors and must fulfill the following purposes:

Provide data over the entire specified operational range for the quality approval.

Provide data for the automated power saving program with variable diffuser and inlet guide vane system.

Provide specific and statistical data as feedback for the compressor design program.

Provide to the customer documentation of the performance data and the performance range in the form of a graphic presentation.

## Specifically during the Standard Shop Test are performed the followings:

### Mechanical/operational test

The lubricating-oil system is put into operation and the safety controls are checked and adjusted.

Initially the compressor is running at low load and special attention is paid to vibrations, the temperature rise of the bearing covers and the labyrinth seal flanges. The housings, flanges, and pipes, including the lube oil system, are checked for tightness.

## Vibration measurements

According to ISO 10816, each compressor is run at maximum load and the vibration velocity is recorded within the range 10–1,000 Hz.

## Noise measurements

According to ISO 3746, the sound-pressure measurements are recorded and an engineer evaluates the test data in relation to the specified data. A noise certificate can be issued on customer request

## Performance test

### Heat balance test:

By establishing a total energy balance for the compressor, by measuring all the losses and adding them to the energy input to the compressed gas.

### Torque meter test:

By measuring the torque using a precision torque meter and the rpm of the driver.

### Electric motor test:

By performing an energy balance on the driver in accordance with the appropriate test codes for the particular type of machine.

# Additional testing

## In addition to the mandatory tests Howden offers to customers an optional testing portfolio.

**Witness test:** The test will be conducted by an experienced engineer in cooperation with the test-bed foreman according to international standards. The complete test procedure is witnessed either by the customer itself or a third party, i.e. an inspector from an independent and neutral inspection company.

**Certified test:** When the client is not in the position to attend the witness test a certified test can be offered. An experienced test engineer will conduct this test. Test log sheets will be signed by the test engineer certifying specified test points selected by the customer.

## National and international test standards

Howden compressor-testing procedures, as well as the testing equipment, instrumentation, and calibration are in conformity with the national and international norms of testing turbo compressors:

### ISO 5389-2, Dec. 2005:

Turbo compressors – Performance Test Code

### PTC 10 – 1997:

Performance Test Code on Compressors and Exhausters

### API Standard 672 fourth Edition, March 2004:

Packaged, Integrally Geared Centrifugal Air Compressors for Petroleum, Chemical, and Gas Industry Services

### EN ISO 5167-1, 2003/EN ISO 5167-2, Jan. 2004:

Measurement of Fluid Flow by Means of Pressure Differential Devices

### ISO 10816-1, 1995:

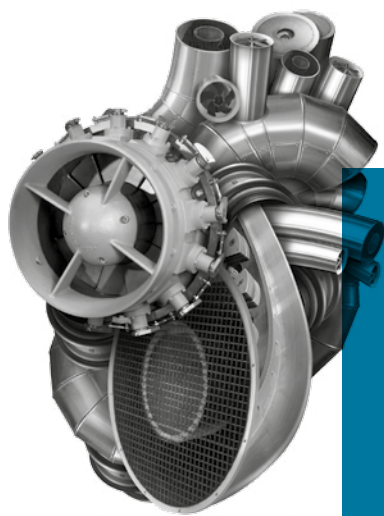
Mechanical Vibration

### ISO 3746, 1995:

Acoustics – Determination of Sound Power Levels of Noise Sources Using Sound Pressure

### EN ISO 9001, 2000:

Quality Management Systems-Fundamentals and Vocabulary.



## At the heart of your operations

Howden people live to improve our products and services and for over 160 years our world has revolved around our customers. This dedication means our air and gas handling equipment adds maximum value to your operations. We have innovation in our hearts and every day we focus on providing you with the best solutions for your vital operations.



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