



HOWDEN PROCESS COMPRESSORS

Process Screw Compressor Systems

Leading the world in process screw compression

Process gas expertise

Process Rotary Screw Compression Business History

During the 1930's, James Howden & Co. worked in co-operation with Professor Lysholm of Svenska Rotor Maskiner (SRM) Sweden and developed the first experimental oil free screw compressor in 1939 using twin rotary meshing screw principles. In 1944 the first screw compressor for process gas applications was developed by Howden which was followed in 1946 by us taking the first "Technology Licence".

Howden Compressors Limited was established to develop the specialist technology. Development continued and in **1961** the world's first oil injected controlled capacity compressor was developed, primarily for Refrigeration applications. During the following four years it was further developed and successfully used on its first Process Gas Application. Development continued through the 1960's and 1970's creating one of the largest ranges of Process Rotary Screw compressors for Oil and Gas and Petrochemical markets as well as the traditional Air and Refrigeration markets. As a consequence of this the market opportunities grew with resultant benefits to our experience.

In **1991** a dedicated 'Process Gas Division' was set up within Howden Compressors Limited concentrating wholly on developing unique, cost effective system solutions around the rotary screw compressor technology for the Global "Process Markets". In **July 1998** the division was made an autonomous "Division" of James Howden and Co. Limited, within the Howden Group, and renamed Howden Process Compressors. This places the business in an ideal position to offer our proven technological experience, quality and cost effective compression solutions designed around Rotary Screw Compressors.

Our Process Rotary Screw Compressor experience

Oil free

Petrochemical applications	over 1000 yrs operational experience
Vapour Recovery applications	over 1550 yrs operational experience
Contaminant (Dirty) Gases	over 100 yrs operational experience
Polymerising Gases	over 50 yrs operational experience

Oil injected

World's largest (510 rotor dia)	over 200 yrs operational experience
Fuel Gas	over 500 yrs operational experience
Offshore applications	over 60 yrs operational experience
Sour Hydrocarbon Gases	over 60 yrs operational experience
Hazardous Gases	over 26 yrs operational experience



Gas liquefaction plant installed by ADGAS in DAS Island.



Fuel gas compression package for North Sea application. Courtesy of Chevron UK.



Flare gas recovery system for pilot plant in the Middle East.

Sales & Projects

Worldwide sales coverage is achieved via an international network of technically qualified regional managers in Europe, USA and Asia, supported by local agents. This is supplemented by Howden Group's comprehensive network of regional facilities. A thorough review of process requirements by qualified project and applications personnel, ensures the most cost-effective and energy efficient design proposal is submitted to the customer, whether for a compressor package or a full process compression module.

Contract Management

Professional contract management has earned us the reputation for on-time delivery. A senior contract engineer is assigned to each project and is responsible for co-ordinating and submitting all required documentation, liaising with the client and closely monitoring progress through to site installation and commissioning. This ensures maximum attention to detail with the greatest flexibility to meet with changing specifications and individual customer needs.



Howden Process Compressor's total commitment to quality covers all aspects of design, manufacturing, testing and servicing. All machines bear the European Standard's C.E. mark (when supplied within the European Community). Our quality systems have been assessed/ approved by a third party to ISO 9001, 2000, ensuring consistent quality throughout all aspects of the company's operations.

Left photograph shows:
a two stage tandem oil free package for Butadiene extraction, in China.

Right photograph shows:
Howden LP booster on hydrocarbon service on Petrobras P43 and P48.



Oil free screw compressor systems

Oil injected screw compressor systems

System Design

Each package is designed for operational flexibility and the highest reliability, incorporating oil-free or oil-injected twin rotary screw compressors. The combination of the latest electronic control and instrumentation technology and a highly skilled workforce ensures a reputation for high precision engineering, quality and performance.

Using the latest CAD technology, customised package sets are designed to comply with the requirements of international standards such as API, ASME (VIII DIV 1), BS, DIN, GOST, AD MERKBLATT, Chinese and Japanese pressure vessel codes, Norsok, NACE, TEMA, when specified. In addition, system designs have and can be approved by many major authorities such as Lloyds; Bureau Veritas; Norske Veritas, RINA; DSRK; Bureau do Mines; Germanischer Lloyd and NKK.

A typical package incorporates compressor, driver, oil management system, controls, instrumentation and additional process components such as coolers, K.O. vessels, condensate removal system and scrubbers. Each package is normally delivered as a fully assembled module with piping and electrical wiring complete ready to 'hook-up' to the clients process and utility interfaces thus minimising the installation and commissioning period. Attention is paid to ensure that maintenance access is fully taken into account.

For oil injected compressor sets, full consideration is given to the compatibility of the lubricant with the process gas and to dew point control within the package.

Package design takes account of the client's space and weight constraints and to ensure operational safety at all times. Care is also taken to ensure environmental restrictions are properly met.

For industrial gas turbine fuel gas compression applications Howden have developed a range of standard modularised packages in addition to customised systems.

Oil free screw compressor systems

Many applications demand that the gas being compressed remains free from oil contamination. Howden specialised seal systems isolate the gas being handled from the compressor oil system by various combinations of shaft seals. As there is no lubricating film present between the rotor surfaces, timing gears are fitted to synchronize the rotors to prevent them touching each other. These gears are external to the main pressure casing. These features guarantee a completely oil free gas delivery.

2 x 50% Oil Free Flare gas recovery systems for new Lukoil Compressor Station in Russia.

Typical applications

- Refineries
- Gas Gathering
- Petrochemical Plants
- Chemical Plants
- Synthetic Fertiliser Plants
- Synthetic Rubber Plants
- Mechanical Vapour Recompression (MVR)
- Offshore Platforms



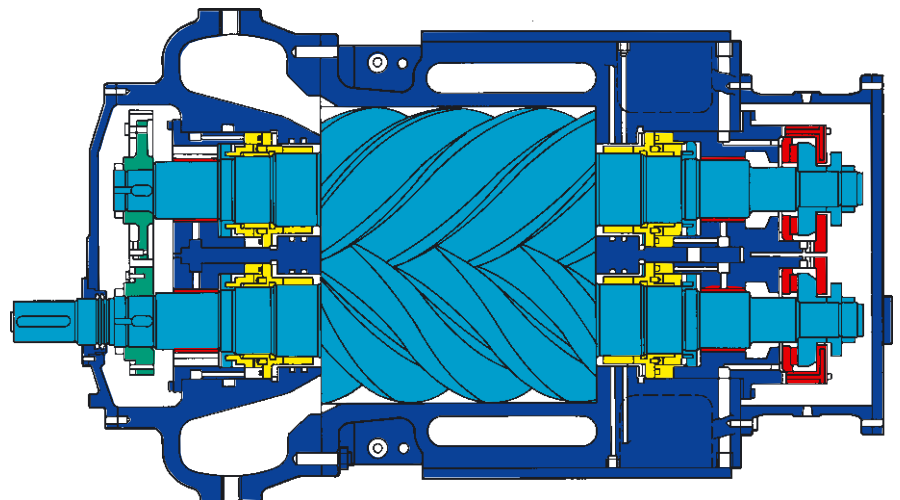
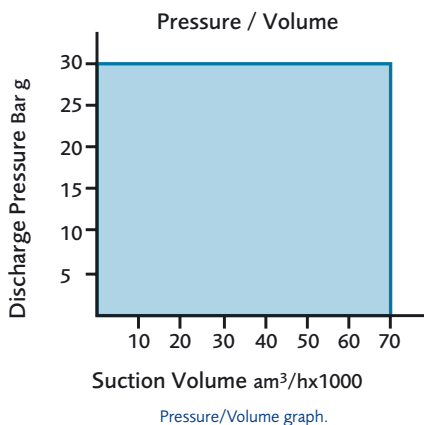
Unique features and benefits of oil free design

- **Completely oil free delivery of gas**
Suitable for a wide range of processes
- **Flexibility of discharge orientation compactness of module design**
Top-in, Top-out arrangement provides optimum compactness of module design
Top-in, bottom-out arrangement permits handling of high liquid and particulate entrainment

Gas Handling

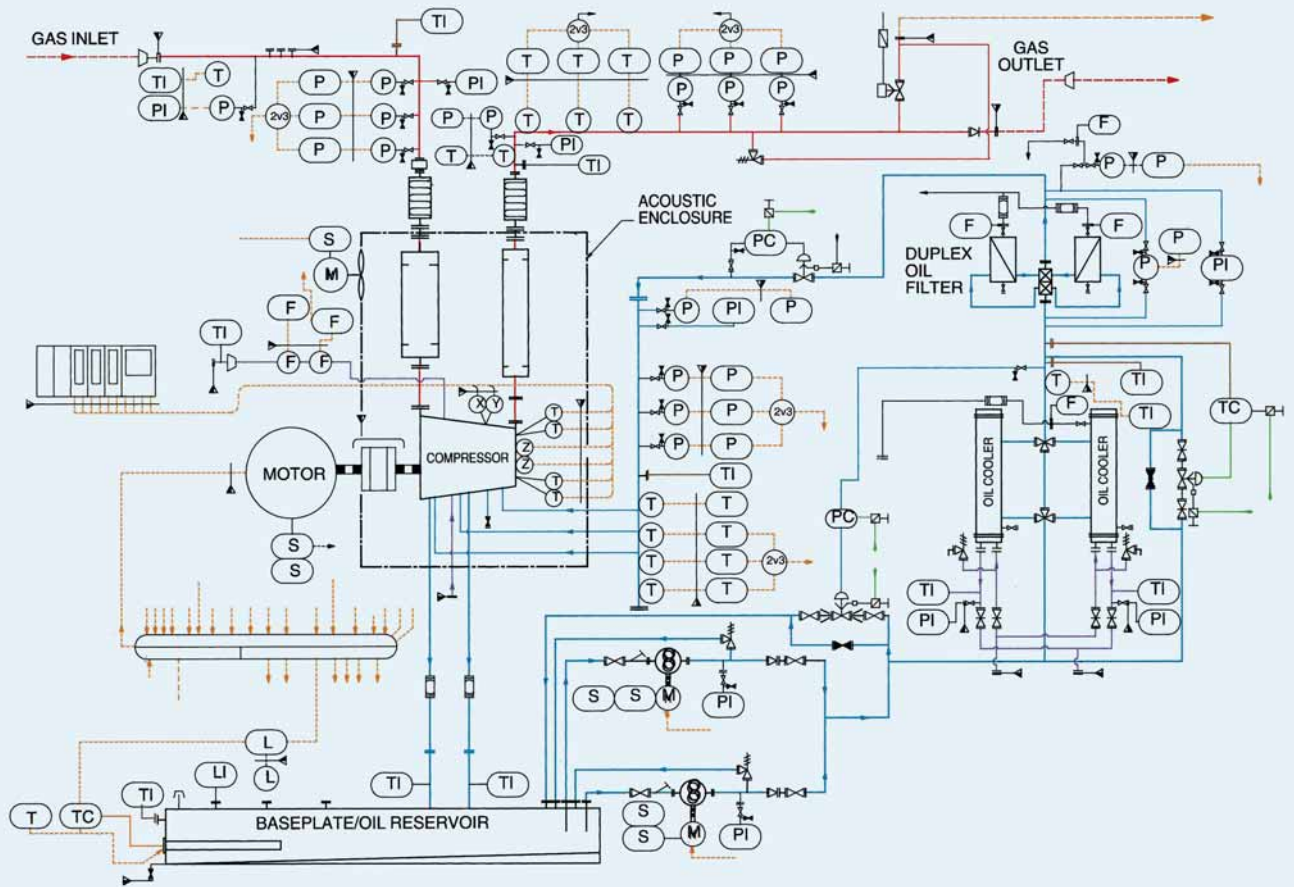
Typical gases handled by the Howden range of oil free compressors include, but are not limited to, the following:

- | | | | |
|---------------------|----------------------------|---------------------|----------------------|
| • Acetylene | • Coke Oven Gas | • Sour Hydrocarbons | • Visbreaker Off Gas |
| • Ammonia | • Cracked Gas | • Natural Gas | • Tail Gas |
| • Blast Furnace Gas | • Ethane | • Nitrogen | • Town Gas |
| • Butadiene | • Ethylene | • Propylene | • Vapour Recovery |
| • Butane | • Flare Gas | • Propane | • VCM Strip Gas |
| • Carbon Dioxide | • Hydrogen | • Styrene Vent Gas | |
| • Carbon Monoxide | • Lime Kiln Gas (Soda Ash) | • Sour Gas | |
| • Chlorine | | • Steam | |



Oil free compressor horizontal section .

An oil free package can be single or multistage configuration with optimal driver arrangement for best efficiency to suit your process requirements.



Typical piping and instrumentation diagram

Features

Designed to applicable API standards

Positive displacement compression

Compressor designed with sleeve journal and tilt pad thrust bearings

Suitable for different configurations of compression seal system

Compact size and weight

Rotary action compression

Water/solvent injection system available

Flexibility of discharge orientation

Benefits

- Full compliance with oil & gas industry requirements

- No surging effect on gas stream

- Operational longevity and availability

- Process flexibility

- Low installation costs

- Vibration & Pulsation free running
 Very high levels of ARM (Availability Reliability & Maintainability)
 Maximum on line availability
 Minimal servicing requirement

- Suitable for extreme process duties for cleaning/discharge temperature control

- Space / cost effective systems



Acoustic Enclosure to satisfy customer specifications.



VCM recycle gas compressor with hazardous area control panel for petrochemical industry.

Oil injected screw compressor systems

Oil injected twin screw compressors are used for process gas applications involving hydrocarbons, fuel, or other specialist applications as well as chilling and process refrigeration.



Typical applications

- Fuel Gas Compression
- Gas Liquefaction
- Petrochemical and Chemical Processing
- Natural Gas Gathering
- Carbon Dioxide Recovery
- Coke Oven Gas
- Vapour Recovery
- Offshore Flare Gas (V.O.C)
- Hydrocarbon Processing
- Process Refrigeration
- Flare Gas Recovery
- Mine Cooling

LP gas booster compressor on hydrocarbon service on BP Amoco Schiehallion FPSO

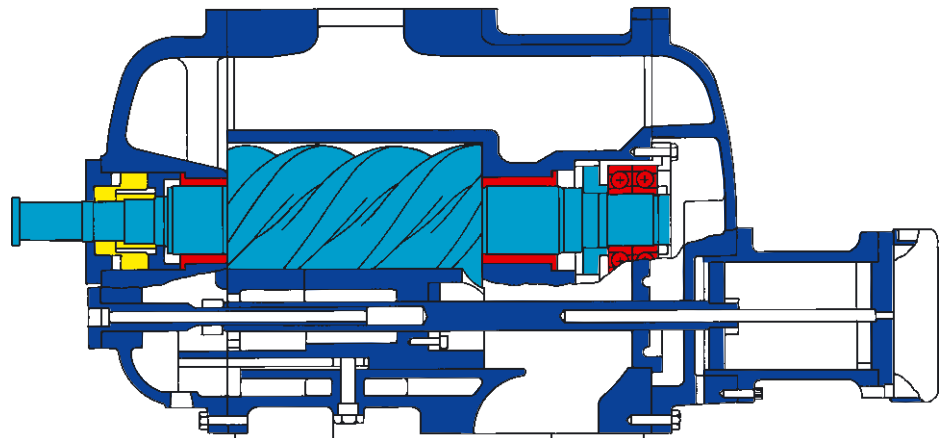
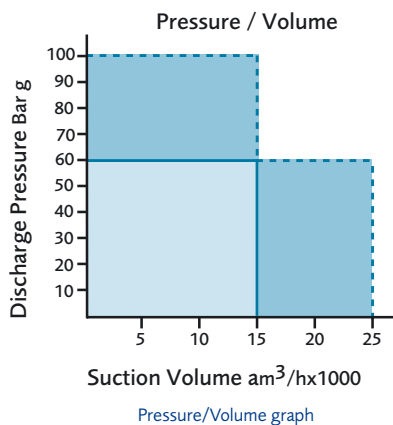
Unique features and benefits of oil injected design

- Stepless capacity control with power savings
- Capacity and energy absorbed match system demand
- Variable Volume Ratio available
- Maximises energy efficiency
- Can take side stream above suction pressure
- Reduced through life costs

Gas Handling

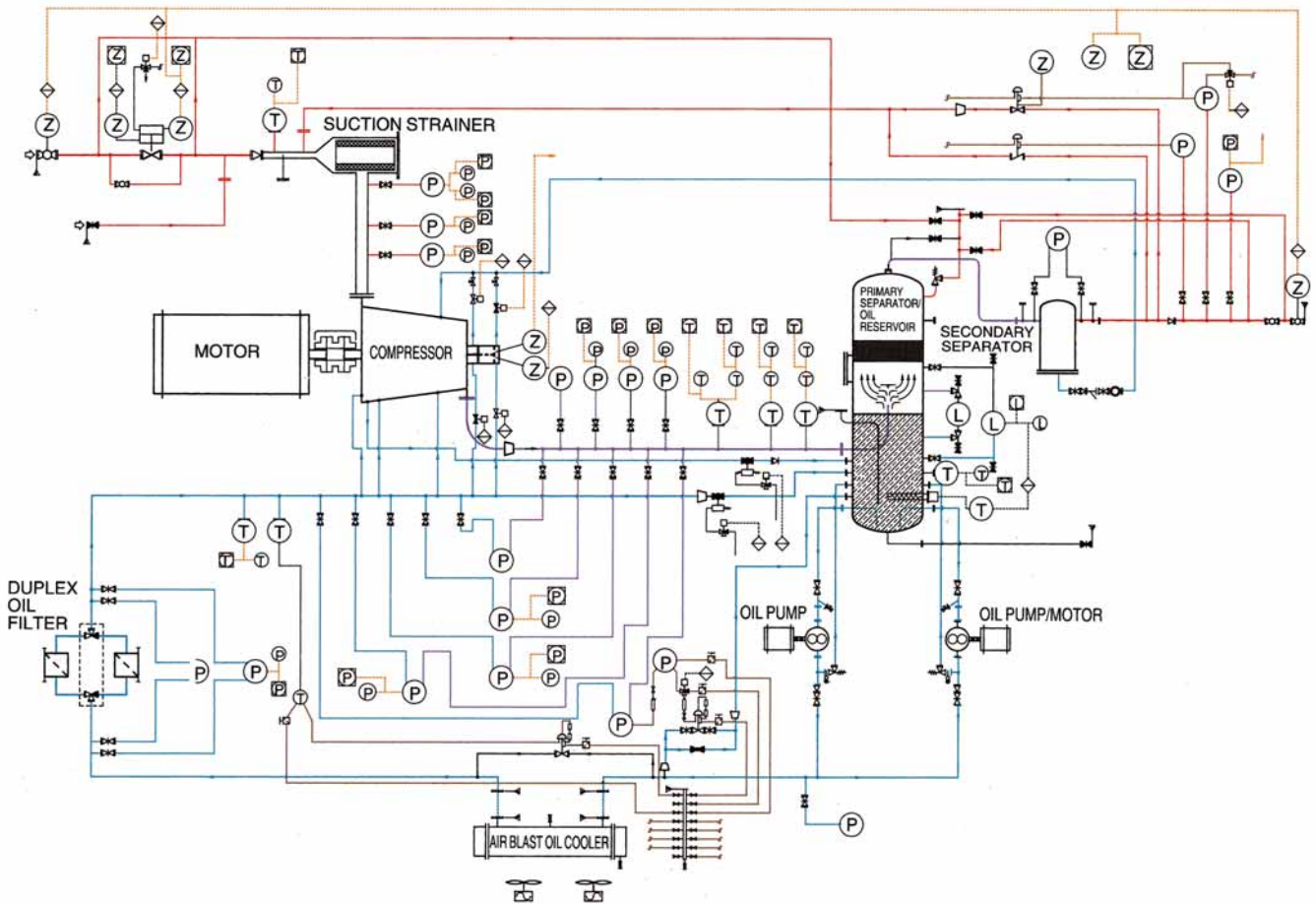
Typical gases handled by the Howden range of oil free compressors include, but are not limited to, the following:

- Ammonia
- Butane
- Coke Oven Gas
- Flare Gas
- Fuel Gas
- Helium
- Hydrocarbon mixtures
- Hydrogen
- Methane
- Natural Gas
- Nitrogen
- Propane
- Propylene
- Refrigerant Gases
- Sour Gas
- Town Gas



Oil injected compressor vertical section

An oil injected screw compressor package gives the following additional features and benefits.



Typical piping and instrumentation diagram.

Features

- Effective gas handling

- Integral capacity control system 100% - 10%

- Enhanced oil separation system

- Minimised acoustic signature (synchronous speed, oil injection). Pipework acoustic suppression

- Designed for direct drive (no gearbox/L.O. system)

- Single and dual shaft seal systems

- Single/dual loop controls

- Oil injection to compression space

- Single casing tandem, two stage systems available

Benefits

- Variations in gas composition and MW accommodated. Capable of handling wet and sour gases
- Tolerant to liquid slugs

- Energy efficient
- Proportional power saving

- Delivery of low oil content gas

- Simplified noise attenuation procedures

- Cost savings
- Ease of maintenance
- Less power
- Reliability
- Simple mechanical configuration

- High sealing integrity

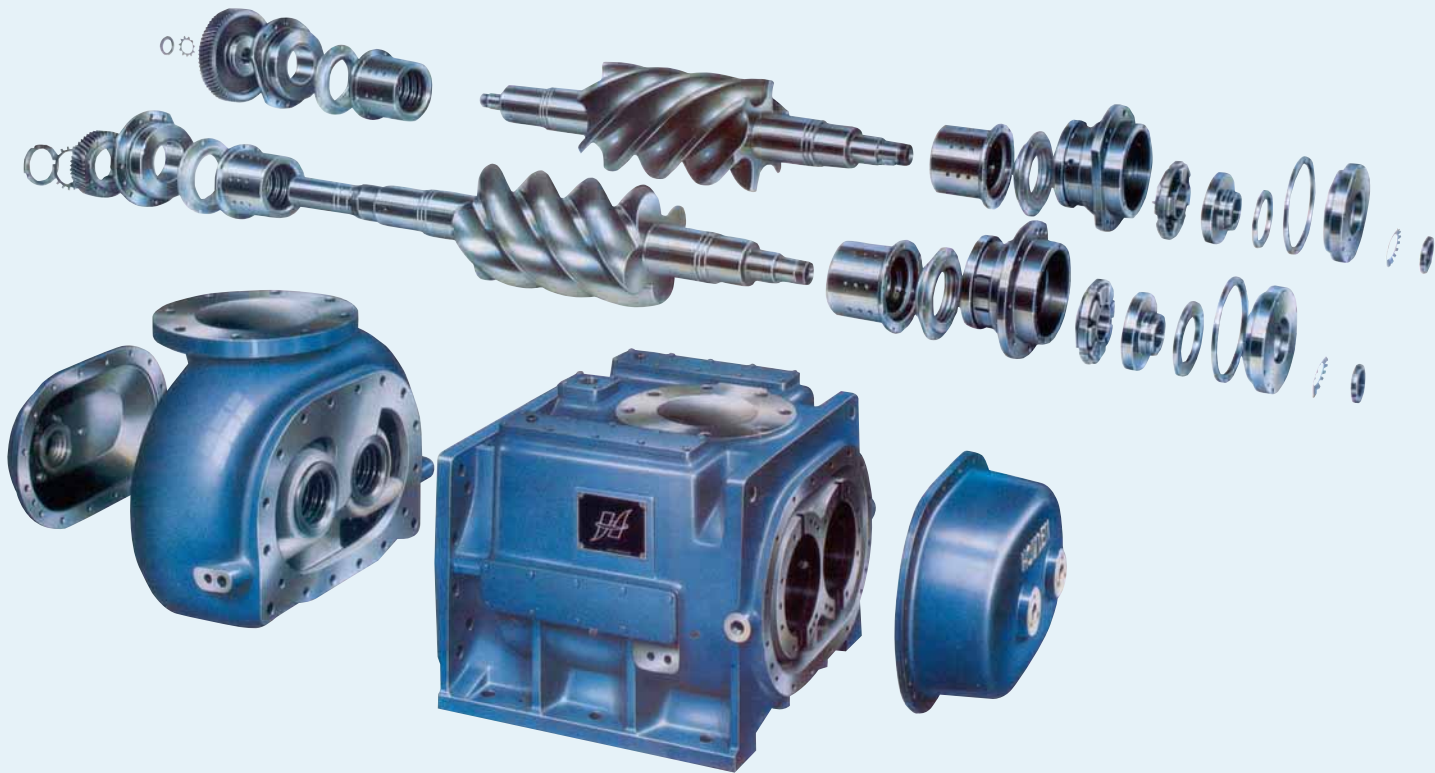
- Flexible process control system interface (PLC and relay logic)

- High compression ratios per stage
- Discharge temperature control avoiding dew point problems
- Compact size with low absorbed power



Final inspection prior to shipment

Screw compressor design



Oil free compressor

Screw compressor systems have gained acceptance and significant growth within the process industries, due to their technical innovation, robustness, compactness and reliability. Designed for long periods of continuous operation, offering online availability of up to 98%. The low cost maintenance associated with screw compressors together with their energy efficiency, ensures economic running costs. The smooth running action of the rotors enables the compressors to handle the most difficult gases, contaminants, or water slugs with vibration free operation. Compressor materials are matched to the particular gas requirements or other operating parameters.

Seal arrangement options

Various seal configurations can be offered according to the gas being handled, giving secure gas tight operation.

On oil free compressors, options of simple restrictor rings, labyrinth seals, water seals, mechanical seals and combinations of these are available to suit the application. Each arrangement can be supplied with inert or process gas buffering as appropriate.

Oil injected compressors are fitted with a single balanced mechanical seal (Wetted Type) as standard. For some applications an additional outboard secondary containment seal (Dry Running Type) or a tandem balanced mechanical seal arrangement (with API seal plan and pressurised seal system to meet specific conditions) can be offered.

Bearing options

Oil free units have sleeve journal and tilting pad thrust bearings.

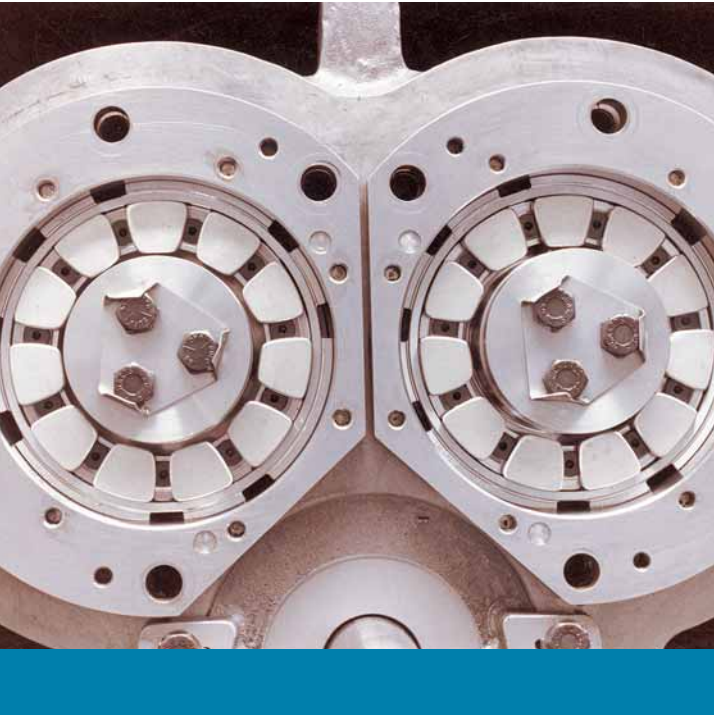
Oil injected compressors have sleeve journal bearings and may either have tilting pad or angular contact anti-friction thrust bearings.

Bearings can be copper free where necessary e.g. on ammonia service.

Rotor options

Oil free and oil injected compressors are available in a wide range of rotor lengths and diameters for optimal selection. Asymmetric profiles and different combinations of male/female rotor lobe/flute numbers result in high efficiency.

Brief comparison between screw, reciprocating and centrifugal compressor types



Tilting pad thrust bearings on an oil injected compressor
(Courtesy of Howden Compressors Ltd).

Availability, reliability

The screw compressor can demonstrate equivalent performance in these areas to a centrifugal compressor and is used in critical applications unspared. The reciprocating compressor, with many moving parts, suffers an inherently greater downtime, spares usage and through life costs.

Low molecular weight gases

These can be handled without problem with a rotary screw compressor. A centrifugal unit will require multiple stages.

Variations in gas characteristics

The screw compressor, being a positive displacement compressor, is unaffected by changes in gas molecular weight. Such variations may cause unstable operation in a centrifugal compressor, which is extremely sensitive to changes in gas density.

Valves

The rotary screw compressor does not require suction/discharge valves which are high maintenance items in a reciprocating compressor.

Drive train configuration

The oil injected compressor is normally direct coupled to its electric motor driver at two or four pole speed, thus obviating the need for a speed increasing gearbox.

Foundations

Unlike a reciprocating compressor, the screw compressor does not generate out of balance forces, thus significantly reducing foundation requirements.

Capacity control

As the screw compressor is positive displacement design, flow is directly proportional to speed. The oil free screw compressor may, therefore, be controlled by means of a bypass or speed control. Speed control can be used to vary throughput at constant suction and discharge pressures.

The oil injected screw compressor, with its integral slide valve, gives variation in throughput between 100% - 10%, with proportional savings in absorbed power, allowing it to closely follow changing process condition. As the centrifugal compressor depends on rotational speed to generate head, a reduction in capacity by speed regulation will reduce discharge pressure.

Pulsation free compression

Due to its rotary operation, the screw compressor gives pulsation free delivery.

Liquid handling

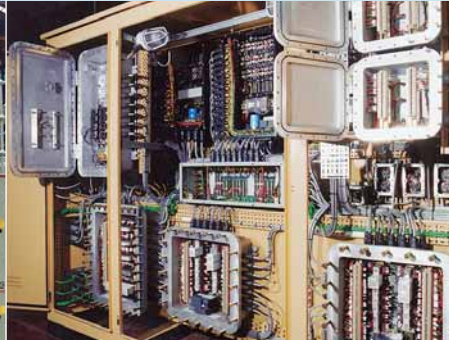
The oil free screw compressor can handle liquid in the gas stream without damage. In some cases liquid injection is needed for process reasons. For butadiene compression, water or a solvent is injected to control discharge temperature to prevent polymerisation. Free liquid to the suction of a reciprocating compressor may cause catastrophic failure.

System design features

The compressor safe area panel for BP Amoco FPSO Schiehallion.



Explosion proof enclosure containing relay logic, refinery, USA.



Fuel gas compressor for Boots pharmaceutical site, UK.



Electrical & Instrumentation

Full consideration is given to all safety requirements including explosion proofing, purging and/or intrinsically safe circuitry, to suit the applicable area classification.

Sets are fully protected with instrumentation for pressure, temperature, oil level, flow or vibration as appropriate. Control can be local or in a safe area. Local and remote area panels can be provided, either relay or PLC based.

Condition monitoring

Howden use leading condition monitoring systems to provide continuous information on the important parameters of the complete drive train during operation.

The screw compressor is a robust stiff shaft machine, and can be inexpensively monitored for vibration by means of 'X' and 'Y' casing mounted accelerometers and 'Z' axial proximity probes. On some

compressor frames "X" and "Y" shaft proximity probes are available. Temperature monitoring of journal and tilting pad thrust bearings can be offered.

Lubrication system

Oil supply systems are provided to meet customer specification and site conditions. These are commonly required to supply combined lubrication and seal oil to the compressor module and may be integral with the module or as a separate console arrangement.

As well as meeting any customer specifications the oil supply system is normally designed to API 614. Exacting international standards are adhered to in the selection of pumps, coolers, filters and valves as well as in the choice of component materials.

Noise treatment

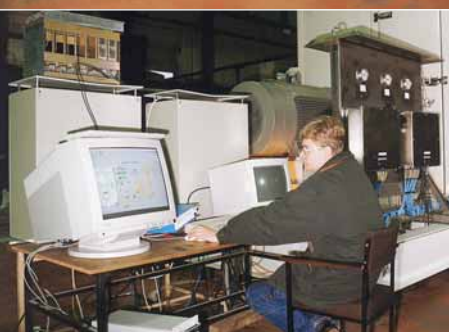
Oil free compressor packages are fully equipped with absorption silencers on suction, discharge and any blow-off lines. Customer requirements relating to noise specifications are used as a basis for design of any supplementary noise treatment enclosures. Where exceptionally low noise levels are required, due to special environmental conditions, acoustic enclosures are available. These enclosures may be supplied with fire / gas detection devices and fire suppression systems.

Safety

In all Howden designs great care is taken to ensure the safety of the operators, the integrity of the package and the prevention of harmful emissions to the environment. Full Hazop studies can be implemented as appropriate.



Oil injected set complete with acoustic treatment.



Factory string test using client's PLC central control system. (DISCOS)



Intelligent 3D package design software.



API614 lube system

Quality

The commitment to quality throughout the organisation is proven by the continued successful accreditation of our Quality Assurance System to ISO 9001, with ongoing audits ensuring continued compliance with the necessary control procedures. Quality Plans are prepared for each contract along with certification as required both by technical requirements and national legislation.

Testing

Prior to package assembly, all compressors are tested on dedicated test beds, to Howden standard or PTC9 test procedures, with witness testing available to customers.

To ensure the design integrity of the fully assembled package, customers have the option of specifying a string test at our Renfrew facility.

After-sales

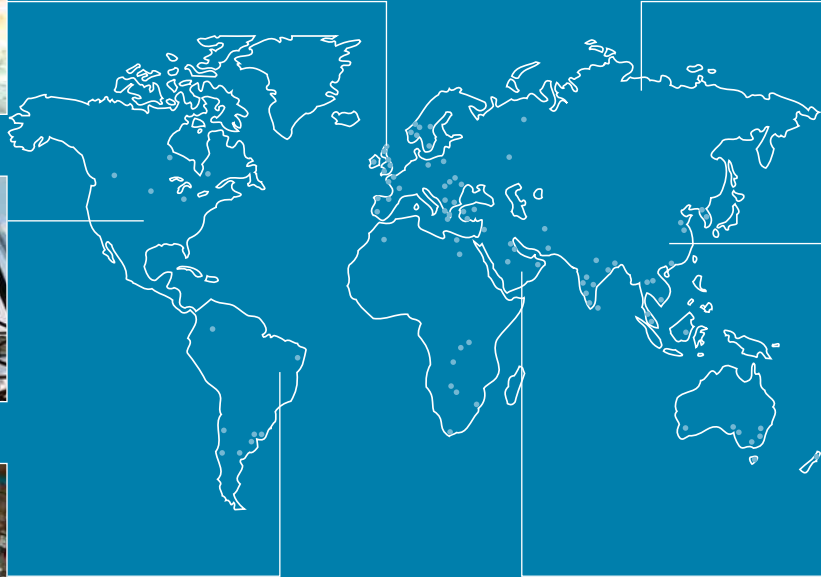
A comprehensive worldwide after-sales service is offered by the Customer Support Division. A team of field service specialists is available to assist with installation, commissioning, on-site inspection and repairs. In-house and on-site training for process operators can be provided.

Plant modification back-up is available as required to suit the revised operating parameters, including total plant removal and re-installation to an alternative location.

To minimise down-time on-site, spares support and service engineers have 24 hour availability worldwide. Long term maintenance contracts are available.

Email: hpc.aftersales@howden.com

Worldwide installations



Head office and Main Plant
Old Govan Road
Renfrew PA 4 8XJ
United Kingdom
Telephone: 44 (0) 141 304 3500
Facsimile: 44 (0) 141 304 3600
Email: hpc.sales@howden.com
Email: hpc.aftersales@howden.com



visit www.howdenprocesscompressors.com

Member of Howden Industrial Group
www.howdenindustrial.com