

# Oil-Free Process-Gas Screw Compressors

Engineering the Future – since 1758.

**MAN Diesel & Turbo**



# Performance Characteristics



Designed for suction volume flows from 200 up to 100,000 m<sup>3</sup>/h, suction pressures down to 0.1 bar and discharge pressures reaching above 50 bar, the robust process-gas screw compressors offered by MAN Diesel & Turbo can handle highly contaminated gases and gas mixtures that could shorten the availability and life expectancy of other types of compressors.

## High operational reliability

The operational reliability of MAN Diesel & Turbo process-gas screw compressors is based on more than 50 years of experience in screw compressor design, and this in turn is supported by 100 years experience of building a wide range of turbomachinery. Many MAN Diesel & Turbo process-gas screw compressor units have proven high availability factors over more than 100,000 hours of trouble-free operation in continuous refinery service.

## Quality

Intensive R & D efforts, the use of the most advanced manufacturing and test facilities, exchange of experience with plant users, close cooperation with leading

research institutes, as well as our collaboration with international standards organisations (i.e. API 619 committee, ISO, etc.) guarantee both high technical standards and cost-efficiency.

## Adaptability

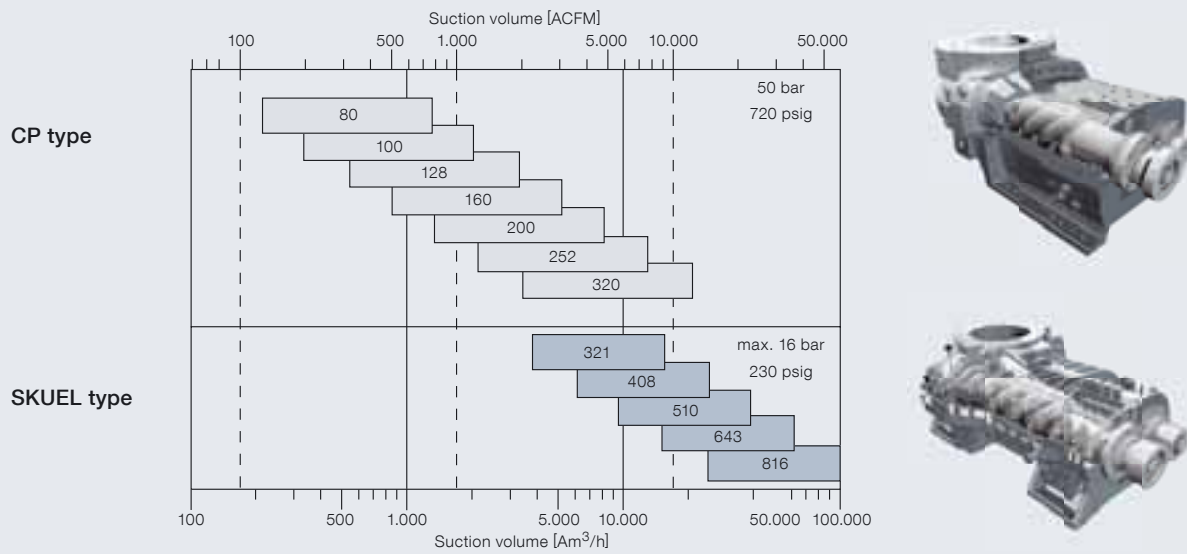
The adaptability of MAN Diesel & Turbo process-gas screw compressors is enhanced by a well-conceived modular design system and field proven features. Extensive calculation programs are available for thermodynamic and mechanical design, which together with state-of-the-art CAD programs for design, engineering and manufacturing ensure that all customer requirements are considered in the most efficient, customized way.

## Application potential

MAN Diesel & Turbo process-gas screw compressors have been successfully applied to almost all branches of industry and many different processes. These include mining, iron and steel mills, chemical works, the petrochemical industry, refineries and oilfields. For virtually every application, the screw compressor can be adjusted to the particular requirements of the process for all kinds of gases and gas mixtures. As a positive displacement compressor, the screw compressor is ideal for the compression of light gases, and wide fluctuations in the gas composition do not influence screw compressor performance. Relatively low tip speeds allow the compression of dust laden gases, as well as the injection of liquids into the compression chamber for cooling or washing.

MAN Diesel & Turbo process-gas screw compressors are designed in accordance to API 619 and are based on a modular design system with 10 different rotor diameters. Designed as single or multi-stage units, they can be driven by electric motors or steam turbines.

# Product Features



Compared to other compressor types employed in process-gas applications the process-gas screw compressor has the following advantages:

- Handles gases containing dust or liquid droplets
- Changes in gas composition, molecular weight, and/or pressure ratio have nearly no impact on actual gas flow rate
- Suitable for liquid injection, for cooling or washing
- Operates below the first lateral critical speed
- No surging
- Excellent part load behaviour with speed control (~ 50% flow and 50% power at 50% speed)
- No lubricant contact with process gas
- No wearing parts, which require regular maintenance
- No oscillating masses and therefore low cost basis
- High availability up to 99%
- Designed for a minimum service life of 20 years and 3 years uninterrupted operation.

## Selection diagram

The selection diagram shows the CP and SKUEL compressor types and their size as a function of suction flow. Depending on the type of gas compressed, pressure ratios between approx. 1.3 and 6 can be handled in a single-stage, multi-stage arrangements or liquid injection, however, allow even higher pressure ratios.

## CP type for high pressures

With 7 different rotor diameters the CP series has 3 different length/diameter ratios, giving suction flow rates from 200  $\text{m}^3/\text{h}$  up to 20,000  $\text{m}^3/\text{h}$ . The vertically-split casing construction allows discharge pressures in excess of 50 bar.

## SKUEL type for high flows

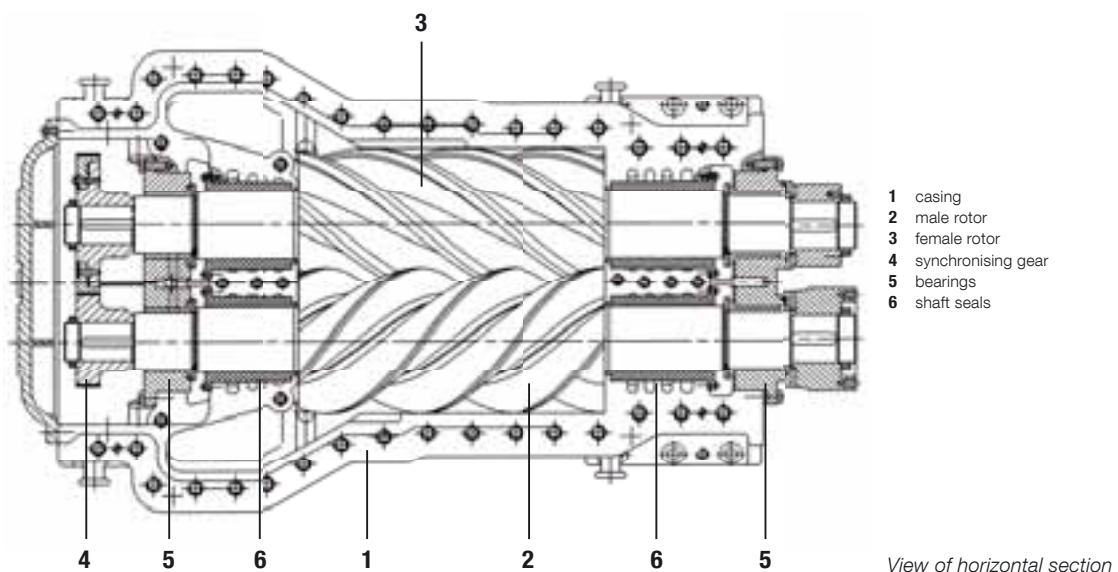
The SKUEL series has 5 different rotor diameters each with 2 different length/diameter ratios, with suction flow rates from 4,000  $\text{m}^3/\text{h}$  up to 100,000  $\text{m}^3/\text{h}$  and discharge pressures of up to 16 bar.

# The MAN Diesel & Turbo Modular System



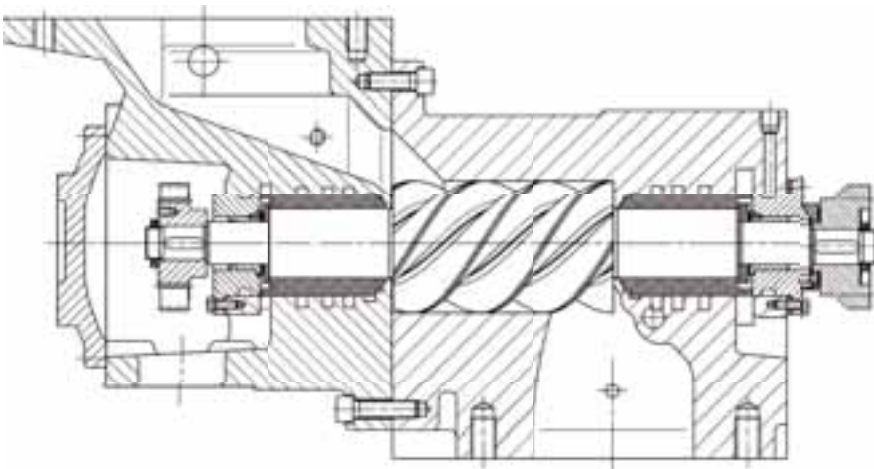
The modular design system is employed for all key process-gas screw compressor components such as the rotor profile, shafts, bearings and seals. These enables MAN Diesel & Turbo to design the compressor according to specific customer requirements and process needs, while retaining its optimum design characteristics.

## Process-gas screw compressor, SKUEL type





Process-gas screw compressor, CP type



*CP view of vertical section*

# Components



*Manufacturing a compressor casing*

## **Casing**

Only cast casings are used for MAN Diesel & Turbo process-gas screw compressors. The bearing housings are an integral part of the compressor casing. The standard nozzle arrangement with suction at the top and discharge at the bottom allows liquid injection due to the free draining arrangement. Single wall construction is used to avoid the use of cooling jackets.

Depending on the type of gas to be compressed, casings can be supplied in nodular cast iron, cast carbon steel or cast stainless steel.

## **Rotors**

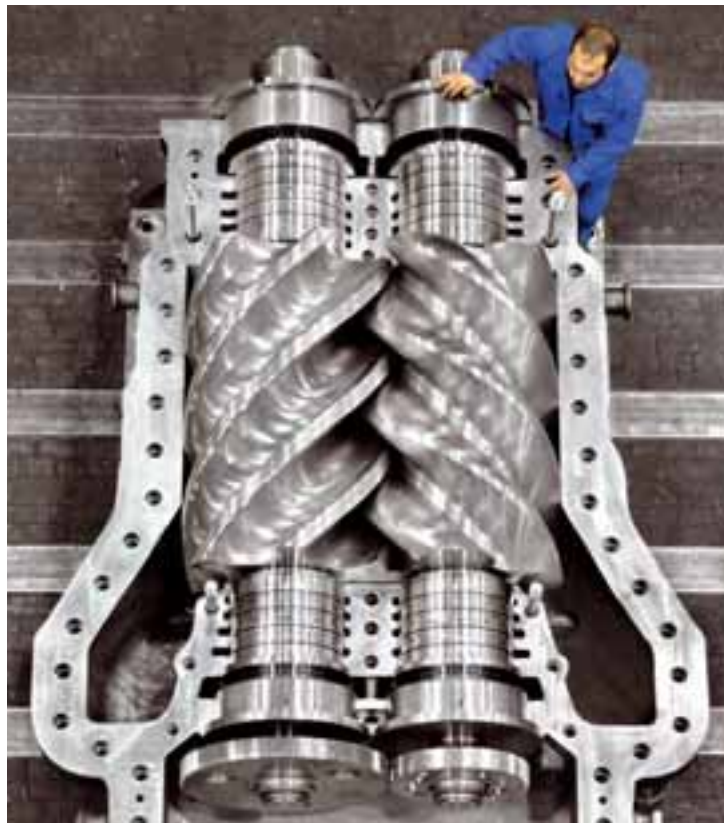
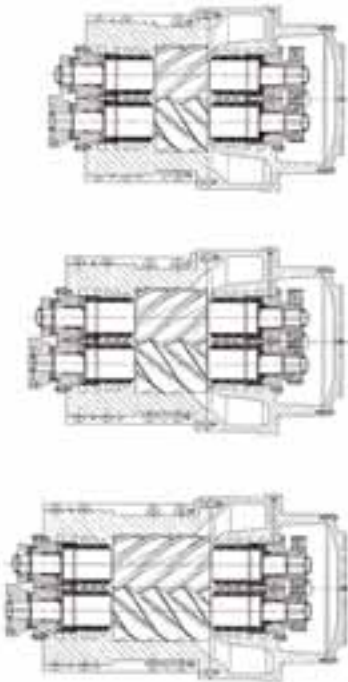
All MAN Diesel & Turbo process-gas screw compressors are equipped with single piece forged rotors with an asymmetric rotor profile, to assure the highest efficiency when handling a wide variety of gases and gas mixtures. No internal rotor cooling is required due to advanced design and manufacturing methods. The synchronized gear, located at the non-driven end of the rotor pair, assures contact-free operation of the rotors whilst maintaining their small clearances.

A variety of rotor materials from carbon to stainless steel is available to resist any corrosive and/or erosive components within the gas mixture.



*Smallest and largest screw compressor rotors made by MAN Diesel & Turbo*

*CP type variation of L/D*



*SKUEL type 816 during assembly*



*Combined journal and thrust bearings of male and female rotor*

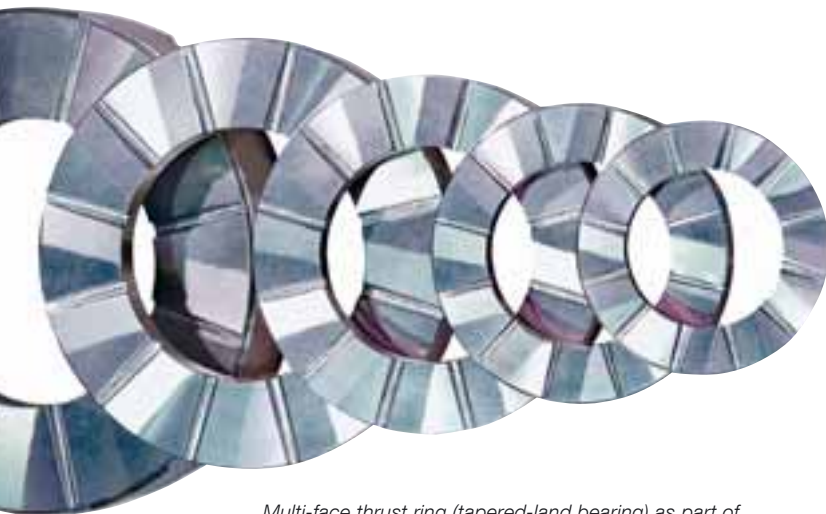
### **Bearings**

Because of high rotational speeds and bearing loads, process-gas screw compressors are equipped with hydrodynamic journal bearings and tapered land thrust bearings. Forced feed lubrication of these bearings provides an unlimited life-time. Tilting pad thrust bearings can be provided, if specially required.

### **Shaft seals**

The compression chamber of the process-gas screw compressor is separated from the atmosphere by shaft seals; these are installed at each end of the compressor rotor shaft.

To adapt the process-gas screw compressor to different applications a wide variety of shaft sealing systems are available. Divided into dry and liquid sealing systems, the examples show the most commonly used shaft sealing arrangements. For specific processes a number of other options have been developed.



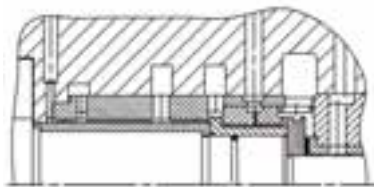
*Multi-face thrust ring (tapered-land bearing) as part of MAN Diesel & Turbo modular system*



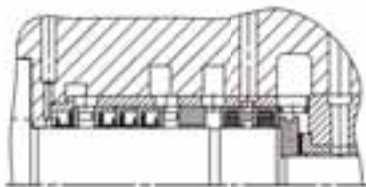
**Possible shaft sealing systems**

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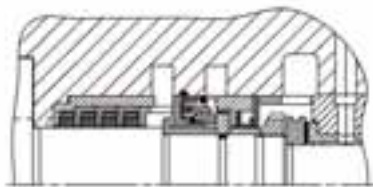
**Liquid systems**



Labyrinth



Floating rings

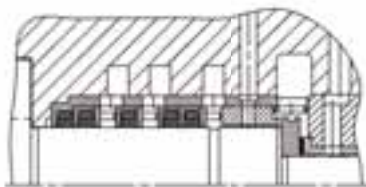


Mechanical contact seal

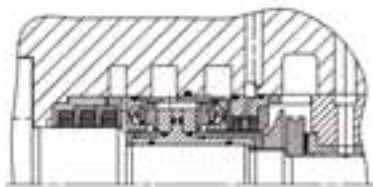
**Dry systems**



Carbon rings



Carbon rings



Dry gas seal

# Single and Multi Stage Process-Gas Screw Compressor Units



3D computer model

Single stage units are best suited for pressure ratios of up to 6. For pressure ratios exceeding the limits of a single stage compressor, units can be built with 2 or 3 stages, which are usually driven through a common gearbox. Any combination of SKUEL and CP compressor types can be arranged into a multi stage unit.

## Package design

Each process-gas screw compressor unit is tailor-made to meet the requirements of a specific application. State-of-the-art 3D design programs are used to optimize the overall compressor arrangement.

## Control and safety equipment

The quality and flexibility demands are steadily increasing on the control and protection system of modern process-gas screw compressor units. Individually designed control systems are provided to comply with the requirements of the process and provide all functions from start-up to emergency shutdown.

## Oil supply systems

Process-gas screw compressor units are equipped with oil supply systems designed by MAN Diesel & Turbo. Normally oil systems are integrated into the compressor package, however separate consoles in accordance to API Standard 614 or specific customer specifications can be provided if required.

## Acoustic treatment

Special attention must be paid to the acoustic treatment of a screw compressor unit. To fulfil environmental regulations, MAN Diesel & Turbo process-gas screw compressor units are equipped with specially designed noise protection equipment, i. e. silencer systems in the connecting pipework, noise enclosures, etc.

## Gear box

The speed increasing gear box, used for single or multi stage compressor designs, is designed by MAN Diesel & Turbo in accordance with the relevant international standards, i. e. AGMA, API 613, etc.



*2-stage process-gas screw compressor unit with a wing pinion speed increasing gear allowing the speed of each compressor stage to be optimized*



*View of a process-gas screw compressor module for an offshore application*



*Typical control panel for a MAN Diesel & Turbo process-gas screw compressor unit*



*Acoustic enclosure of a process-gas screw compressor unit*



*Separate oil supply console designed according to API 614*



*View inside a gearbox*

# Selected References



## Oil and gas production

- CP200
- 4,000 m<sup>3</sup>/h associated gas
- 5 to 20 bar



## Refinery (flaregas recovery)

- SKUEL321/CP128
- 8,200 m<sup>3</sup>/h flaregas
- 1 to 16 bar



## Butadiene extraction

- SKUEL321 and CP128
- 7,200 and 1,900 m<sup>3</sup>/h butadiene
- 1.2 to 6 bar



## Styrene monomer production

- SKUEL816
- 77,000 m<sup>3</sup>/h
- 0.3 to 1.6 bar



### Hydrogen purification

- SKUEL408
- 14,000 m<sup>3</sup>/h PSA waste gas
- 2.5 to 8 bar

### Power generation (fuelgas)

- 4 x CP100
- 1,000 m<sup>3</sup>/h fuelgas
- 15.3 to 28 bar



### Soda ash production

- 3 x SKUEL408
- 17,400 m<sup>3</sup>/h lime kiln gas
- 0.8 to 4.8 bar

### Steel production

- 2 x SKUEL643/SKUEL408
- 41,000 m<sup>3</sup>/h coke oven gas
- 1 to 11 bar

# Core Competencies and Capabilities



MAN Diesel & Turbo offers one of the most comprehensive turbomachinery product portfolios in the world. Incorporating more than 200 years of technological achievements by distinguished Original Equipment Manufacturers (OEM), we supply state-of-the-art products and services for nearly all industrial processes. Tailor-made solutions by MAN Diesel & Turbo are based on an unique range of compressors and turbines from single machines to total train arrangements.

## Product line

- Compressors (axial, centrifugal, pipeline, gear type, isotherm, process-gas screw)
- Vacuum blowers
- Process-gas expanders
- Gas turbines
- Steam turbines
- turbolog® control and monitoring system
- After sales service

Using large state-of-the-art production sites and test facilities which include a type 1 test stand, MAN Diesel & Turbo provides cost-effective and efficient solutions worldwide.

## Core competencies

- Design and engineering
- Research and development
- Manufacturing
- Testing
- Installation, commissioning and service support
- Quality assurance



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