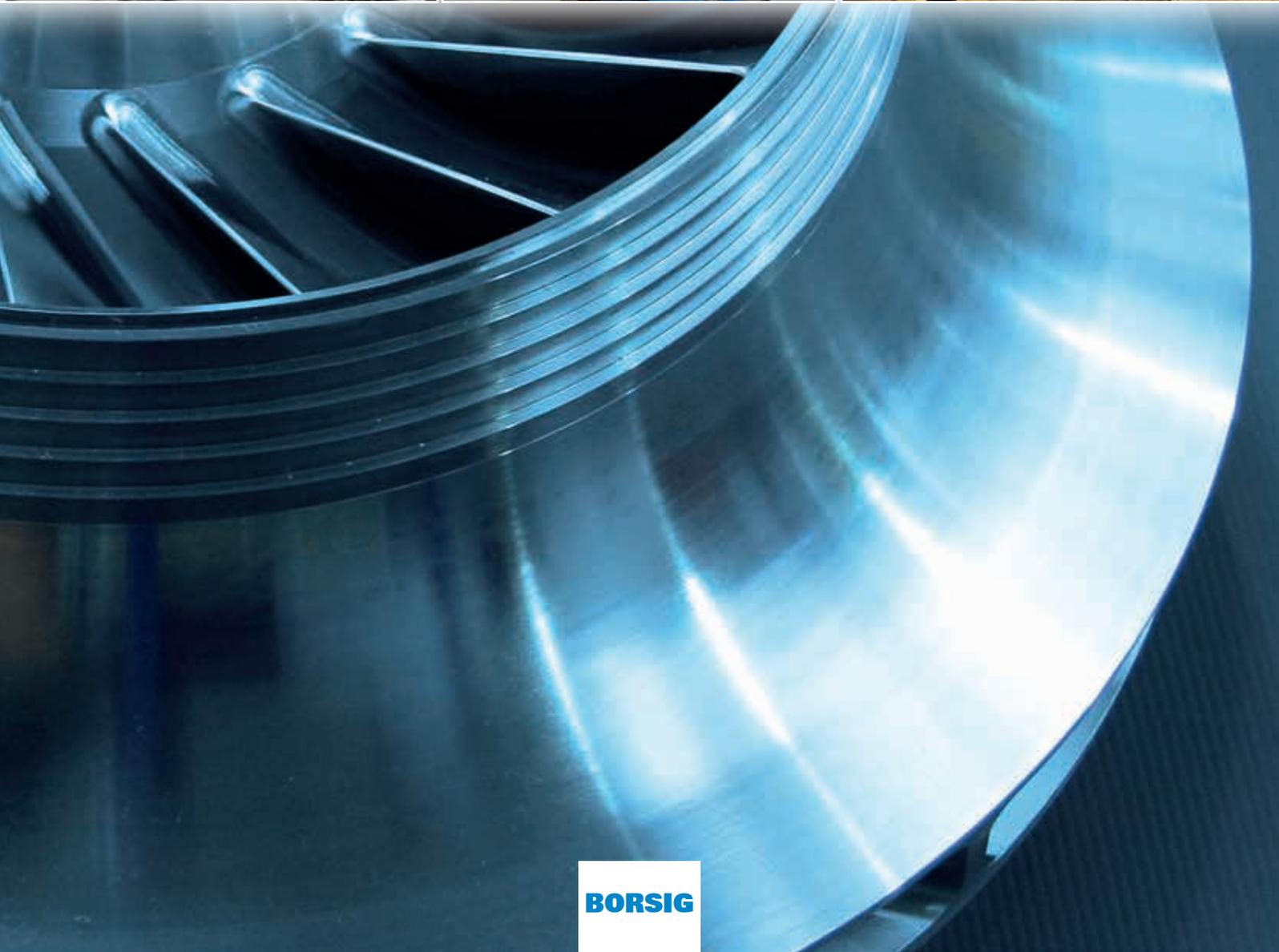




BORSIG ZM
COMPRESSION ZM

**INTEGRALLY GEARED CENTRIFUGAL
COMPRESSORS FOR PROCESS GASES**



BORSIG

About BORSIG ZM Compression GmbH



BORSIG ZM Compression GmbH, a member of the BORSIG Group, offers compressors, compressor units, compressor monitoring systems, compressor valves and a comprehensive compressor service.

The company is situated in Meerane/Saxony, the centre of the economic area of Leipzig, Chemnitz and Zwickau – which is known as native town of the composer Robert Schumann and the beginning of automobile industry in Saxony – in the highly industrialized German State of Saxony and has been developing to a modern and efficient business location in the past few decades.

Our experience is based on more than 175 years of company history. The resulting competence enables us to successfully master all economic, technical and social challenges both today and in the future.

BORSIG ZM Compression GmbH – innovative solutions, state-of-the-art technology, perfectly trained specialists and comprehensive know-how are the basis for our position as a “single source” supplier of leading technology.

BORSIG ZM Compression GmbH – Commitment for Life

Integrally Geared Centrifugal Compressors for Process Gases



BORSIG ZM Compression GmbH manufactures centrifugal compressors for process gases for more than 55 years.

The BORSIG ZM centrifugal compressor series comprises multistage integrally geared compressors which comply with the corresponding API design standards, such as API 617, 672 and 614.

High efficiency thanks to

- speed variation
- cooling between each stage
- inlet guide vane control
- axial flow into blades

Wide scope of applications:

- Chemical and petrochemical plants
- Refineries
- Fuel-gas delivery for gas turbine refinery systems
- Process gases
- CO₂ applications
- Air separation
- Gas storage

Performance Range

BORSIG ZM Compression offers integrally geared centrifugal compressors with up to 8 stages or 4 pinion shafts.

Performance ranges:

Discharge pressure: ... 150 bar
Capacity / flow: ... 300,000 m³/h
Power: ... 25,000 kW

Higher pressure, capacity / flow and power on request

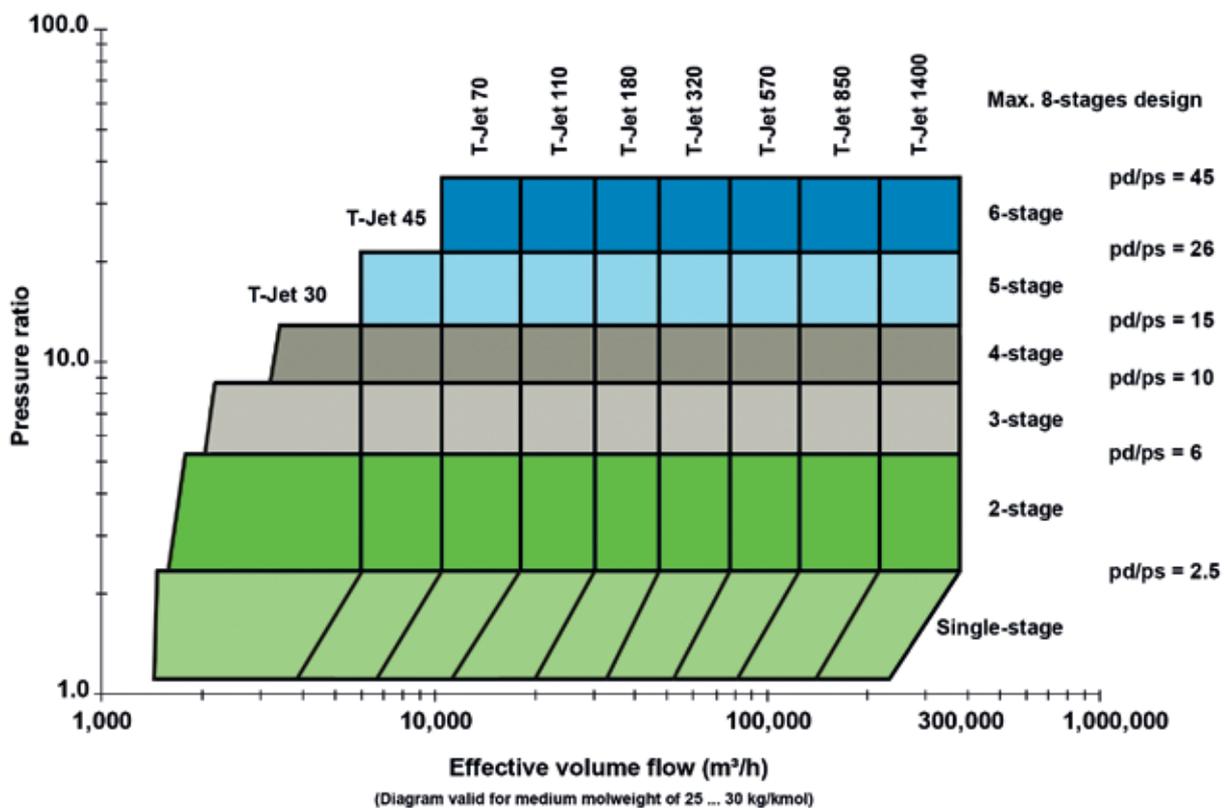


Fig. 2

Fig. 1: Performance range diagram for BORSIG ZM T-Jet series

Fig. 2: Reference for T-Jet 180 with 6 stages

Fig. 1



Impeller

Fig. 1



The impeller is the heart of the centrifugal compressor stage. Impellers with backwards curved blades generate a considerably higher efficiency than impellers with radial blades. The residual kinetic energy (moderate exit velocity) is converted into additional pressure by a long parallel-wall diffuser and a precisely calculated volute channel. This results in high efficiencies.

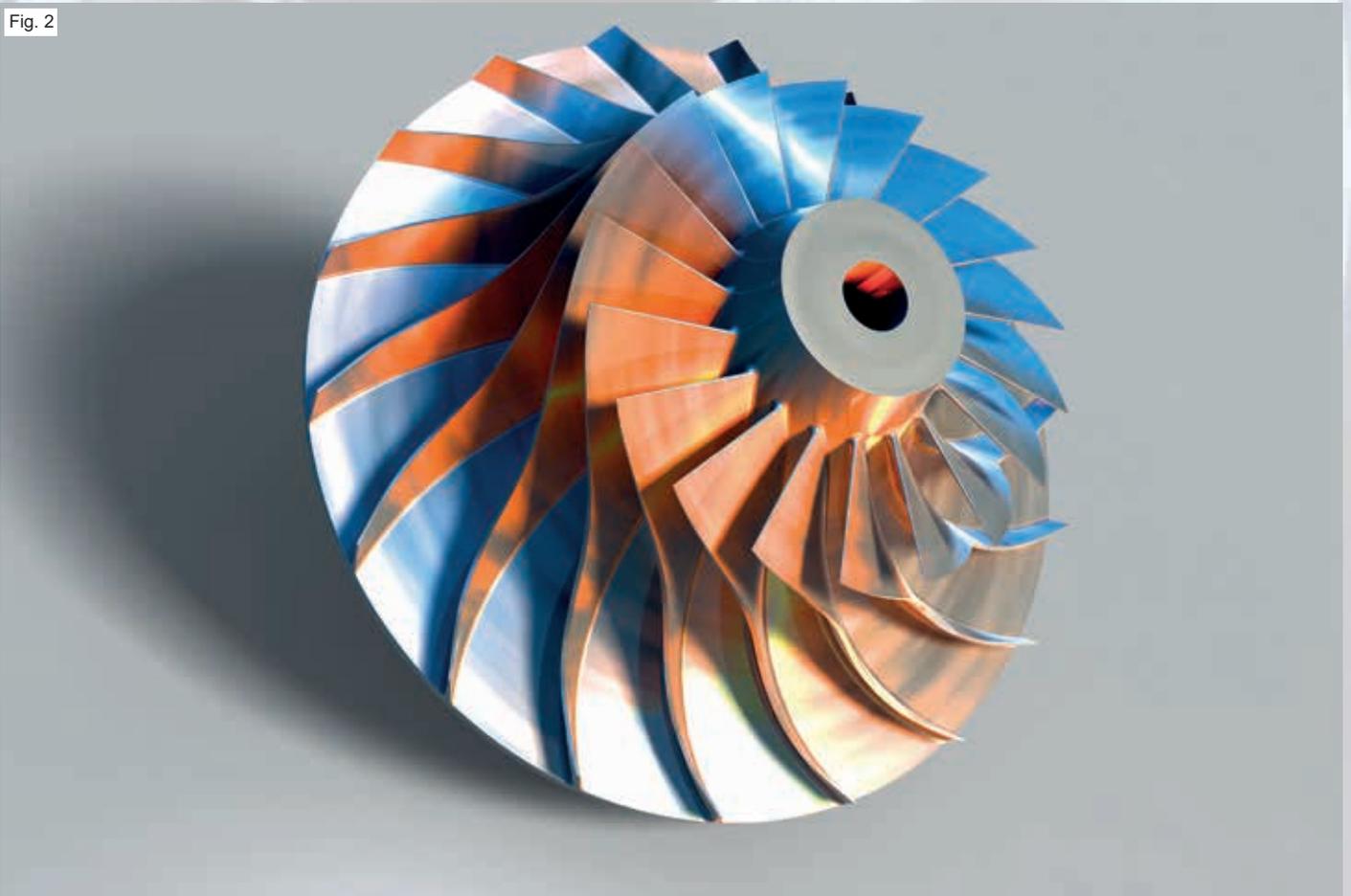
The **BORSIG ZM** impellers are calculated and designed according to the customer-specific requirements and may be open or closed types. The closed impellers are integrally milled from one blank, but may also be manufactured with soldered or welded shroud.

Special materials for the impellers and volutes e.g. stainless steel or titanium, guarantee that the requirements of the process industry will be met.

Fig. 1: Integrally milled closed impeller

Fig. 2: Open impeller with backward swept blades

Fig. 2



Compressor Flow Control Methods

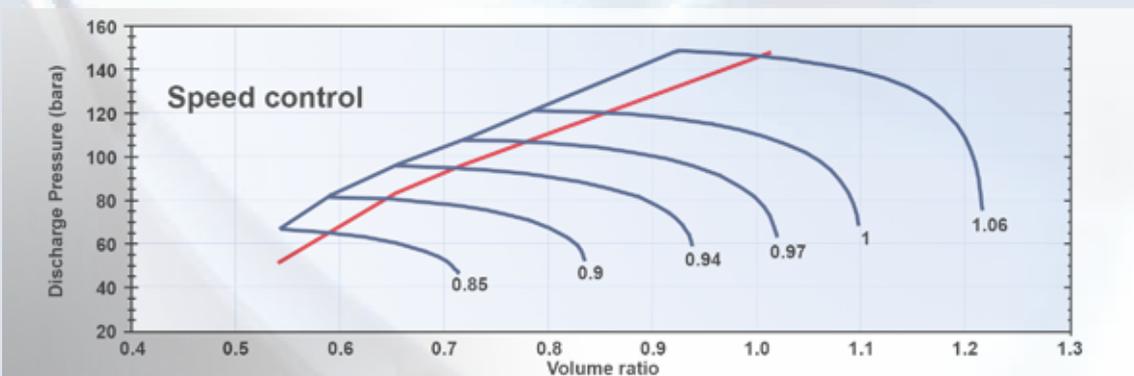
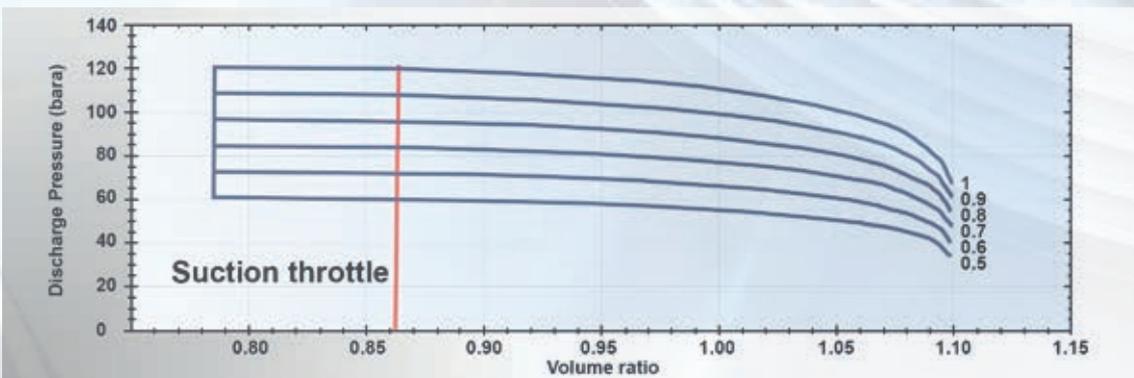
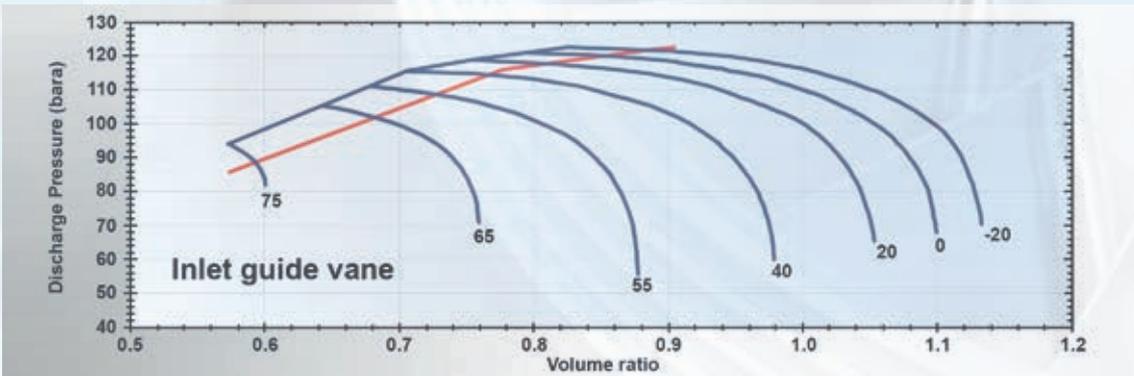
BORSIG ZM Compression offers 3 flow control options for its integrally geared centrifugal compressors:

- Inlet guide vane control
- Suction throttle control
- Motor speed control

The inlet guide vane control achieves the best efficiency when operating at partial load.

	Pressure range	Flow range	Efficiency	Lowest capital investment
Inlet guide vane	++	+++	++++	+++
Suction throttle	+++	+	+	++++
Speed control *)	++(+)	+++(+)	++	+

*) Limitations are possible due to the multi-shaft design of the compressor (number of pinion shafts)



Inlet Guide Vane / Volute Casing

The adjustable inlet guide vane device enables a stepless modification of the volume flow.

The volume flow can be changed in a range from 60% to 115%. By the design of **BORSIG ZM**'s inlet guide vane, an excellent efficiency can be achieved over the complete control range.

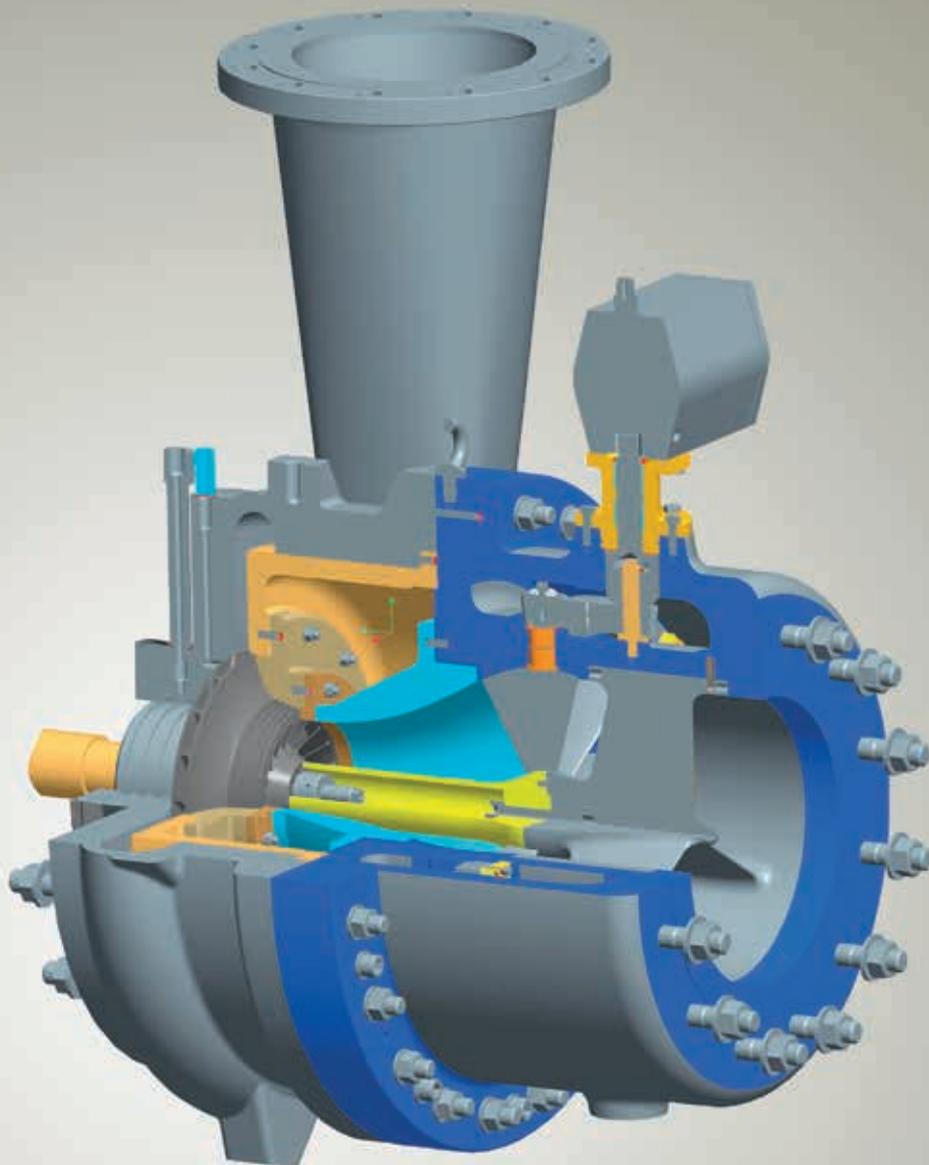
The inlet guide vane is controlled by means of an electrical or pneumatically driven shifting device.

Depending on the process requirements, the volute casing is cast in ductile iron, cast iron or stainless steel. Special materials are possible, too.

It is designed with the newest techniques of aerodynamics in association with CAD-tools and FEM. In accordance with the inlet guide vane and the impeller highest levels of efficiency are reached.

Fig. 1: Compressor stage with inlet guide vane

Fig. 1



Drive / Gearbox

The drive unit of **BORSIG ZM**'s integrally geared centrifugal compressors basically consists of electric motor, coupling and gearbox.

The gearbox is one of the main components of integrally geared compressors. It is designed and manufactured by BORSIG ZM or provided by competent suppliers when required. The impellers of the compressor stages are mounted directly at the high speed shafts which are designed to enable the optimum speed levels for each compressor stage for best efficiency. The gearboxes are designed according to API 613 standard.

The basic design is a helical spur gear with up to 4 pinions. Each pinion drives one or two compressor stages. The bearing of the high speed pinions is effected by tilting pad bearings for radial forces and a thrust collar design for axial forces induced by impeller and tothing. The thrust collar transmits the axial force to the low

speed wheel with journal bearings. So the power losses will be reduced. The bearing at the low speed shaft is effected by journal bearings.

The coupling is full metal flexible type according to API 671 or manufacturer's standard.

Fig. 1: Gearbox for a 2-stage compressor

Fig. 2: Design with 3D CAD system

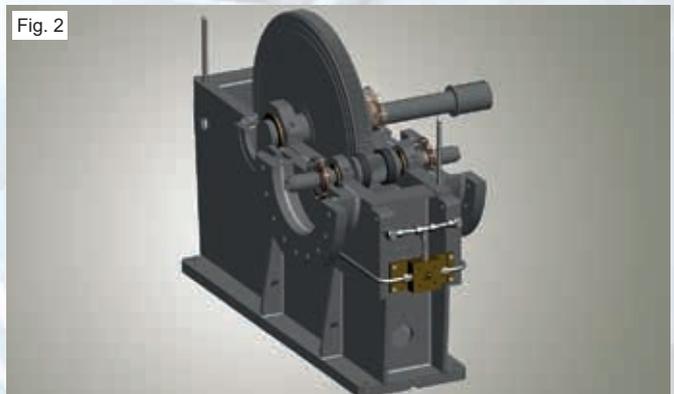


Fig. 1



Oil Supply System

The lube oil console is designed to provide pressurized lubricating oil to the rotating equipment of the gear box and also the main bearings of the driver if necessary. It mainly consists of an oil reservoir, mechanical driven oil pump, electrical driven auxiliary oil pump, oil cooler, double oil filter, safety devices and instrumentation for safe compressor operations. **BORSIG ZM** uses only high-quality and reliable components for its oil supply systems and so achieves a high reliability which may be further increased by means of main components. The design of BORSIG ZM's oil supply systems is according manufacturer's standard or API 614.

Oil supply systems for centrifugal compressors are designed either integrally with the base frame or as an independent free standing system.

An integral oil system is characterized by a compact design of the complete unit and will be delivered completely assembled (fig. 1).

By comparison, the location of an independent system is not predetermined which enables a better integration into existing plants. It may be designed either as unit with all the equipment and piping mounted on the top of the oil reservoir (fig. 2) or with a separate reservoir and equipment mounted on common steel frame for reservoir, piping and equipment (fig. 3).

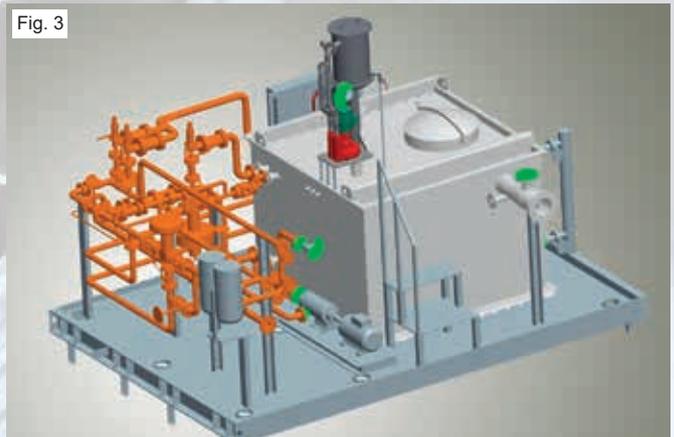
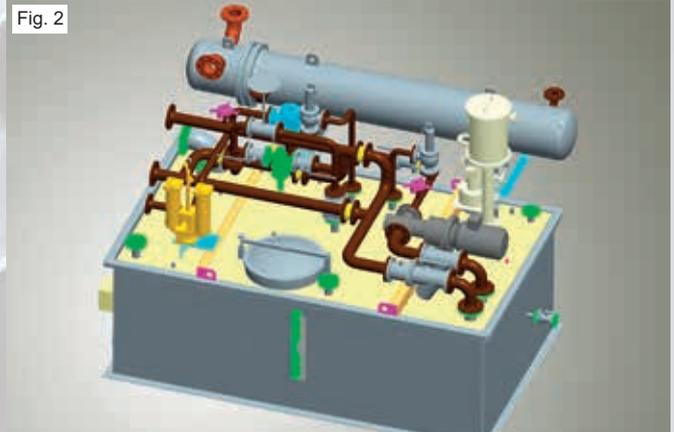
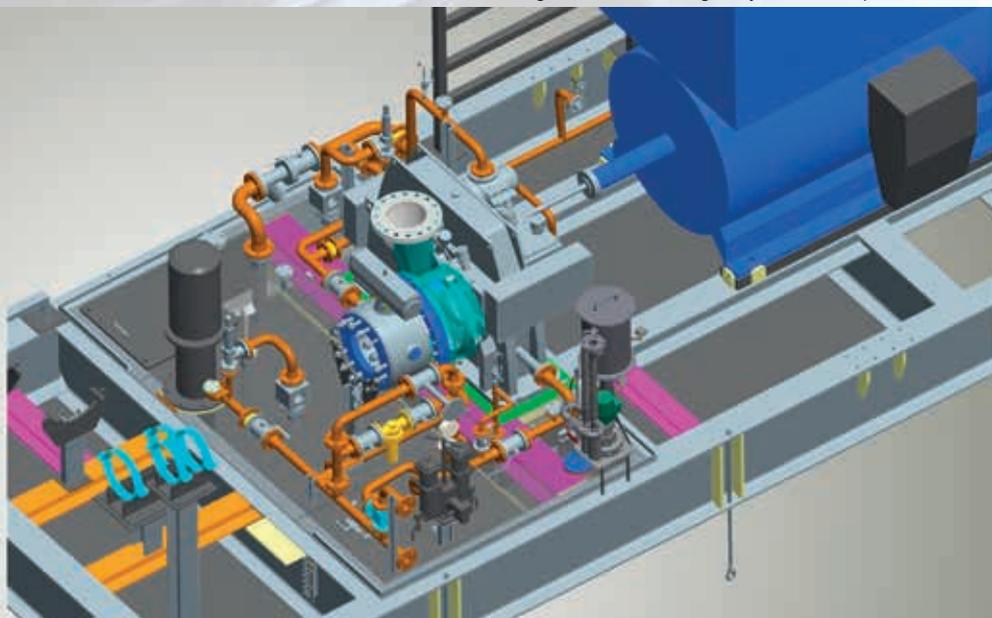


Fig. 1: Oil system integrated in compressor base frame
 Fig. 2: Free standing oil system with top mounted equipment and piping
 Fig. 3: Free standing oil system with separated oil reservoir

Fig. 1



Sealing and Supply System

Dry gas seals

Integrally geared compressors are high speed machines. The sealing of the compression chamber towards the atmosphere is a matter of importance. In particular, when toxic or explosive media are compressed, this sealing serves as protection from danger to life. Dry gas seals are designed for special application and are adapted to the various process conditions. There are appropriate sealing types available for the different requests and conditions, such as:

Single seals:

Used in air, nitrogen or CO₂ compressors. Leakage towards the atmosphere is harmless. The radial shaft sealing protects the dry gas seal. To be connected to the flare or for venting purposes, this sealing type can also be used as zero-emission model.

Double sealing:

Double seals are used when product leakages towards the atmosphere are not allowed. The seal design provides a seal gas leakage towards the process, because the seal gas pressure has to be higher than the process pressure. This type of sealing is used if a neutral seal gas is available. Part of the seal gas leaks to the atmosphere side.

Tandem sealing with intermediate labyrinth:

This type is particularly recommended when

leakage towards the atmosphere as well as product contamination by sealing gases are not allowed. The process gases are toxic and/or explosive. The gas pressure is relieved via the seal ring pair which is mounted on the gas side. The entire leakage is discharged via the flare connection. The atmosphere side sealing is pressurised under nitrogen or air. The pressure of the sealing gas has to ensure that the flow goes via the labyrinth to the flare. Thus, the process gas cannot get to the atmosphere side pair of sealing rings.

Carbon ring sealing:

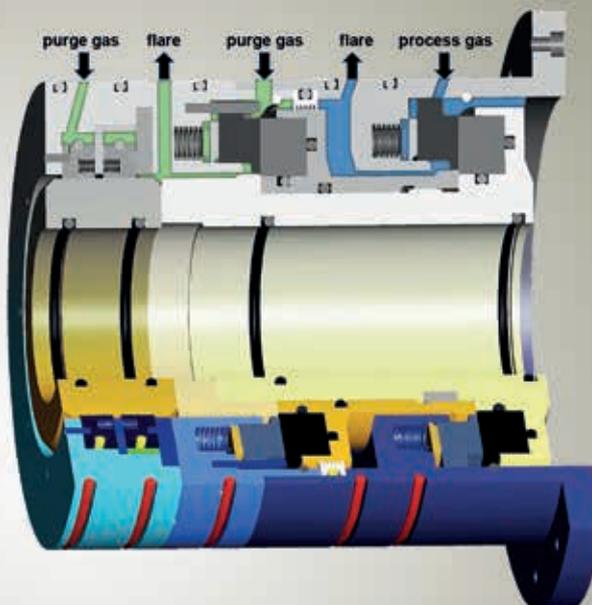
This type of sealing is also used in the oil and gas industries as well as in the power plant technology. It is dry-running and utilized for sealing of various gases and gas mixtures. The carbon rings run contact free, so there is no additional friction. This robust and functional sealing system may also be adapted to the customer's process conditions.

Monitoring

Each sealing is equipped with a monitoring system which controls the supply of purge gas, sealing gas and separating gas. It also monitors the leakage gas. The monitoring system is adapted to the specified statutory orders on hazardous incidents and to the safety requirements of the operator.

Fig. 1: Tandem seal with intermediate labyrinth

Fig. 1



Instrumentation and Controls / BORSIG BlueLine

BORSIG ZM provides state-of-the-art solutions for instrumentation according to national and international standards.

The instrumentation follows a high safety standard and is available worldwide to an advanced standard with application using high quality techniques. These requirements are continuously controlled and adapted according to customer demands and along with new developments.

BORSIG ZM offers a highly available BORSIG BlueLine automation system with scalable redundancy and up to SIL3 (safety integrity level) for industrial use.

The system combines control system, emergency shutdown, machine protection and machine monitoring for BORSIG ZM's integrally geared centrifugal compressors.

The BORSIG BlueLine system family is the basis for integrated SIL3 automation. Safety-related communication and processing with, if required, multiple redundancies enable the efficient distribution of complex applications and the integration of several systems.

In addition to regular automation, modern plants require an increasing amount of certified safety functions. BORSIG BlueLine systems allow the mixed operation of certified safety components (up to SIL3) with standard automation systems in one system.

Fig. 1: BORSIG BlueLine GA BASIC / CM

Fig. 2: Concept of BORSIG BlueLine

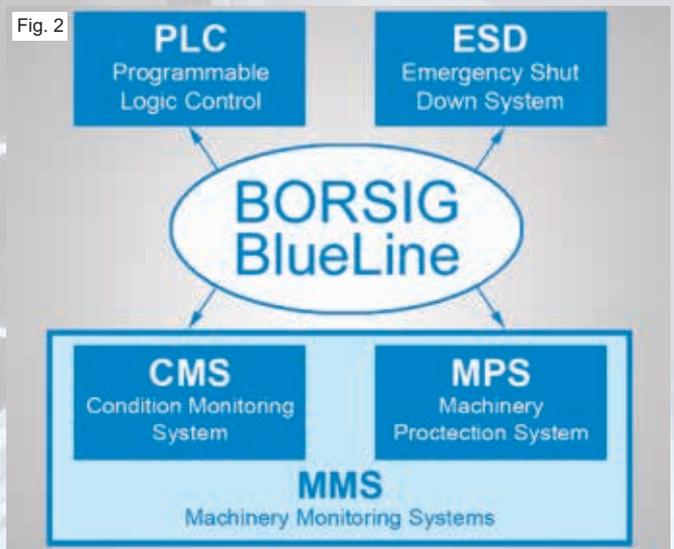


Fig. 1



Manufacturing

BORSIG ZM Compression GmbH's fabrication shop in Meerane/Saxony has more than 10,000 m² area available, equipped with up to 100 tons of crane capacities.

The heart of the fabrication shop are two CNC boring and drilling machines with a maximum travel path of 14 m and a piece weight of up to 40 tons. The extensive CNC machinery is linked to a modern programming system for the simulation of complex machining tasks followed by error-free processing. Thus, BORSIG ZM is capable to machine cylinders, impellers and further components for our compressors in-house. The machining of forged components, cast steel, modular graphite cast-iron and stainless steel is a daily routine for us.

All compressor units are carefully assembled and prepared for the agreed test runs. A high degree of vertical integration, a sophisticated machine outfit and well-trained permanent staff are guarantors of BORSIG ZM's high quality production standard. It is self-evident that quality assurance and ontime-delivery are the basic essentials of BORSIG ZM's business.



Fig. 1: 5-axis machining of integrally milled impeller with 580 mm diameter

Fig. 2: Fabrication shop in Meerane



Quality

BORSIG ZM Compression GmbH's Quality Management System is certified according to DIN EN ISO 9001:2008.

Our high quality standards are also verified by additional certifications such as DIN EN ISO 14001 - Environmental Management System and the SCC** certificate (Safety Certificate Contractors).

A high product quality level is guaranteed when competent engineering performance is connected with state-of-the-art production processes and a complete quality management. BORSIG ZM applies modern portable measurement technique such as laser trackers, scanners, index arms etc.

The Quality Assurance Team works based on appropriate testing schedules, measurement equipment administration and is linked to the production planning and control system (PPS).

Quality assurance at BORSIG ZM runs its tests and checkups completely independent from manufacturing and production control. It guarantees the compliance of processed material, manufactured components, equipment, products and services with the requirements of national and international standards, with regulatory and contractual requirements as well as with BORSIG rules and policies.

We have an own testfield with a surface of 1,700 m², 8 work stations and a power input of up to 5 MW for function and performance tests of our compressors as well as any other machinery with high current or even mean voltage.

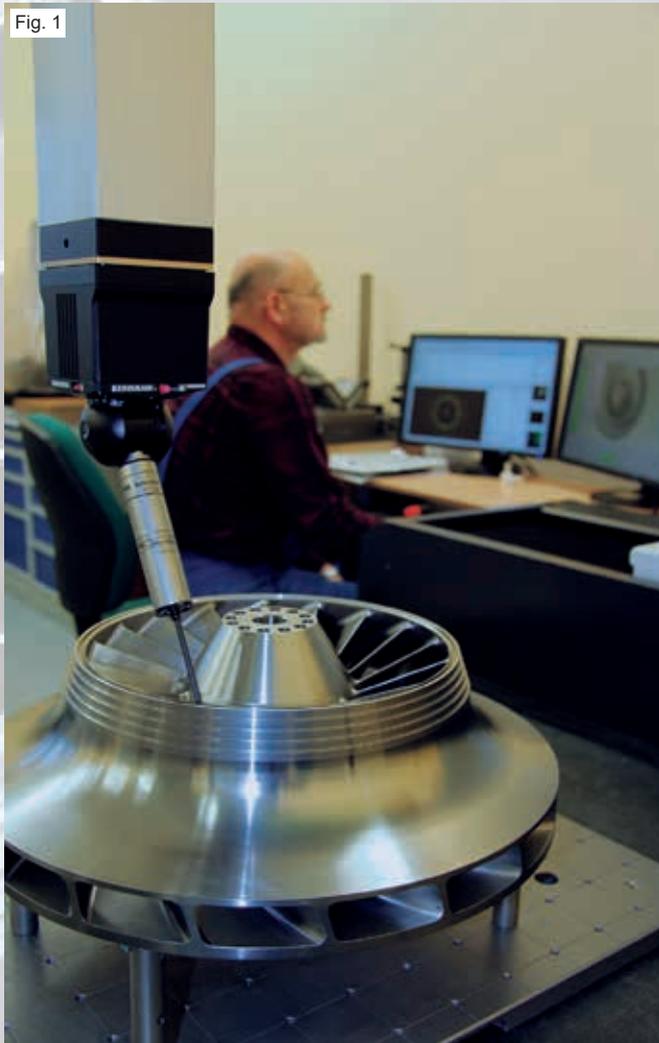


Fig. 1



Fig. 2

Fig. 1: Impeller measurement with 3D coordinate measuring machine

Fig.2: Performance test according ASME PTC 10 of 6-stage centrifugal compressor

Compressor Services

As a leading manufacturer of compressor systems worldwide, **BORSIG ZM Compression GmbH** offers you a comprehensive service from one source. Our after sales service takes care for your concerns flexibly and efficiently, whether you require service for a BORSIG ZM product or for compressors made by other manufacturers.

Competence based on long-time experiences in the field of compressors and the high quality of our services makes us the partner you can rely on.

Portfolio of services

- Installation and commissioning of compressor units
- Spare part management
- Revamp and refurbishment engineering
- Feasibility and pulsation studies
- Maintenance and overhauling
- In-house and on-site training
- Compressor valve service and engineering

Portfolio of products

- Reciprocating Compressors for Process Gases
- Centrifugal Compressors for Process Gases

Based on its own engineering, BORSIG ZM provides support from the installation and commissioning of compressor units up to their revamp, modification and modernization.

To keep the system availability on a high level, a comprehensive maintenance service is provided.

A wide range of constantly available spare parts together with short manufacturing times and high quality standards guarantee a minimal downtime of your compressor.

In emergency cases short reaction times are required. BORSIG ZM's service staff is available for its customers worldwide and 24 hours, 7 days a week and 365 days of the year.

24-hours service hotline

Phone: +49 3764 5390 5120

E-mail: service@zm.borsig.de

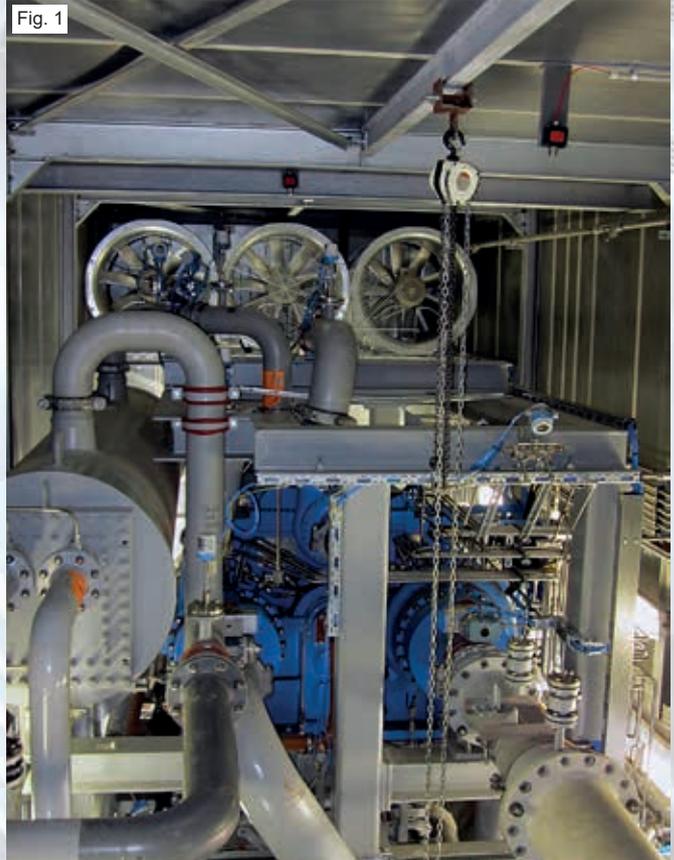


Fig. 1: Installed centrifugal compressor unit

Fig. 2: Completion of maintenance works

Fig. 3: Installed booster compressor station for gas turbines

Fig. 4: Manufacturing of spare parts

Fig. 5: Practical on-site training



Fig. 3



Fig. 4



Fig. 5

BORSIG ZM Compression GmbH

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