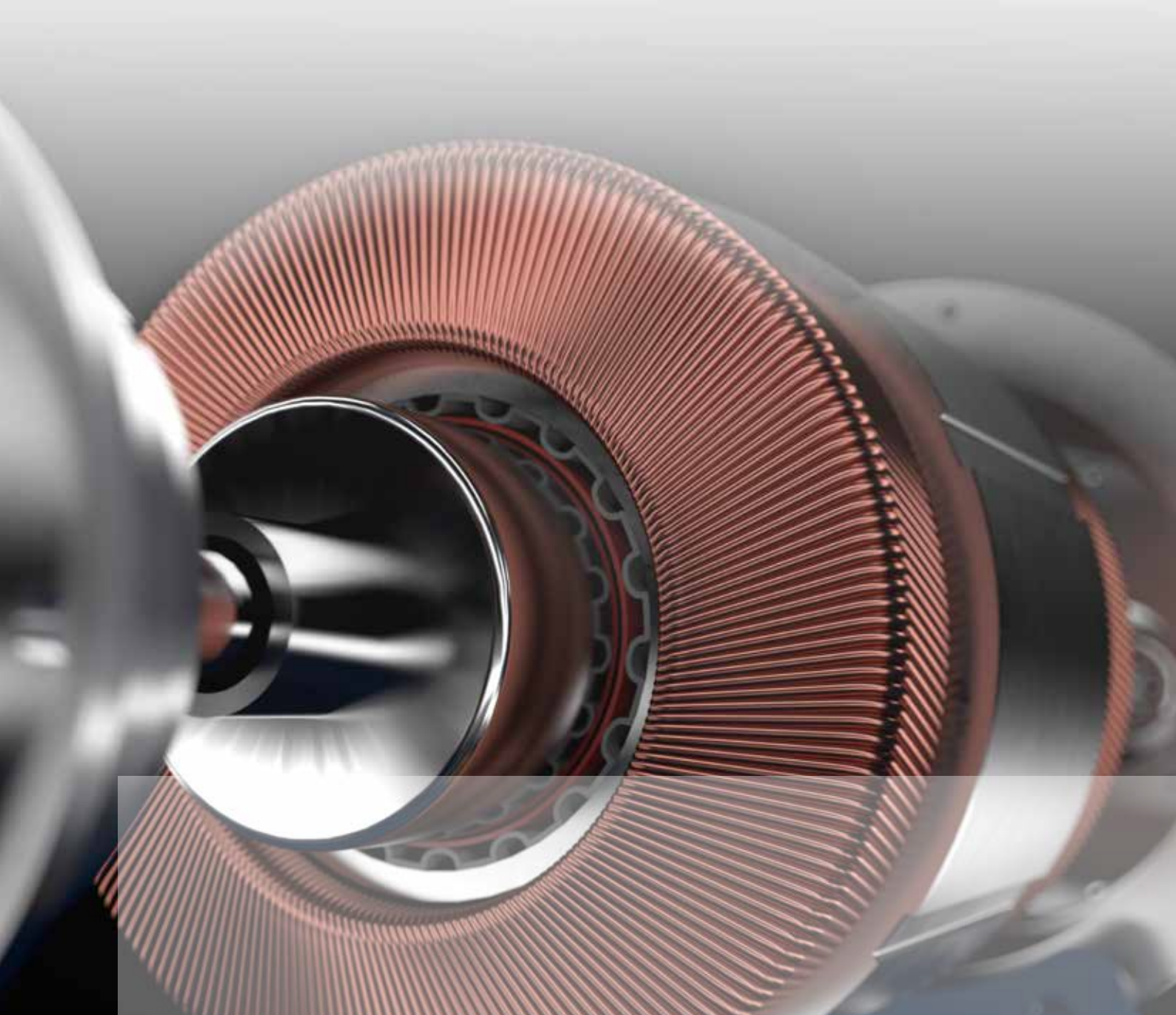


MAGNETIC VS. AIR FOIL BEARING.

AERZEN AIR FOIL BEARING - TRENDSETTING INNOVATION
FOR SAFE AND EFFICIENT OPERATION



AERZEN

SIMPLE AND EFFECTIVE: AIR AS BEARING SYSTEM.

Construction and functional principle of a turbo blower of the current AERZEN series are simple and at the same time effective. The air supply of modern applications is designed for maximum availability, high energy efficiency and long maintenance cycles as it is the case in wastewater treatment plants. This is why AERZEN uses only air for the complex bearing within the turbo blowers. Neither oil nor other lubricants are necessary - but simply air.

Bearings with simple physics.

As effective bearing system without mechanical friction AERZEN relies on compressed air in the two radial bearings of the drive shaft and in the axial bearing for absorbing axial forces. In doing so, in no case air is pumped with high pressure externally into the bearing shell, but rather in a brilliantly simple way the compressor principle is used. Due to natural unbalance, when starting the turbo blower, the rapidly rotating shaft generates an eccentric circular motion in the air gap of the bearing. As the shaft increases the pressure in this section on the minimal way to the bearing wall, counterforce is generated in form of a pressure increase. This counterforce pressed down the shaft - similar to a compressor or a Wankel engine - in the opposite direction. Due to the rapidly increasing speed the shaft centers in the bearing itself and increases the pressure in the air gap to more than 30 bar. The prevailing force couples are so high, that they keep the shaft permanently in the centre of the bearing even in case of considerably varying and challenging operation conditions (e.g. pressure surges) - and this free-floating without surface contact.

The brilliance of this principle is the fact that in operation the air cushion forms automatically - and thus without further energy input. Alternatively, turbo blowers made by other manufacturers run with a magnetic bearing system which also aims to handle high speeds free of a mechanical bearing system. Concerning magnetic bearings, however, electric current is needed, so that the coils arranged circularly around the drive shaft can develop their forces during operation and have the shaft rotating free from mechanical friction. Particularly changing operation conditions put the highly complex regulation system of the

magnetic bearings to a test. Frequently it comes to safety shutdowns of the entire turbo blower due to technological reasons.

Long service life with decreasing operation costs.

Concerning the air foil bearing principle no electrical, mechanical or pneumatic regulations are necessary - not even in case of dynamic load changes. Nevertheless, critics of the simple and efficient air foil bearings deny the fact, that when starting the



turbo blower the driven shaft lies on the bearing and generates wear friction up to the development of an air cushion. AERZEN is addressing this theoretically existing disadvantage with innovative air-foil bearings. For this purpose, the specialist for blower and compressor technology uses a 2-component coating which is specially developed and is unique on the market. One of these materials is composed of polytetrafluoroethylene, the other is graphite-based. PTFE is one of the thermoplastics used as anti-stick coating due to their very low friction coefficient. To ensure, that this construction can absorb the friction forces occurring within a fraction of a second when starting a turbo

Air foil bearings:

- Theoretical bearing lifetime >80,000 operating hours independent of start/stop cycles (>80 starts/stops per hour)
- 100% free of maintenance
- Highly functional without any additional features (e.g. electric control system, emergency bearing, auxiliary

- electronics such as battery systems), highest operational reliability, even in the event of voltage fluctuations and power failures
- Insensitive to pressure peaks (e.g. SBR plants, pulsation caused by positive displacement machines) and compressor pumps

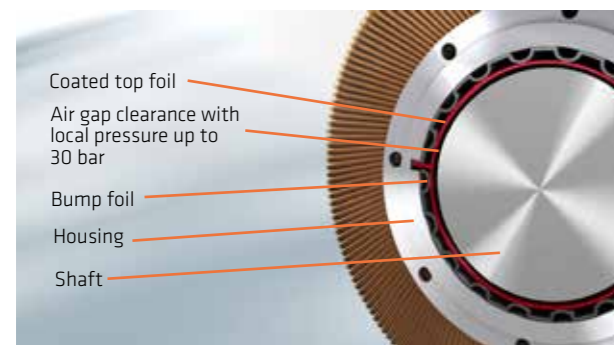
blower even stable, high surface quality is necessary. All in all, with the new Turbo Generation compared with the highly complex magnetic bearings, AERZEN succeeded in finding a considerably more cost-efficient and more favourable-priced solution. But PTFE as tough bearing material alone is not yet a durable bearing. As the compressor effect in the bearing compresses the air so significantly that the layer between bearing ring and shaft is virtually hard as steel, AERZEN designed a dampening layer specially tuned for this application. This is a sheet plate with a thickness of one millimetre, rolled undulatingly, supporting the sliding layer of the bearing and simultaneously absorbing the vibrations.

Air offers reserves for higher speeds.

With the sophisticated conception of the air foil bearings AERZEN succeeded in maintaining the simple construction of a turbo blower with the high-frequency permanent synchronous motor as energy-efficient drive. This bearing type still has reserves to support higher speeds as this is possible with magnetic bearings. As a consequence, the performance density of the turbo blowers can be increased further as a result of faster rotating blade wheels, if the appropriate motors are used. Mainly performance limiting for the magnetic bearings is the electronic control system, which has to readjust the forces of the magnetic fields permanently. Sensors permanently query where exactly the shaft is located in the magnetic field. "This is a complex and extremely expensive control circuit," says Helmert. To ensure, that in case of a malfunction, an emergency shutdown, or a power failure, the system remains active for a certain period of time turbo blowers must always be provided

with an uninterruptible power supply. A battery storage guarantees in case of electricity failure, that the magnetic field is maintained as long as the shaft has reached an uncritical speed for the mechanical back-up bearing. The simply designed back-up bearing is needed to absorb the motor shaft with the blade wheel in case of standstill and for maintenances. Due to the simple design of the back-up bearings, they can withstand only few plant failures.

But an uninterruptible power supply only offers the necessary safety if it is really safely available. Therefore, sophisticated load cycles are as necessary, as the regular exchange of the battery cells within a fixed maintenance plan. Consequently, an uninterruptible power supply inevitably increases the life-cycle costs. A similar expenditure is necessary for the magnetic bearing system, as - permanently in operation - it uses electrical energy continuously. Its complex regulation technology necessitates regular maintenance intervals. In comparison, air foil bearings, with their energetically adjusted no-load operation, are maintenance-free and can be changed very easily at site during plannable revisions of the blower technology in case of need due to their simple construction. Moreover, expert opinions confirmed that the total amount of service costs in connection with an air foil bearing is considerably less, as the design of the system is more simple and service providers are available locally. This detail finally leads to an increase of the availability of the turbo blowers - an aspect which becomes important at the latest when concerning the design and modernisation of e.g. wastewater treatment plants the provision of redundant systems is considered.



Air foil bearings in cross section:

- Shaft centers itself automatically with increasing speed, an internal pressure of up to 30 bar is built up
- A top foil with 2-component coating of PTFE and graphite serves as a reliable and durable lubricating film in contact with the shaft
- Any unbalance or extreme force is dampened and absorbed by the bump foil

AERZEN Air foil bearings with bump foil





AERZEN. Compression – the key to our success.

AERZEN was founded in 1864 as Aerzener Maschinenfabrik. In 1868, we built Europe's first positive displacement blower. The first turbo blowers followed in 1911, the first screw compressors in 1943, and in 2010 the world's first rotary lobe compressor package. Innovations "made by AERZEN" keep driving forward the development of compressor technology. Today, AERZEN is among the world's longest established and most significant manufacturers of positive displacement blowers, rotary lobe compressors, screw compressors and turbo blowers. AERZEN is among the undisputed market leaders in many areas of application.

At our 50 subsidiaries around the world, more than 2,500 experienced employees are working hard to shape the future of compressor technology. Their technological expertise, our international network of experts, and the constant feedback we get from our customers provide the basis for our success. AERZEN products and services set the standard in terms of reliability, stability of value and efficiency. Go ahead – challenge us!

Aerzener Maschinenfabrik GmbH
Reherweg 28 – 31855 Aerzen / Germany
Telephone: +49 5154 81 0 – Fax: +49 5154 81 9191
info@aerzen.com – www.aerzen.com



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