Koyo®

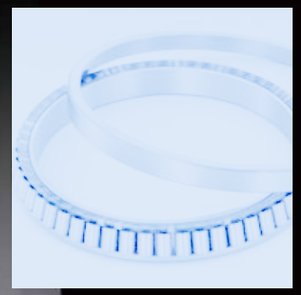
Wind Turbine Generator Products

JTEKT

JTEKT CORPORATION

JTEKT
Koyo TOYODA

CAT.NO.B1002E-2



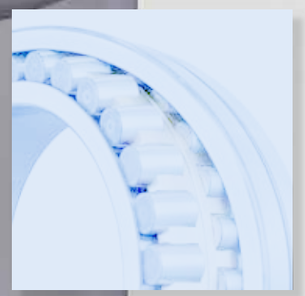
Trust

Synergy of cutting-edge bearing technologies and machine tool technologies…JTEKT

Established in 1935, “Koyo” has continued to evolve as a leading international bearing brand for over 70 years. Many kinds of bearings are manufactured that contribute to society such as the launch of the world’s first ceramic bearings into market. The bearing business is based on a core technology that supports every product and industry where there are lots of rotational components. The machine tool business has a very important role to support the basis of manufacturing industries as “TOYODA” a global brand. Combining these two businesses, a new company was established in 2006, JTEKT. Manufacturing bearings and large-scale machining tools (i.e., for gearbox machining) enables us to respond to a wide variety of market needs. Besides machine tools and bearing technologies, we also have the technologies to produce automotive steering and drive line parts for transmitting torque. We also contribute to the environment as a world-leading parts manufacturer.

Contributing to the realisation of an environment-friendly society through not only eco-cars but also wind turbine generators

Nowadays, Ultra fuel efficient environmentally friendly cars, where JTEKT bearings and steering components are implemented, have attracted much attention worldwide. We have also begun providing the bearings for the “main shaft” of the wind turbine generators, introduced in Europe even before the Kyoto Protocol was enacted in 1997. The wind turbine generator (wind turbine) market has been growing rapidly, backed by the rising public interest in bringing a halt to global warming. The generating output of wind turbines has also improved significantly, increasing from the 200kW class to a 2MW class, and now even to multi-MW classes. In 2007, wind turbines utilising JTEKT bearings for the main shaft contributed to reducing CO_2 by 7.6 million tons. In addition to bearings, we also supply numerous large-scale machining centres for manufacturing gearboxes. Based on the three aspects of “safety,” “environment” and “comfort,” JTEKT is committed to environment-friendly manufacturing that society can trust.



Quality

Offering Japanese quality with prestigious development and manufacturing techniques

In recent years, the output capacity of wind turbine generators has continued to increase. However, growth in terms of the size of wind turbines has reached its limits. The current demand is for smaller and lighter wind turbines with equivalent or better power-generating capability, higher reliability, and maintenance-free systems. With this background, the performance requirements demanded from bearings have become increasingly diverse. Other important issues include consideration for characteristics such as energy efficiency, safety, high product quality that is compliant with global standards, and more competitive pricing. Utilising its development expertise, JTEKT is introducing cutting-edge technologies to resolve such issues. To support this, basic technologies applied in various fields, such as tribology, nano technology, materials development, precision machining and heat treatment processes, are included as well. We have established a worldwide network to further deepen the use of these basic technologies and expand our technology development capabilities even further. High evaluations are received not only from our customers, but also from other markets. In terms of manufacturing, we integrate mass production technologies acquired through automobile bearing production and large-scale product production technologies acquired through bearing production for the steel-making industry and tunnel boring machines to create manufacturing lines never before imagined. Product management systems such as “KAIZEN” and “MIERUKA” are also implemented to ensure world-class Japanese quality.

Technology

Wind turbine generator operating environment

The wind energy moving wind turbine blades is changed into rotational energy at the rotor. This energy is then transferred through the main shaft and gearbox, and finally transformed into electricity by the generator. This is the main flow of the power train in a wind turbine generator. The load on the wind turbine generator varies widely from light to heavy according to the wind speed and direction, which changes every 0.1sec, and this affects rotational speed as well. Additionally, the operating temperatures can range from -30 to 100°C. Even under such severe conditions, the designed service life for bearings is over 20 years, a strict requirement in order to ensure high reliability.

Main shaft bearings

After the wind load is transferred through the rotor, this important component transmits the rotational torque to the gearbox. Spherical roller bearings (Fig.1) are mainly utilised for the main shaft bearings because of their superior aligning characteristics and load durability. At JTEKT, compact and highly reliable bearings are selected taking into account thorough analyses of complicated rotor rotational speeds, appropriate loads, the shaft, housing rigidity and lubrication. An example of the main shaft configuration is shown in Fig. 2, and Fig. 3 shows an FEM analysis example for the main shaft housing. Both larger and hybrid wind turbine generators are likely to be keys in order to improve power efficiency and reliability. Consequently, not only bearing sizes are increasing but also the types of bearing are diversifying from conventional spherical roller bearings to cylindrical roller and tapered roller bearings. JTEKT are supplying all types of bearings depending on wind turbine sizes.

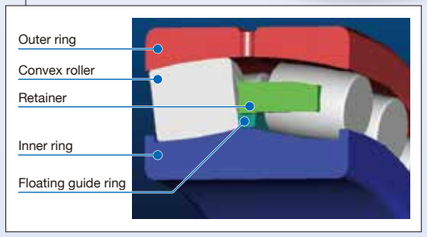


Fig. 1 Main shaft bearings (spherical roller bearings)

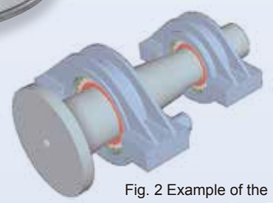


Fig. 2 Example of the main shaft configuration

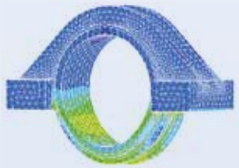


Fig. 3 Example of a FEM analysis for the main shaft housing

Main shaft oil seal

Full-rubber Seal (MS type)
- Full-rubber material simplifies installation
- Can be manufactured with a cut-type in one location

Pressure-resistant seal (MHSA type)
- Reduction of lip deformation due to pressure
- Excellent sealing performance under high-pressure conditions

Gearbox bearings

The gearbox is the device that increases the rotational speed transmitted via the main shaft up to the speed where power can be converted into electricity, which consists of some planetary drives (a set of a sun gear, planet gears and a ring gear) and parallel shafts. Fig. 4 shows a major configuration, which includes one- stage- planetary gear and two- stage- parallel shafts (an intermediate and a high speed shafts). In many cases, double- row cylindrical roller bearings are used for the planet gear section, but recently the utilization of an integral- type bearing (Fig. 5) is on the increase. It is also important to investigate the proper bearings implemented to the gearbox using an analysis program considering shaft stiffness, shaft inclination, lubricating condition and bearing internal design (clearance and rolling contact profile) since the operating condition of the gearbox is severe. An example of analysis result for the planet gear section is shown in Fig. 6. If the rigidity of the planet is low, the ring gear deforms, which may have an influence on the inner components and shorten the service life of the bearings. Another example of analysis result for the contact stress distribution on the contact area is shown in Fig. 7. If the contact stress concentrates at the contact area, the shaft where the bearing sits deforms, which makes the service life of the bearing short. Fig. 8 and 9 also show shaft deformation of each shaft and load distribution of each rolling element on each shaft. Consequently, it is important to select appropriate bearings using an analysis program considering shaft deformation and load distribution on a roller.

Example of a double-row-cylindrical roller bearing (integral type) adoption

Example of a double-row-tapered roller bearing (integral type) adoption

Fig. 5 Example of a bearing arrangement for a planet gear section on a low-speed shaft

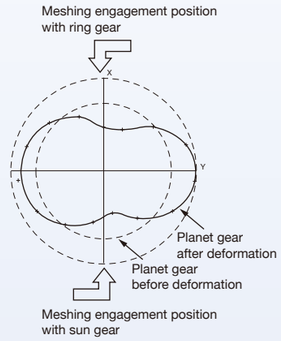


Fig. 6 Planet gear rigidity study results

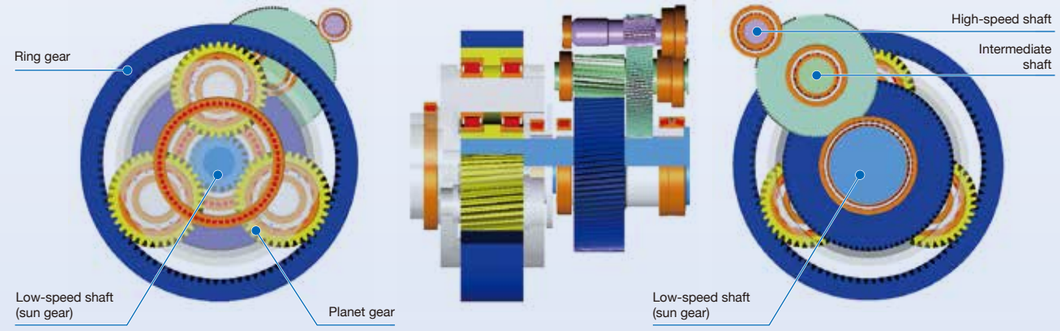


Fig. 4 Example of a gearbox configuration

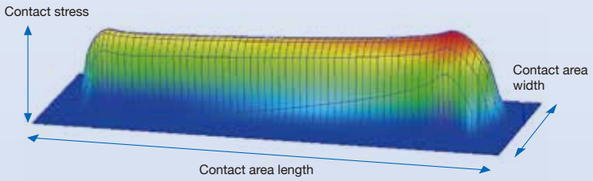


Fig. 7
Contact stress considering the rolling element profile

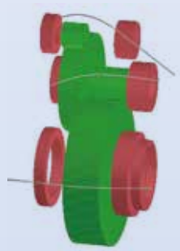


Fig. 8
Deformation of each shaft

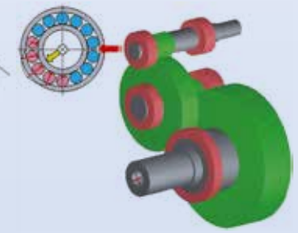
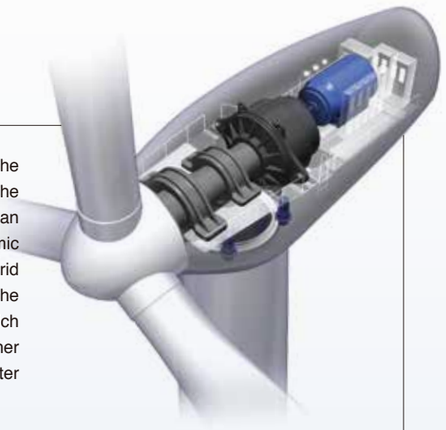


Fig. 9
Load distribution on rolling elements of each bearing

Hybrid ceramic bearings for generators



Bearings used in generators are subject to electric pitting, a phenomenon where the surface melts locally because sparks are generated as electricity passes through the ultra-thin oil layer and into the bearing while it is rotating. This is one of the factors that can lead to damage and reduce bearing service life. As a measure to prevent this, a ceramic ball with excellent insulation performance is used for the rolling elements, creating a hybrid ceramic bearing with good efficiency. Furthermore, compared to common bearings, the hybrid ceramic bearing does not reach high temperatures when rotating (Fig. 10), which improve the life of the lubrication and the duration of preventive maintenance. The further advantages of ceramics are shown in Table 1. The lower density contributes to lighter weight, and excellent anti-seizure is to be expected.

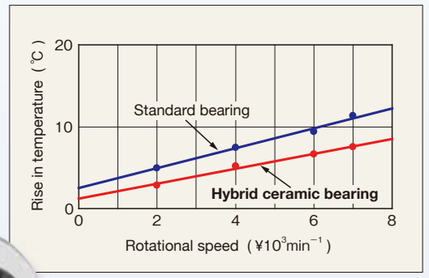


Fig. 10 Temperature rising characteristics of hybrid ceramic bearings

Items		Silicon Nitride	High carbon Chromium (Bearing steel)
Heat resistance	℃	800	180
Density	g/cm³	3.2	7.8
Linear expansion coefficient		3.2×10^{-6}	12.5×10^{-6}
Vicker's hardness	1/℃	1300 to 2000	700 to 800
Longitudinal elastic modulus	Hv	310	210
Poisson's ratio	GPa	0.29	0.3
Magnetic property		Nonmagnetism	Magnetism
Electric property		Insulator	Conductor
State of material bonding		Covalent bond	Metallic bond

Table 1: Comparison of characteristics between Ceramics and Bearing steel

KE bearings for yaw-driven reduction gears

The bearings utilised in reduction gears can be subjected to contamination of metallic particles resulting from exposure to abrasive microscopic particulates, and this can influence the bearing service life. Koyo KE tapered roller bearings have the best results when subjected to such severe conditions. KE bearings have an extremely hard raceway surface, and the volume of the retained austenite has been optimised, resulting in bearings that have dramatically improved performance in contaminated lubricants. The service life characteristics for these bearings are shown in Fig. 11.

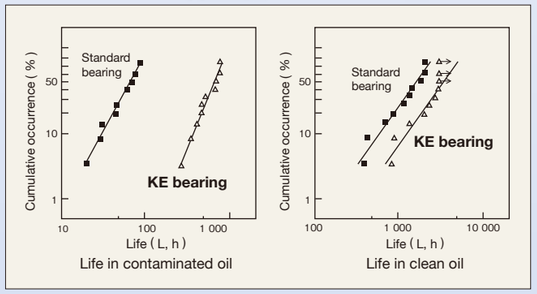


Fig. 10 KE bearing life characteristics

JTEKT Products Utilised in Wind Turbine Generator Production and Control

Machine tools

JTEKT Products Machine Tools & Mechatronics Brand | TOYODA

Machine Tools with Wider Machining Ranges and Higher Productivity
Big, Fast and Powerful for Even Higher Efficiency Machining of Large Parts.

FH1250SX
Large-scale Horizontal Machining Center

This advanced machining center leads its class in both maximum workpiece size machining capability and fastest rapid-feed rate.

Maximum workpiece size: Ø 2,400 x 1,800mm
Maximum load on pallet: 5,000kg
Pallet size: 1,250 x 1,250mm
Rapid-feed rate: 42m/min
High-torque spindle speed: 8,000min^{-1}
Maximum spindle torque: 1,009Nm

Select G7
Large-scale Combination Grinder

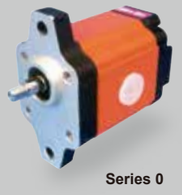
This multiuse grinder is equipped with a grinding-wheel swivel function that enables switching between straight and angular grinding.

Swing over table (mm): Ø660
Load between centers (kg): 1,500
Distance between centers (mm): 1,000, 2,500, 3,200, 4,000
Grinding wheel size (mm): Ø760, Ø 915, Ø1,065
Grinding wheel width (mm): 200, 300
Grinding wheel speed (m/s): 30, 45

Pitch brake hydraulic pumps

JTEKT HPI

Series 2



Series 0

Utilised as the power pack for pitch brakes. Power packs reduce the rotor speed using a disc in a way similar to that of the disc brakes used in automobiles. For safety, the brake is equipped with an independent hydraulic system.

JTEKT

www.jtekt.co.jp

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