Preventing Global Warming

World Goal: Limit temperature rise to 1.5°C

By installing the automatic balancer "Zero Shin" on rotating parts: Vibration loss prevention!

- Energy saving rate increased by 20% to 30%
- \cdot Extend the lifespan of consumable parts by over 50%

Achieving CO2 Reduction





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Turbine shaft installation for various power plants

Automatic Balancer "Zero Shin"

Increase the energy saving rate by 20% to 30%

•Extend the lifespan of consumable parts by over 50%



Structure Diagram of Wind Turbine Generator

Installation Position of Automatic Balancer "Zero Shin"



Consumable Parts



<u>Construction and Maintenance Costs of Wind Power</u> <u>Generation</u>

By equipping the rotating parts with an automatic balancer "Zero Shin": Energy efficiency increases by 20% to 30%. The lifespan of consumable parts extends by more than 50%.

Cost per 1 kW: Approximately 220,000 yen

As of 2030, the construction cost is 220,000 yen/kW, with the breakdown as follows: •Turbines and electrical equipment: 151,000 yen

•Foundations, system interconnection, land, etc.: 69,000 yen

Additionally, the annual maintenance cost is 6,000 yen/kW. Considering the current domestic wind power construction speed, the cost is expected to be between 268,000 yen to 300,000 yen/kW by 2030.

For constructing a 10MW wind power plant

It is estimated that constructing a 10MW wind power plant will cost about 3 billion yen. The largest wind power plant in Japan currently is the Shin Izumo Wind Farm in Shimane Prefecture, with a capacity of 78MW, which is approximately eight times the 10MW capacity, hence, the construction cost is estimated to be 24 billion yen.

Assuming an equipment utilization rate of 20% for wind power generation: With favorable conditions for wind power (average wind speed of 6 meters/second or more), the equipment utilization rate is expected to be around 20%.

Annual electricity sales revenue

•10,000 kW \times 20% \times 22 yen/kW \times 24 hours \times 365 days = 385.44 million yen

Costs

•Construction cost of 3 billion yen (including the cost of equipping 4 Zero Core automatic balancers ZS400 type and ZS600 type, approximately 20 million yen), totaling about 3.02 billion yen.

•Annual operation and maintenance cost: 6,000 yen/kW

•Cost over 20 years of purchase period: 3.02 billion yen + 10,000 kW \times 6,000 yen/kW \times 20 years = 4.22 billion yen

Revenue over 20 years of purchase period

•385.44 million yen \times 20 years = 7.7088 billion yen

Profit over 20 years of purchase period

•7.7088 billion yen - 4.22 billion yen = 3.4888 billion yen It is clear that profitability can be achieved.

*Reference: Smart Japan "What is the construction cost of a 10MW wind power plant?"

Lastly

Risk management becomes crucial:

•Do not misestimate the wind conditions of the installation environment.

- •Do not build in places with no wind at all.
- •Prevent massive management costs due to disasters such as typhoons and lightning.
- •Ensure the quality of the main unit during construction stages.
- •Obtain backup including insurance.

<u>Assumed Benefits of Equipping the Generator with an</u> <u>Automatic Balancer "Zero Shin"</u>

[Comparison of A. With Equipment and B. Without Equipment]

A. Generator with Automatic Balancer "Zero Shin"

- 1 Fast startup time until power generation begins.
- 2 Fast startup time until maximum output is reached.
- 3 20% to 30% more power generation at the same rotational speed.
- 4 Although inertia is high, there is less vibration and shorter stop time after braking.
- 5 The lifespan of consumable parts (bearings, speed increasers, generators) extends by more than 50%.

B. Generator without Automatic Balancer "Zero Shin"

- 1 Slow startup time until power generation begins.
- 2 Slow startup time until maximum output is reached.
- 3 20% to 30% less power generation at the same rotational speed.
- 4 Although inertia is low, there is more vibration and longer stop time after braking.
- 5 The lifespan of consumable parts (bearings, speed increasers, generators) shortens by more than 50%.



<u>How the utilization efficiency of equipment changes by 20% when an</u> <u>automatic balancer "Zero Shin" is installed on the rotating part of wind</u> <u>power generation (Assumed change items)</u>

- 1 To maintain zero-shin rotation against load fluctuations, the lifespan of consumable parts (such as bearings, gearboxes, generators) extends by more than 50%, reducing the downtime for part replacement and necessary costs.
- 2 By maintaining zero shin misalignment, the rotational inertia force doubles, and the rotation stops nearly twice as long if the brake is not applied even when the rotation stops.
- 3 By preventing core misalignment loss during rotation startup and stopping, rotation becomes easier even at low wind speeds, resulting in a 20% to 30% energy-saving rate and more than 50% extension of the lifespan of consumable parts.
- 4 <u>As a result, it is conceivable that the utilization efficiency of equipment can be</u> expected to increase from 20% to about 40%.

<u>Conceptual diagram of automatic balancer "Zero</u> <u>Shin" installation on the generator turbine shaft</u>



Low-pressure turbine 1500 rpm (reaction turbine)

Solution to prevent resonance points in high-speed rotation

Even during normal rotation

<u>A.R.I.LLC</u> Hiroaki Yamamoto

Due to differences in the inherent vibration values and masses of the various materials (parts) attached to the core of the rotating shaft, core vibration occurs when the rotation speed increases. Depending on the rotation area, two vibration areas overlap, which leads to increased core vibration in the core of the rotating shaft and causes resonance. This can lead to damage to the rotating part, and currently the only way to deal with this is to slow down the rotation speed or use a damper.

In this way, different parts are mounted on the same rotating shaft, and the shaft core runout caused by changing the rotation speed or applying load fluctuations is solved by our patented automatic balancer "Zero Shin". The balance adjustment weight is fixed at three points on the circumference of the main body at equal intervals of 120° , but it achieves multi-dimensional oscillation in a hollow space, preventing core runout caused by rotation fluctuations in multi-dimensional directions and load fluctuations. It is the world's first patented product proposal that makes it possible to prevent resonance phenomenon, which is difficult to solve with high-speed rotating shafts, by preventing shaft core runout.



<u>Automatic balancer</u> <u>"Zero Shin"</u>

Centripetal theory

<u>The center of an</u> <u>equilateral triangle</u> <u>inscribed in a perfect</u> <u>circle is the center of</u> <u>rotation.</u>

<u>Generator turbine part processing accuracy specifications</u>

Generator turbine part processing accuracy specifications

- 1 Rotor design stage difference between maximum and minimum values 0.05 mm
- 2 The gap cannot be zero for rotation. The smaller the steam leak from the rotating rotor, the higher the power generation efficiency.
- 3 The rotor diameter is 2 to 4 meters, length is 6 to 10 meters, weight is 3 to 150 tons, and it rotates at a maximum of 4320 rpm.
- 4 The maximum 150-ton rotor is balanced and assembled in 1g increments.
- 5 The gap between parts at the assembly stage is 0.01 mm.
- 6 The allowable range for lathe machining of turbines is within 0.05 mm, but the target is within $5\,\mu$ m.
- 7 Each machining tool has subtle quirks, and fine adjustment skills are required for straight machining.
- 8 <u>Each machining tool has subtle quirks</u>, and fine adjustment skills are required <u>for straight machining</u>.

Large machining machine for generator machining

Automatic balancer "Zero Shin" used for processing

(High precision, energy saving, correction-free, unmanned processing realization)

Zero Shin misalignment machining achieved with a processing accuracy within 0.05 mm!

