Application of Mobile Vibration Online Comparison Sensor in Wind Power Field

Hua Wang, Jinshan Wang, Wenqiang Tian, Zhiqiang Bao, Bao Wang, Yanxu Gou

Inner Mongolia Datang International Zhuozi New Energy Co., Ltd Ulanchap 012300, China

Abstract. MEMS sensor is a new type of sensor manufactured by micro electronics and micro machining technology. Compared with traditional sensors, it has the characteristics of small size, light weight, low cost, low power consumption, high reliability, suitable for batch production, easy integration and intelligent realization. This project adopts a multi in one sensor based on MEMS principle. The sensor is a wireless passive three-axis sensor that integrates acceleration, speed, displacement, temperature, inclination and other parameters. It is very convenient to install and disassemble, and can realize the cycle monitoring of the whole wind field.

Keywords: MEMS sensor; Mobile Vibration; Online Comparison Sensor; Wind Power.

1. Background

The main vibration sources in the wind turbine include the main shaft, gearbox, generator, engine room, tower, etc., which are all important components in the entire power generation system [1]. The occurrence of vibration will not only make the fan inefficient, but also affect the safe operation of the fan and the life of other components [2]. At present, all types of vibration sensors are equipped on the newly put into operation wind turbine generator units, but the status assessment of the sensors is still blank. After installation, they will not be disassembled or submitted for inspection, and no assessment status scheme has been provided [3].

2. Main basis

Wind power equipment has been operating under the action of complex alternating loads such as gusts all day for a long time, and the harsh service environment has seriously affected the operation safety and maintenance guarantee of wind power equipment [4]. The alternating load acts on the wind turbine blades and is transmitted through the bearings, shafts, gears, generators and other components in the drive chain, making the drive chain prone to failure during service. At present, the monitoring system widely equipped on wind power equipment is SCADA system, which can monitor the operating status of wind power equipment in terms of current, voltage, grid connection and other conditions, and has the functions of alarm and report; However, the state parameters monitored by the system are limited, mainly including current, voltage, power and other signals, and the vibration monitoring and fault diagnosis functions for key components are still lacking [5].

Foreign countries, especially western developed countries, have developed condition monitoring equipment and analysis software for wind power equipment for a long time. Among the condition monitoring equipment for the drive chain of wind power equipment, the more famous developers and their monitoring systems include: the wind turbine remote monitoring and vibration system VI-BROWEB XP and the condition monitoring software OMNITREND of Germany PRUFTECHNIK; ADAPT of Bently Nevada Corporation Condition monitoring system of wind power generation equipment drive chain; Winergy AG, a wind electronics company of Flender, Germany, has built a full set of wind power operation and maintenance plans. The service department can install a status monitoring system to detect the operation of each transmission component of the wind power generation equipment in real time and online, and provide maintenance and repair services for the transmission system; New Zealand Commtest Company has developed vboine and other systems to diagnose the fault of the transmission chain of wind power generation equipment.

Although the domestic vibration monitoring technology started late, the development of the domestic monitoring system has entered a rapid development stage driven by the huge domestic market demand for remote operation and maintenance of wind power. Anhui Rongzhi Rixin Technology Co., Ltd. has specially developed an online monitoring and fault diagnosis system WindCMS for wind power equipment, which can monitor various operating data during operation and automatically store them. Beijing Tangzhi Technology Development Co., Ltd. has developed the online fault diagnosis system JK10460 for wind turbines, focusing on automatic real-time diagnosis. XJ Electric Co., Ltd. has developed an online status monitoring system FJK-530 for wind turbine generators, which can identify and evaluate the potential faults of wind turbine equipment through vibration signals, and evaluate the service life. Domestic wind power equipment OEMs have also developed health management systems for the later operation and maintenance of wind power, to improve the utilization and intelligence of wind turbines. Xinjiang Goldwind Technology Co., Ltd. has developed the intelligent health management system SPHM, which has realized intelligent fault diagnosis, classified conventional faults, difficult faults and "difficult and miscellaneous diseases", formed standard fault work orders and standard processing results, thus achieving the effect of intelligent operation and maintenance deployment. For fault diagnosis of wind turbine generator units, the fault diagnosis system developed by Guodian United Power Technology Co., Ltd. can quickly determine the type of fault of wind turbine generator units, quickly and accurately extract the main faults from a large number of relevant fault information, thereby improving the efficiency of unit fault troubleshooting and reducing manual troubleshooting time. The intelligent fault diagnosis and early warning protection of wind power equipment can reduce the cost and increase the efficiency of wind power operation and maintenance.

It can be seen that the monitoring system based on vibration, inclination, temperature, displacement and other parameters is relatively well developed, but the evaluation of the sensor status in the above system is still blank. This technology aims to achieve the sensor status evaluation in the monitoring system through technical means to ensure the quality of analysis data.

3. Basic information of the original system or equipment:

With the vigorous development of wind power, the sensors arranged on wind turbines are also being upgraded and improved synchronously. At present, most of the newly built units are equipped with vibration, inclination and other sensors. However, the state evaluation method for sensors is still traditional, mostly offline, that is, the sensors in use are removed from the installation position and sent to the metrological department for verification. However, unlike thermal power units, once the wind turbine sensor is installed, it is almost difficult to disassemble it for inspection. In addition, many factors such as installation, disassembly, transportation and comprehensive error are ignored in the inspection. Only the state of the sensor under laboratory conditions is evaluated, not the true state under working conditions.

4. Scheme demonstration:

Develop a set of in-situ comparison methods and algorithms for wind turbine generator vibration, inclination, temperature and displacement sensors, analyze the possible vibration interference factors in the position of the wind turbine generator room, form a vibration sensor evaluation system, conduct a comprehensive evaluation of the sensor body, transmission system, etc., and analyze the cause of error.

By arranging multiple in one sensors at the main vibration source, the vibration sensor body and data transmission system are evaluated separately by comparison.

This part focuses on the basic research of data analysis algorithm.

Based on the accumulation of sensor data arranged within three months, the alarm range is analyzed. This section analyzes the monitoring data of the main bearing rear end cover, gearbox low speed end, gearbox high speed end, generator front shaft end cover, generator rear shaft end cover, and generator bottom frame to determine the boundary value of the vibration evaluation area.

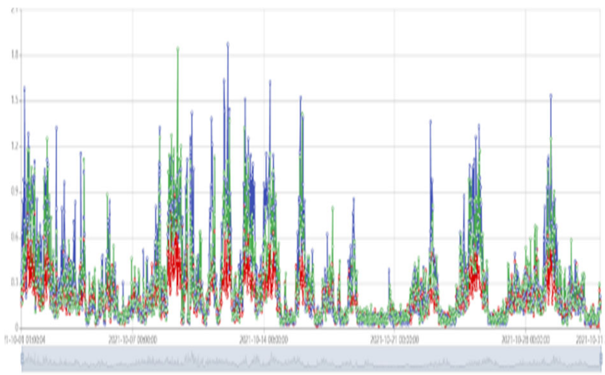

Fig. 1 Acceleration data sampling of main bearing rear end cover

 https://doi.org/10.1051/e3sconf/202337502005

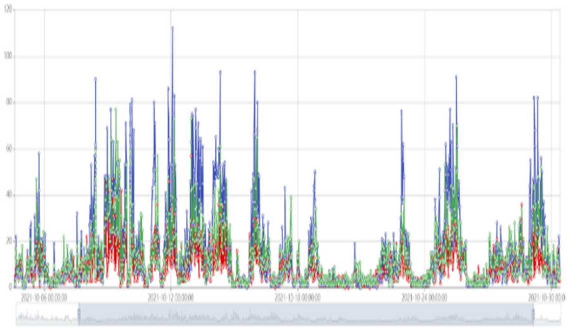

Fig. 2 Speed data sampling of main bearing rear end cover

Fig. 3 Main bearing rear end cap displacement data sampling

Fig. 4 Main bearing rear end cap inclination data sampling

Fig. 5 Temperature data sampling of rear end cover of main bearing

5. Conclusion

The main bearing position mainly focuses on the axial and radial acceleration and speed parameters, where the root mean square of acceleration triaxial data is 0.09-0.137m/s2, and the root mean square of velocity triaxial data is 0.24-0.48 mm/s. Displacement parameters are helpful to compare acceleration and velocity parameters; The inclination parameter is relatively stable; In addition, temperature monitoring shall be combined with outdoor temperature to determine whether there is abnormality.

References

1. Xiaolin Ge, Quan Chen, Yang Fu et al. Optimization of maintenance scheduling for offshore wind turbines considering the wake effect of arbitrary wind direction[J] Electric Power Systems Research, 2020, 184(C)
2. Yizhong Chen, Jing Li, Li He Tradeoffs in cost competitiveness and emission reduction within microgrid sustainable development considering price-based demand response[J] Science of the Total Environment, 2020, 703(C)
3. Pan Keda, Chen Zhaohua, Lai Chun Sing et al. An unsupervised data-driven approach for behind-the-meter photovoltaic power generation disaggregation[J] Applied Energy, 2022, 309
4. Ying Deng, Rashid Asif, Sheng Liu He et al. Research on power increase adaptive control strategy based on 5 MW wind turbine[J] Energy Reports, 2021, 7(S1)
5. Jiang Hongli, Ma Shiying, Song Ruihua et al. Analysis on subsynchronous oscillation stability for large scale offshore wind integration[J] Energy Reports, 2020, 6(S9)