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Operation and Maintenance and Development Trend of 1.5Mw Wind Turbine in Xinjiang

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Abstract.With the rapid development of wind power industry in Xinjiang, the 1.5MW wind power generating unit has a large use base. After running for a period of time, the problems of maintenance and repair after its failure appear on paper.This article in view of the xinjiang region of the 1.5 MW wind turbine variable flow system, electric control system, generator system, variable propeller system, yaw system, hydraulic system and other aspects of the fault, has carried on the detailed statistics and analysis, combining with the actual production situation puts forward the solutions to these faults daily operations, and put forward combined with preventive maintenance operations strategy.Correct operation and maintenance is the guarantee of improving productivity. Finally, the paper points out that intelligent operation and maintenance is the future development trend of wind power operation and maintenance, which can effectively promote the improvement of wind farm operation and maintenance management level.

Keywords.Wind Turbines; Operations; Fault diagnosis; Maintenance

1. Introduction

Xinjiang has nine major wind regions and is extremely rich in wind energy resources. The proven reserves account for about one-fifth of the country's total, reaching 890 million kilowatts. In recent years, Xinjiang has accelerated the construction of "three bases and one channel", made every effort to develop the wind power industry, and strived to promote the transformation of the energy structure. After more than 30 years of development, Xinjiang's wind power industry has achieved remarkable results. As of October 27, 2020, the installed capacity of Xinjiang's wind power equipment has jumped over the 20 million kilowatt mark, reaching 20.099 million kilowatts, and has gradually developed into a Xinjiang power grid. The second largest type of power supply [1-3].

The 1.5MW wind turbines accounted for 65.4% of the total installed capacity of all wind turbines in Xinjiang in 2013. The rapid development has made the 1.5MW wind turbines have a very large base and is currently one of the main models of wind power generation in Xinjiang. After a period of production and operation of 1.5MW wind turbine, it faces problems such as daily operation and maintenance and maintenance after failure [4].

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Xinjiang wind farms, especially some wind farms located in southern Xinjiang, are usually located in deserts, mountains and other inaccessible places, with inconvenient transportation and long distances from cities, coupled with poor communication in some areas, which greatly affects the operation and maintenance management of wind farms, and the failure of wind farms. Post-overhaul brings a lot of challenges [1,5]. The operation and maintenance of wind power equipment must be analyzed through practical and specific analysis. Based on this research, the development of feasible solutions and operation and maintenance management methods can significantly reduce operating costs and increase operating efficiency.

2. Fault characteristics of 1.5MW wind turbine in Xinjiang

Xinjiang wind turbines operate in a poor natural environment, and each system is extremely prone to failures under the influence of alternating loads and large temperature differences between morning and evening. In order to accurately grasp the fault characteristics of 1.5MW wind turbines, the total failures of all 1.5MW wind turbines in a large wind farm in Xinjiang for a total of 8 months from January 2018 to August 2018 were counted, and a total of 318 failures occurred, and the failures were mainly concentrated. For IGBT (Insulated Gate Bipolar Transistor) fan feedback loss, speed comparison failure, generator circuit breaker failure, pitch capacitor voltage unbalance, pitch substation bus failure, pitch position comparison failure, motor side capacitor fuse feedback Loss of feedback, loss of capacitor fan feedback, main control cabinet UPS battery failure, etc., the total number of these failures accounted for more than 80% of the total number of failures.

By classifying all the faults, it can be found that the faults of Xinjiang 1.5MW wind turbine mainly occur in the converter system, electronic control system, generator system, pitch system, yaw system and hydraulic system. The proportion of faults in each system is shown in Figure 1. It can be seen from Figure 1 that the faults are mainly concentrated in the converter system, electronic control system, generator system, pitch system and yaw system.

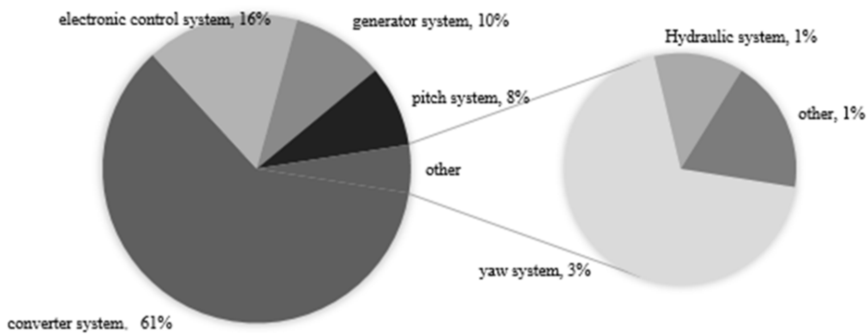

Figure 1. The proportion of failures in each system

3. Common fault analysis and operation and maintenance suggestions

3.1.converter system

The main function of the converter system in the entire wind power generation system is to change the wind energy into electrical energy suitable for the grid, and feed the electrical energy back to the grid. The electricity generated by the generator is alternating current. At this time, the frequency of the electricity, including the voltage, changes. In addition, it also changes with the change of the impeller speed. The electricity needs to be passed through the rectifier unit and then through the chopper boost system. It is sent to the DC busbar, and then inverted by the inverter unit, so that it can be matched with the grid, and finally fed back to the grid [6-7].

The faults of the converter system are mainly concentrated in the loss of IGBT fan feedback, the failure of the generator circuit breaker, the loss of the capacitor fan feedback, the current imbalance and the overcurrent of the converter braking system. Among them, IGBT_ok is lost (IGBT feedback is lost), IGBT fan feedback is lost, current is unbalanced, grid voltage is low, and the longest fault duration of generator circuit breaker fault is more than one hour. Poor on-site environment, heavy pollution and some harsh conditions such as electromagnetic interference will affect the performance of the converter system, and it is also very easy to cause failures.

Table 1.Converter system fault statistics

Classification	Fault description	Occurrence	Proportion	Maximum failure time
converter system	IGBT_ok lost	4	2%	3:18:41
	IGBT fan feedback lost	136	70%	5:43:24
	Inverter braking system overcurrent	6	3%	0:14:54
	Charge contactor feedback lost	2	1%	0:00:53
	current imbalance	8	4%	5:17:57
	Capacitor Fan Feedback Lost	11	6%	0:31:43
	low grid voltage	1	1%	9:49:31
	Generator breaker failure	20	10%	1:55:14
	Bottom fan feedback lost	5	3%	0:25:17

During the operation and maintenance of the converter system, in the face of serious faults, necessary inspections are required, and remote reset operations are strictly prohibited. In order to ensure that the tower door is tightly sealed, check and update all the sealing strips on the cabinet and the tower, and ensure that all cabinet doors on the cabinet are locked. For units with ultra-low inlet (outlet) valve pressure, carefully check the pipes of the water cooling system. If there is a shortage of water, immediately carry out water replenishment operations. If there is water leakage, repair it immediately. Finally, it must be noted that if the unit experiences a long-term power failure, dehumidification must be performed before powering on again [8-9].

3.2.Electronic control system

The control system of the wind turbine is composed of some modules that can realize information transmission. It plays an extremely important role in the entire wind power system. Its main function is to sense all the devices in the entire wind power system, so as to achieve monitoring In order to achieve the smooth operation of the system [10].

The faults of the electronic control system mainly include the bus fault of the pitch substation, the OK fault of the safety chain (the feedback of the safety chain is lost), the feedback loss of the capacitor fuse on the motor side, and the fault of the UPS battery of the main control cabinet. shown, where the safety chain OK fault and motor side capacitor fuse feedback loss, the longest fault time is more than four hours. The working environment of wind turbines is harsh, and the work is accompanied by high temperature and vibration, resulting in a high failure rate of the electronic control system.

Table 2. Electronic control system fault statistics

Classification	Fault description	Occurrence	Proportion	Maximum failure time
Electronic control system	Pitch substation bus fault	12	24%	0:19:56
	LVD control cabinet temperature is high	2	4%	0:11:41
	Safety chain OK failure	7	14%	4:54:57
	Motor side capacitor fuse feedback lost	12	24%	7:41:07
	high cabin temperature	2	4%	0:01:40
	Impeller lock not fully released	2	4%	0:02:15
	The main circuit breaker fails to close	4	8%	0:02:26
	Main control cabinet UPS battery failure	10	20%	0:34:09

In the operation and maintenance process of the electronic control system, the first step is to check the working status of the PLC, whether a crash condition occurs, whether the PLC display and operation interface are normal, and whether the PLC shell is overheated. If the PLC check is normal, carry out the second-step communication check, including the working conditions of the module power supply, the wiring between the communication modules and other main contents. If the communication check is normal, proceed to the third step of the safety chain inspection to carefully check all nodes in the safety chain loop to ensure that all problems in the safety chain loop can be found [11-12].

3.3.Pitch system

The pitch system installed in the fan hub can control the power of the unit by changing the pitch angle of the wind rotor, and can also be used as an air brake to make the wind rotor feather brake, which is an important protection for the wind turbine. and control devices [13-14].

The faults of the pitch system include the pitch position comparison fault, the unbalanced pitch capacitor voltage, the pitch 5° proximity switch fault and the high temperature of the pitch motor. Balance, pitch position comparison failure and pitch 5° proximity switch failure all have a maximum failure time of more than ten hours. During the operation of the fan, the hub of the fan is in a state of continuous rotation, which causes all the components inside the pitch system to bear the pulsating load caused by the centrifugal force and the continuous change of gravity in the direction. Poor conditions are prone to failures [15].

Table 3. Pitch system fault statistics

Classification	Fault description	Occurrence	Proportion	Maximum failure time
Pitch system	Pitch capacitor voltage unbalance	12	44%	10:52:40
	Pitch motor temperature is high	1	4%	0:02:49
	Pitch 5° proximity switch failure	2	7%	12:24:01
	Pitch position comparison failure	12	44%	17:19:46

During the operation and maintenance of the pitch system, in order to ensure that the braking torque of the pitch motor meets the requirements for use, it is necessary to check the working conditions of the pitch motor brake pads on time. If the wear is serious, it should be replaced in time. In addition, in the process of operation, if the limit switch is found to be faulty, it should be replaced immediately. At the same time, pay attention to the aging of the battery and the tightness of the mechanical and electrical connections. Finally, make sure to clean the slip ring regularly. The pitch system can significantly reduce the occurrence of failures by performing component inspections and regular maintenance in daily operation and maintenance [16-17].

3.4.Generator system

The generator in the wind turbine is used to convert mechanical energy into electrical energy and achieve the purpose of supplying power to the power grid. The generator is prone to failures when it works continuously under various variable conditions including electromagnetic interference [18].

The faults of the generator system are mainly speed comparison faults. As shown in the fault statistics of the generator system in Table 4, the fault occurred 31 times in eight months. The fault may be caused by loose wiring of the generator system, failure of the impeller speed proximity switch, failure of the speed measurement circuit fuse, damage to the system module, deformation of the speed detection disc, etc.

Table 4. Generator system fault statistics

Classification	Fault description	Occurrence	Proportion	Maximum failure time
Generator system	Speed comparison failure	31	100%	0:39:09

When a speed comparison fault occurs in the generator system, the following methods can be used to check during the operation and maintenance process: The first step is to observe the signal detected when the impeller is in a free rotation state, and determine whether the proximity switch is faulty. disposal and replacement. The second step is to check the Overspeed, Gspeed and Gpulse modules to see if the wiring between these modules is correct. At the same time, check whether the insurance of the Gpulse circuit works. If the above problems exist, the wiring needs to be corrected. The third step is to check the speed proximity switch. On the premise that the impeller is locked, determine whether the distance from the generator speed detection plate meets the actual needs, and at the same time, check whether the grounding of the shielding layer can work normally, and observe by placing a metal object on the top. If the fault still exists after completing the first three steps of troubleshooting, you need to use the troubleshooting method to find the fault, replace the same module between the units, and observe whether the fault is transferred to the replacement unit [19].

3.5.Yaw system

The unique servo system of the wind turbine is the yaw system, also known as the wind system, which is a part of the wind turbine cabin. Quasi-wind direction [20].

The faults of the yaw system are mainly left yaw feedback loss, yaw position overrun and yaw speed fault, as shown in Table 5 yaw system fault statistics, among which the left yaw feedback loss not only occurs more frequently, but also has the longest fault duration. more than three hours.

Table 5. Fault statistics of yaw system

Classification	Fault description	Occurrence	Proportion	Maximum failure time
Yaw system	Yaw speed failure	1	9%	0:03:17
	Yaw position overrun	2	18%	0:34:19
	Left yaw feedback lost	8	73%	3:11:15

The left (right) yaw feedback is lost in the wind turbine. During the operation and maintenance process, check whether the wiring in the system is correct, whether the contactor, yaw solenoid valve, yaw motor resistance, fan yaw and air switch are correct. Normal operation, whether there is peculiar smell in the cabin, etc., such faults should be analyzed in detail, and targeted analysis and processing should be carried out for the fault phenomenon [21-23].

3.6.Hydraulic system and others

The 1.5MW wind turbines that have been put into operation in Xinjiang all use variable pitch technology [24]. In the variable pitch wind turbine, the main function of the hydraulic system is to control the power of the wind turbine by controlling the pitch mechanism. As well as the rotational speed, at the same time, it can also control the drive yaw reducer and the mechanical brake mechanism [25].

The failure of the hydraulic system is mainly due to the low oil level of the hydraulic system, as shown in the statistics of the hydraulic system and other failures in Table 6. The possible cause of this failure is that there is an oil leakage in the hydraulic system. Due to the existence of the oil leakage point, the hydraulic oil inside the system leaks out, resulting in a low oil level. Other failures mainly include anemometer failure and abnormal operation of the cabin acceleration sensor.

Table 6. Statistics of hydraulic system and other faults

Classification	Fault description	Occurrence	Proportion	Maximum failure time
Hydraulic system	Hydraulic system oil level is low	2	40%	0:06:18
others	Anemometer failure	1	20%	0:01:13
	The cabin accelerometer works abnormally	2	40%	1:27:57

If the oil level of the hydraulic system is low, check the following procedures in sequence: whether each oil pipe in the hydraulic system is damaged, whether the sealing gasket of the body is damaged, whether the sealing gasket at the interface of the high-pressure filter is damaged, and check the oil level of the oil level gauge. Check the oil level of the oil level gauge again after the oil filling is completed. If it is not normal, the oil level gauge is damaged and needs to be replaced. According to the detected oil leakage point, select the appropriate maintenance method [26-27].

The causes of the anemometer failure may be the damage of the anemometer, the loose connection of the anemometer loop, or the damage to the measurement module corresponding to the anemometer. In the operation and maintenance process, first observe whether the wind speed data has obvious jumps. If there is, it may be caused by a problem with the resistance. At this time, the resistance needs to be replaced. Next, check the measurement module of the anemometer. If it is abnormal, the module needs to be replaced. At the same time, check whether the wiring of the anemometer is loose. If it is loose, strengthen the wiring. Finally, if the fault still exists, the anemometer needs to be replaced[28].

The abnormal operation of the cabin acceleration sensor may be caused by loose or disconnected feedback signal loop wiring, damage to the acceleration module, damage to the measurement module, extreme severe wind conditions, and sensor signal interference. During the operation and maintenance process, first judge whether the fault is caused by extreme wind conditions according to the wind condition information at that time, and then check whether the corresponding wiring is loose according to the drawings, and tighten the wiring at the same time, and then check whether the internal wiring is burnt. If not, you can try to replace the acceleration sensor, and finally check whether the indicator light of the module is abnormal, and replace it if it is abnormal.

4. Preventive Maintenance

During the daily operation and maintenance of wind farms, regular inspection and post-fault maintenance should be combined with preventive maintenance, including technical means such as spectrograph analysis, vibration analysis and temperature recorder analysis. By adding preventive maintenance, potential problems can be predicted before equipment failures, and related components can be dispatched and replaced in time, reducing equipment failure rates, reducing downtime, increasing power generation, and better managing spare parts inventory, providing flexible and flexible adjustment maintenance cycle [29-32].

4.1.Spectrograph analysis

Every six months is a cycle, take part of the oil samples and send them to the laboratory for analysis to detect the viscosity, moisture, suspended particles and pH in the oil samples. If the increase of the above indicators exceeds the limit value, it means that new oil needs to be replaced.

The change in viscosity indicates that the oil is in extreme temperature conditions, and the additives in it have lost their function; if the moisture exceeds the upper limit, the lubricating performance will be reduced, and the maximum allowable upper limit for the fan is 2%; the increase of suspended particles indicates that the components inside the gearbox are seriously damaged Wear; an increase in total acidity indicates an increase in the acidity of the oil, which will cause the internal components of the gearbox to be susceptible to corrosion.

4.2 Vibration Analysis

The vibration of key parts is regularly detected with a vibration analyzer, and the analysis of the vibration signal can reflect the internal operation of the machine. Displacement detection can be used to detect low frequency vibration, velocity detection can be used to detect high frequency vibration, which can reflect unbalance, misalignment and loose foundation, and acceleration detection can be used to analyze bearing operation and high frequency vibration.

For example, in the fan impeller, by monitoring the vibration of the blade, the state characteristics of the blade during operation are extracted, and then the self-associative artificial neural network is used to analyze the fatigue of the blade to identify and identify the faults in the blade. In the gearbox, the frequency spectrum of the high-speed horizontal axis and the time-domain waveform can be observed by the vibration analysis method. If there are some peaks exceeding the threshold in the frequency spectrum, combined with multiple frequency spectra, it means that the deviation between the generator and the gearbox is serious. middle.

4.3 Analysis of temperature recorder

The temperature is measured at various points, and an abnormal rise in temperature will indicate a problem. Temperature recorders (infrared cameras) are used to identify hot spots on electrical equipment, or other hard-to-reach areas of machinery.

Whether the temperature is normal or not is an important observation method for judging whether the bearing is abnormal. If the temperature rises abnormally, it means that the bearing is in an abnormal state. Excessive temperature will cause the working clearance of the bearing to decrease rapidly and the thermal stress to increase rapidly. The problem of frictional heat generation will be aggravated by this. At the same time, the bearing will generate a large amount of heat in a short period of time, which will cause large thermal stress deformation, thereby reducing the working efficiency and reliability of the bearing.

5. Development Trend

With the development of computer technology and data acquisition technology, a unified online monitoring system platform has been established. Some of the existing advanced monitoring methods include unit online condition monitoring system, expert system, oil online monitoring system and big data, etc. By adopting the online condition monitoring system, predictive maintenance can be carried out, excess maintenance can be eliminated, and equipment availability can be improved, increasing the power generation [33]. The use of expert systems can provide a basis for preventive maintenance of wind farms and improve fault diagnosis capabilities [34]. Using the oil online monitoring system, the wear condition of the gearbox can be judged by monitoring the oil quality used, which helps to find faults in advance [35-36]. Through the use of big data, and the fusion and deep mining of big data, the efficiency of fault diagnosis can be effectively improved [37].

Through the construction of a unified online monitoring operation and maintenance system, effective results have been shown in improving operation and maintenance efficiency, reducing operation and maintenance costs, and intensive management. With the continuous development of "Internet +" technology, the operation and maintenance of wind turbines will become more intelligent, and the intelligent operation and maintenance of the whole life cycle will definitely be the key and core technology of wind power operation and maintenance. Intelligent operation and maintenance is the comprehensive use of Internet technology and big data processing technology, combined with control technology and sensor technology, by matching the big data platform and the Internet of Things platform built by wind turbines, to coordinate the operation, management, monitoring, maintenance and other work, so as to realize wind power generation. An intelligent operation and maintenance model that maximizes the economic benefits of the farm.

Application Scenario 1: Analyzing Cross-Application Systems

At present, the operation and maintenance monitoring system of most wind farms is composed of multiple platforms, and different platforms are usually completed by different development teams. The development environment and code language between platforms are inconsistent, which leads to various internal monitoring systems. The platforms work independently and lack integrity and unified management capabilities. Based on the existing IT monitoring system and log data of the enterprise through the cloud smart business operation and maintenance platform, the intelligent data collector is used to obtain performance-related indicator data. The business process is completely sorted out and displayed.

Application Scenario 2: Fault Location and Analysis

The unified online monitoring operation and maintenance system will be set to a fault warning mode, the faults will be sorted by level, the severity of the fault will be distinguished, the priority of the fault will be determined, and the fault will be sent to the operation and maintenance management department of the wind farm as soon as possible. " function, the site photos, fault location and root cause analysis are sent in time, so that the site operation and maintenance personnel can diagnose the fault in time and determine the maintenance strategy before arriving at the fault site. The use of intelligent operation and maintenance makes the operation and maintenance work prioritized, the on-site work is more orderly, and the fault location and troubleshooting efficiency are significantly improved.

6. Conclusion

1) In view of the frequent failures of the converter system, electronic control system, generator system, pitch system, yaw system, hydraulic system and other aspects of the 1.5MW wind turbine in Xinjiang, wind farms should pay attention to these problems in the daily equipment management of wind farms. Scientific management and allocation of common equipment and spare parts ensure that maintenance time is not wasted due to shortage of equipment and spare parts.

2) As the wind power generation industry has entered a stage of rapid growth, the importance of maintenance and operation and maintenance after wind farm failures has also increased significantly. Fault handling methods, and continue to explore and summarize, sum up experience and methods, establish a set of detailed operation and maintenance procedures suitable for their own wind farms, and formulate scientific and reasonable wind farm management regulations.

3) The advantages of intelligent operation and maintenance are fully demonstrated, and the ability of professional and technical personnel in the daily operation and

maintenance of wind farms has been continuously improved. It is not only necessary to deal with daily faults and safe operation and maintenance of wind farms, but also to combine the characteristics of enterprises to make intelligent High-quality and efficient operation and maintenance, continuous innovation in the process of intelligentization, and improvement of the operation and maintenance management level of wind farms.

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