Research on improvement of ambient temperature of wind turbine engine room

Gao Yang¹, Fu Shiming¹, Liu Baoliang¹, Leng Xuemin¹

1 Shenyang Institute of Engineering, Shenyang, China
E-mail: gaoyangsie@163.com

Abstract. A good cabin environment and reasonable cabin temperature are a powerful guarantee for the safe operation of wind turbines. By installing the cabin intelligent filtering and cooling system in the wind turbine, the cabin environment can be effectively improved, the cabin temperature can be reduced, the downtime of the wind turbine can be reduced, the grid-connected operation time of the wind turbine can be improved, the safe operation of the wind farm can be guaranteed, and the wind farm can be improved. Operational efficiency and economic benefits.

1. Introduction
With the increasing shortage of energy in the world, the global warming of the climate, and the increasing awareness of environmental protection, the low-carbon economy has become the focus of global attention [1]. Wind power generation has a low-carbon, low-pollution, low-carbon power development model, and has become one of the important strategic choices for sustainable energy development. In recent years, China's demand for energy and environmental protection have been continuously strengthened. The advantages, advantages, economics and practicality of wind power generation have been prominent, making the installed capacity of wind turbines the first place in the installed capacity of renewable energy power generation.

The wind turbine is a large and complex mechanical device that is unattended for high-altitude operation. The installation location is in a harsh environment, and the work will continue to generate heat in the form of friction, collision, and electromagnetic loss. Although the wind turbine is equipped with a heat sink, there are still serious problems such as an increase in the cabin ambient temperature, a decrease in the lubrication level of the lubricating oil, an acceleration of the cabin pipeline aging, and even a deflagration of the cabin. To this end, the temperature rise threshold of the main heat-generating components bearings, gearboxes, generators, etc. in the engine room is set. After the over-temperature, the wind turbine group actively implements shutdown and risk avoidance. According to the statistics of Datang (Chifeng) wind farm, the number of unit shutdowns caused by over-temperature of components exceeds 40% of the total number of abnormal shutdowns. It can be seen that the problem of heat dissipation in the cabin has not been effectively solved, which seriously inhibits the availability of wind turbines and Cost recovery. The study of the ambient temperature over temperature problem in the wind turbine nacelle focuses on three aspects. (1) Internal study of component heating. Many scholars analyze the distribution of temperature fields by simulating wind turbines [2-3]. (2) Research on heat dissipation of wind turbine cabin structure. Ma Tieqiang et al. studied the layout of the wind turbine nacelle and its different heat dissipation airflow
configuration, the heat dissipation efficiency of the unit is different, and the thermal coupling between the airflow and the components becomes a key factor affecting heat dissipation [4]. (3) Research on the influence of working environment of wind turbines on heat generation. SMAILI and others provide power matching for the cabin cooling system by studying the thermal performance of the wind turbine nacelle at extreme temperatures [5].

The above research laid the foundation for controlling the heating and cooling of the wind turbine engine room. However, for the actual operation of the wind power system, it is still very important to improve the cabin environment to reduce the cabin temperature, avoid the limited power operation of the unit, and even be forced to stop the research.

2. Cabin temperature over temperature causes

2.1. Cooling system itself problem

Problems with the cooling system itself can cause the cabin temperature to be too high. (1) Cooler failure, such as short circuit of the internal wiring of the cooler, open circuit, burned out of the motor, etc., can cause the fan to not operate and affect heat dissipation. (2) The large amount of dust on the cooler fins affects the heat dissipation of the cooler, resulting in insufficient cooling. (3) The relief valve is a pressure relief element and should function when the oil temperature of the gearbox is low and the pressure is high. At present, when the oil temperature is high, the overflow valve still has oil flow, so that the amount of oil that has been cooled is reduced, and some of the oil is directly returned to the gear box without cooling, resulting in insufficient overall cooling and high oil temperature. (4) Insufficient cooling causes the oil temperature to be too high, so that the high-speed bearing temperature cannot be effectively removed, resulting in an excessively high bearing temperature and an increase in the cabin ambient temperature.

2.2. Lubrication system does not function fully

The lubrication system does not function effectively and the cabin temperature is too high. (1) Open the rear box observation cover to check the bearing oil condition, and find that the oil is small, indicating that the bearing oil quantity is insufficient. The main reasons for this situation are: the oil inlet hole design is too small, resulting in insufficient oil intake; the tank oil inlet hole and the oil inlet ring oil tank are misplaced; the oil hole is blocked by impurities, resulting in a decrease in oil volume; the oil inlet hole is not drilled. through. (2) The pressure valve or temperature control valve of the lubrication system is wrong. When the oil connection between the filter and the gearbox is correct, when the oil temperature exceeds 55 °C, the filter to the oil distributor tube still has oil flowing, indicating that there is a problem with the temperature control valve of the filter and affecting heat dissipation. (3) If the gear is insufficiently injected or the oil hole is not aligned with the gear, the gear temperature will be too high, and the bearing temperature will be high[6].

3. Traditional treatment methods for the cabin environment

3.1. Manual dust removal

Traditional dust removal methods in the cabin environment are usually carried out by the operation and maintenance personnel on the top of the wind turbine. Generally, manpower is used to clean the cabin equipment and the heat exchanger of the gear box. If the cabin environment temperature is high, the operation and maintenance personnel open the cabin sunroof and rely on the natural wind to reduce the cabin temperature. This requires both manpower and material resources, long downtime, and limited dust removal and heat dissipation. At the same time, due to repeated flushing of the surface of the gearbox cooler, the service life of the gearbox oil cooling fan oil circuit board is seriously affected[7].
3.2. Using a high power cooler
In order to avoid overheating of the gearbox, the equivalent cooling power of the “wind/oil cooler” in the system can be increased by increasing the heat exchange capacity of the lubrication system, i.e., the design is larger without changing the original oil circuit and the fan structure. The power cooler replaces the original cooler.

3.3. Add a cooler
In order to improve the heat exchange capacity of the lubrication system, a separate air-cooled oil cooler is added to the original cooling system to work with the original cooler, and the oil circuit is connected in series with the original cooler.

4. Intelligent control of the cabin ambient temperature
In order to solve the shortcomings of the traditional treatment methods in the cabin environment, this paper installs the cabin environment intelligent filtration and cooling system in the wind turbine to improve the cabin environment and reduce the cabin temperature.
The cabin environment intelligent filtering and cooling system has 6 temperature sensor access control systems, which are arranged in the front and rear ends of the gearbox radiator, the circulation and outer circulation in the gearbox radiator oil pipe, the outside of the engine room cabinet and the outside of the engine room. When the temperature difference between the front end and the rear end of the heat sink is less than 10 °C, it proves that the heat dissipation effect of the heat sink is not good, and the heat sink is clogged with dust, and the control system automatically sends a start command to the cabin dust removal filter device. The frame of the cabin dust removal filter device adopts German standard 50*50 aluminum profile, the structure is fastened, shockproof and tensile; the filter mesh adopts 304 stainless steel with good air permeability, which does not affect the heat dissipation effect of the radiator. When the control system sends a servo motor start signal to the dust filter device, the servo motor automatically drives the filter through the synchronous teeth belt to drive the screen guide shaft. In order to ensure that the filter is always stretched, it will not slant and run out of the track. The filter device is equipped with a damping device to work with the servo motor.
When the temperature of the gearbox tubing outer circulation and internal circulation monitors that the temperature reaches 60 °C, and the internal circulation temperature is greater than the external circulation temperature, it proves that the temperature control valve fails. When the control system monitors that the cabin temperature exceeds 45 °C, the cabin temperature is high, and the control system sends a start command to the axial fan of the ventilation device. When the cabin temperature drops below 45 °C, the axial fan stops working. The axial flow fan adopts integrated thick cast iron fan blade design, which has high strength and is not easy to deform and fall off. The impeller has a good aerodynamic performance after strict dynamic balance calibration, large air volume, thick cast iron casing, high temperature spray paint treatment, and wear resistance. Loss, corrosion resistance, light weight, high hardness, anti-shock and anti-drop. At the same time, the motor is fixed by triangular mechanics, which can effectively reduce the vibration generated by the motor during operation and ensure the continuous and safe operation of the motor. The motor is powered by 220V, the power is 0.12kW, the speed can reach 1450r/min, and the air volume is 2000m³/h. It achieves low energy consumption, low noise and high air volume, and the cooling effect has been tested to 7.6°C.

5. Economic Benefit Analysis
The wind turbines of the wind farm each have a capacity of 1.5 MW. Each year, due to the high temperature and windy weather, the wind turbines are shut down about 10 times, and the average time for each downtime recovery is 8 hours. Each wind turbine is polluted by the fan environment and the heat dissipation of the gear box is not good. The resulting oil temperature is overheated and the power loss can
reach 1.2 million kWh. A wind farm with 33 units of 49.5 MW capacity will lose 39.6 million kWh per year. According to the standard of wind power on-grid 0.6 yuan/kWh, the annual loss will be 2.376 million yuan. It can be seen that after the wind turbine is installed in the cabin environment intelligent filtering and cooling system, the cabin environment is improved, the cabin temperature is reduced, the number of shutdowns of the unit is reduced, the grid-connected operation time of the wind turbine is effectively improved, and the power generation of the wind farm is increased, thereby improving The economic benefits of wind farms.

6. Conclusion
After installing the cabin intelligent environment filtering and cooling system, the wind turbine greatly improved the cabin environment of the wind turbine, reduced the cabin temperature, ensured the safe operation of the wind farm, reduced the downtime of the wind turbine, ensured the utilization of the wind turbine, and improved the operating efficiency of the wind farm. Economic profitability.

7. References
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