Short circuit fault analysis and solution research of equipment electric gas cabinet under conductive dust pollution environment

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Abstract: The production of conductive dust not only pollute the environment, harm people's health, but also bring great harm to the safe operation of electrical equipment. Such as shorting electrical equipment, electrical switch according to touch bad, poor ventilation, etc., it is easy to cause equipment electrical cabinets failure problems, in order to strengthen the reliability of enterprise production, for the timely and effective maintenance of the equipment failure, and take effective measures to guarantee with the safe operation of the equipment electrical cabinets in conductive dust environment. A great deal of work has been done in this paper to prevent the harm of dust to the electrical equipment and remarkable results have been obtained.

1. INTRODUCTION
The hot pressure tank hall is mainly responsible for the production of composite products, while the winding machine hall is mainly responsible for the production of carbon fiber products. Carbon fiber dust is usually PM0.3-PM10, of which more than 95% is PM0.3-PM1. Because sealing performance of the traditional electric cabinet are very poor, carbon fiber is easy to be dispersed into the air and fall to the inside of the electric cabinet through the gap of the electric cabinet, thus falling on the parts of the electric cabinet, thereby damaging the insulation performance of the electric cabinet and causing short-circuit phenomenon of the electric cabinet. The short circuit of the electric cabinet will directly destroy the power module, thus causing economic loss. In the short circuit of the electric cabinet, carbon fiber is vulnerable to thermal gasification, which will produce electric arc, causing losses to the workers and electrical equipment. With the accumulation of carbon fiber dust, the power supply of electrical equipment will be insufficient and abnormal, and the quality of electrical equipment will appear. From 2017 to 2019, the manufacturing center of composite products analyzed and studied the short-circuit fault of electrical equipment caused by carbon fiber entering the electric cabinet, repair and replace the electric cabinet, and evaluate the potential safety problems of the electric cabinet based on the future development trend of the electric cabinet. To sum up, the facilities and equipment of the electric cabinet in the hot pressure tank and winding machine hall need to protect and deal with carbon fiber regularly, and the electric cabinet should be cleaned and sealed strictly, so as to effectively avoid casualties and equipment damage caused by the short circuit of the electric cabinet. [1-4]

2. PROGRAM ANALYSIS
In order to effectively solve the problem of carbon fiber protection of the electric cabinet facilities and equipment in the composites workshop, relevant departments analyzed it and formulated the following solutions: through the purification renovation of the workshop, replacing the traditional electric cabinet with the new anti-riot electric cabinet or the traditional electric explosion-proof renovation. After several
inspections and discussions on the site, relevant personnel decided that the explosion proof transformation of the traditional electric cabinet was the best solution to the carbon fiber problem after considering the relevant issues such as cost and cycle. Under the premise of the lowest cost, implement the dustproof renovation plan of the electric cabinet in the composites workshop, and then maintain and manage the electric cabinet regularly, so as to achieve a better dustproof effect. See Table 1 for the number and types of electric cabinet facilities and equipment that need to be reformed to prevent dust.

Table 1 Number and type of equipment electric cabinets

| type                                      | Quantity |
|-------------------------------------------|----------|
| Ventilating and circulating equipment electric cabinet | 20       |
| Air-conditioning internal circulation equipment electric cabinet | 12       |
| Crane equipment electric cabinet          | 13       |

Firstly, the environmental conditions of the composites workshop are evaluated. The test results of conductive dust such as carbon fiber floating in the air of some workshops are shown in Table 2. The classification of environmental conditions is shown in Table 3.

Table 2 Test results of conductive dust in electric cabinet before modification

| Project | Outside the ark |
|---------|-----------------|
|         | PM0.3           | 35690/ft3 |
|         | PM0.5           | 14580/ft3 |
|         | PM1             | 9450/ft3  |
|         | PM3             | 5690/ft3  |
|         | PM5             | 2632/ft3  |
|         | PM10            | 785/ft3   |

Table 3 Environmental condition grade

| level                        | Environmental conditions                                                                 |
|------------------------------|------------------------------------------------------------------------------------------|
| Pollution level 1            | Non-conductive pollution with no contamination or only drying                             |
| Pollution level 2            | In general, there is only non-conductive pollution. However, occasional temporary conductivity due to condensation is also considered |
| Pollution level 3            | The presence of conductive contamination or the conversion of dry non-conductive contamination from condensation into conductive contamination |
| Pollution level 4            | Cause persistent conductive contamination                                                |

Hazard identification and risk assessment were carried out for the electrical cabinet dustproof renovation project in the composites material workshop of our factory according to the control procedure of Q/WR-E/O-CX01-2012 in the E/O system program file (See Table 4).

Table 4 Hazard identification, risk assessment and risk control Table

| workplaces                          | hazards                                                                 | An accident that could result                | Risk assessment of operating conditions | Control measures to be adopted                  |
|-------------------------------------|-----------------------------------------------------------------------|----------------------------------------------|-----------------------------------------|------------------------------------------------|
| Enter the production site           | Wear do not conform to the requirements of the production              | Personal injury, equipment injury           | L E C D                                 | Dress in strict accordance with the production site management requirements, admission inspection |
### 3. IMPLEMENTATION PLAN

The specific implementation plan is as follows:

1. Ventilating and circulating electric cabinet equipment can cooperate with 3FD3310X air duct cleaning machine and MD industrial vacuum cleaner to clean the electric cabinet in the workshop.

2. Due to the sealing of the electric cabinet itself, there is little gas leakage, but the cable trench and trough of the electric cabinet need to be sealed with anti-dust sealing materials such as explosion-proof
mud and sealant, so as to ensure the normal operation of the gas flow channel in the electric cabinet.

3. Self-designed high efficiency purification air supply module can effective dustproofing and 24-hour continuous operation. The high-efficiency purification air supply module is composed of the large-volume silent axial flow fan and ultra-low resistance high-efficiency particulate filter, and it is calculated through the air volume, pressure difference and air change times, so as to select the appropriate components.

The air entering the electrical cabinet from the air supply module can be discharged from the fan at the top of the electrical cabinet, forming an airflow path inside the cabinet, and some of the air will leak out from the gap in the electrical cabinet, forming a slight positive pressure of about 5Pa inside and outside the electrical cabinet.

For the air conditioning internal circulation electric cabinet, the same rectification plan as above, cleaning - sealing - installation of industrial dustproof dedicated high-efficiency purification air supply module, to achieve its internal purification cycle, reduce the carbon fiber dust accumulation speed. The actual air supply capacity of the efficient air supply purification module should be more than 88m3/h. Establish a 5-10Pa pressure difference between the inside cabinet and the external environment. The size of the typical electric cabinet is also about 1000×800×2200mm, and the internal volume is about 1.76m3, which ensures that the air change times in the electric cabinet can reach more than 50 times per hour. The device selection is shown in Table 5.

### Table 5 Specifications and parameters of selected materials

| Equipment | Specification | Parameter |
|-----------|---------------|-----------|
| High Volume Silent Fan (20060HA2BL) | speed | 2500(r/min) |
| | Blade diameter | 180mm |
| | The initial air volume | 285m3/h |
| | Overall dimensions | 200*200*60mm |
| | voltage | AC220 |
| | power | 65w |
| Ultra-low resistance and high efficiency particulate filter | The initial wind resistance | 28Pa |
| | The initial wind damage | 45% |
| | Filtering level | H12 |
| | Testing standard | 《Air Filter》GB/T 14295-2008 |
| | Filtration efficiency | 99.95% |
| Purification air supply unit | The initial air volume | 156m3/h |
| | Initial air change | > 50times/h |
| Control the reasonable pressure difference of the electric cabinet | The differential pressure is achieved through the air supply module and the hermetic modification of the electrical cabinet. | 5-10Pa (filter should be replaced when the differential pressure is less than 3Pa or there is no air supply in hand feeling) |

After the electric cabinet is upgraded, maintenance shall be carried out every 3 months or so, the coarse and fine filter screen of industrial grade FFU installed in the electric cabinet shall be replaced, and trace carbon fiber dust which may accumulate in the electric cabinet shall be cleaned with alcohol.
4. TEST THE RECTIFICATION EFFECT
A phased summary test was conducted on the reformed electric cabinet. The ground electric cabinet of winding machine with frequent short circuits and severe pollution was taken as samples. After opening the automatic purification device for 5 minutes, a comprehensive comparative test was conducted on the concentration of dust particles in the internal and external environment of the electric cabinet, and the test results were shown in Table 6. The test results show that the concentration of conductive dust pollutants within the range of PM0.3 to PM10 in the modified electric cabinet is far superior to the external environment, and the purification effect reaches the design purpose.

Table 6 Test results of conductive dust in the electric cabinet after modification

| project | Outside the ark | ark | Outside/inside the cabinet |
|---------|----------------|-----|---------------------------|
| PM0.3  | 34590/ft3      | 520/ft3 | 66                        |
| PM0.5  | 14960/ft3      | 310/ft3 | 48                        |
| PM1    | 9660/ft3       | 90/ft3  | 107                       |
| PM3    | 5560/ft3       | 60/ft3  | 92                        |
| PM5    | 2530/ft3       | 50/ft3  | 50                        |
| PM10   | 820/ft3        | 10/ft3  | 82                        |

5. CONCLUSION
Through the self-designed high-efficiency purification air supply module, as well as the old equipment electrical cabinet sealing modification, achieved carbon fiber protection of equipment electrical cabinets in conductive dust environments. After modification, the electrical cabinet can continuously generate 5-10Pa of micro positive pressure to prevent the entry of conductive dust. After the modification, the internal environment of the electrical cabinet reached the level of ten thousand and clean room, after 3-4 months of use, there is no obvious dust accumulation in the electrical cabinet, no short-circuit failure, the transformation effect is good.

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