Research and analysis on the dustproof structure of low voltage switchgear

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Abstract. This study improves the dustproof effect by changing the appearance structure of the low voltage switchgear. The exterior structure of the low-voltage switchgear adopts S profile to prevent dust from entering the cabinet body and make dust proof treatment at the connection of the cabinet board parts. Through the dust experiment, compare the protective effect of low-voltage switchgear with common appearance structure, low-voltage switchgear with common appearance structure after dust-proof processing and the new type of structure. Finally, it is concluded that the low-voltage switchgear can effectively reduce the entry of dust by increasing the complexity of dust entry channels, and the S-shaped appearance structure can reduce more than half of the dust entering compared with the ordinary appearance structure.

Keywords: dustproof structure, low voltage switchgear.

1. Background

Low voltage switchgear is an important power transmission and distribution equipment in power industry, which is closely related to national economy and social development. With the wide application of intelligent distribution system, the emergence of new technologies, new materials and the rising economy, the complete set of low-voltage switchgear equipment also has new requirements and new directions [1]. At present, a large number of research and practice are constantly improving the intelligence level and reliability and stability of switchgear, it has become the inevitable trend of the development of low-voltage switchgear in developed countries among which intelligence, miniaturization, high performance and safety performance, high reliability, maintenance free, pay attention to environmental protection and so on [2]. Digital integration technology has been widely used in low-voltage switchgear sets due to its important characteristics of convenient digitalization in control, protection and detection. With the development of economic society and science and technology in our country, power transmission and transformation industry had a golden opportunity of development, the domestic study of low-voltage switchgear mainly concentrated in the intelligent control system, in order to adapt to a higher voltage class [3]. With the development of intelligence, the application range of low-voltage switchgear is more and more extensive, including electric power industry, machinery manufacturing industry, petrochemical industry and commercial construction industry, etc [4].

However, the wide range of applications will inevitably increase the requirements for stability, and the requirements for dust prevention are harsh in some special environments. At present, there are few
literatures on the dust prevention of the appearance structure of the low-voltage switchgear, the dust prevention methods mostly adopt the traditional sealing method, which can meet the requirements of the general environment, but the effect is poor in the harsh environment, and the protection grade cannot meet the requirements of the use.

2. Research ideas and contents
Based on the existing problems of low-voltage switchgear dust, this study provides a new design idea. A new appearance is adopted to increase the structural complexity of the joint of the low-voltage switchgear and increase the length of the entry passage of dust, to reduce the quality of dust which enter the low voltage switchgear. For this purpose, the following low-voltage switchgear is designed. The exterior structure of the low-voltage switchgear adopts S profile to prevent dust from entering the cabinet body and make dust proof treatment at the connection of the cabinet board parts. Through the dust experiment, compare the protective effect of low-voltage switchgear with common appearance structure, low-voltage switchgear with common appearance structure after dust-proof processing and the new type of structure. The specific design of the new exterior structure is as follows.

New appearance structure including the frame body, top cover plate, on the left side of the sealing plate, the right side of the sealing plate, after sealing plate, door plank, and floor; The frame body by a number of beam and column connection of removable fixed, the column using S profile, the S-shaped body formed by folding the plate, folding overlapping to form a double-layer structure, a sealing strip is provided at the connection between the outer folding edge of the S profile and the sealing plate and the door plate.

![Figure 1. new-type exterior structure drawing of low-voltage switchgear.](image-url)
Figure 2. Enlarged view of the new exterior structure of low voltage switchgear.
11- First Flanging, 12- Second Flanging, 13- Third Flanging, 14- Fifth Flanging, 16- Sixth Flanging, 17- Seventh Flanging, 18- Eighth Flanging, 181- Eighth folding turn edging, 1811- Flanging Installation Hole, 19- Side Installation Hole, 2- left side of the seal plate, 3- Door Beam, 31- Door Beam Flanging, 4- Front and Lower Door, 5- Instrument Door, 6- Top Cover, 71- Sealing Strip 1, 72- Sealing Strip 2, 8-Back seal plate, 9- Right side of the seal plate, 10- Bottom Plate

3. Experimental method and procedure
The common appearance structure of the low-voltage switchgear, the common appearance structure after dust prevention treatment and the new structure were scaled down to make models, which were divided into three groups A, B and C for dust prevention experiments.

Using the dustproof experimental equipment as above, Group A, B and C were put into the experimental equipment with the temperature of 25°C and relative humidity of 40%. The dust is replaced
by talcum powder, and the dust concentration in the equipment is set at 2Kg/m3. Adjust the gas pressure of the dustproof experimental equipment to 20mbar. Group A, B and C were placed in the dustproof experimental equipment for 30min, 60min, 90min, 120min, 150min, 180min, 240min, 300min and 360min respectively, and during the time, using 20mbar of compressed gas blows talcum powder continuously, after reaching the setting time, take out three groups of equipment A, B and C and measure the quality of talcum powder entering the low-voltage switchgear. The experimental data are as follows:

Table 1. Quality of talcum powder inside low voltage switchgear.

| time(min) | 30 | 60 | 90 | 120 | 150 | 180 | 240 | 300 | 360 |
|-----------|----|----|----|-----|-----|-----|-----|-----|-----|
| A(g)      | 60.33 | 115.56 | 160.52 | 200.31 | 238.41 | 262.64 | 283.25 | 303.26 | 336.67 |
| B(g)      | 10.36 | 15.62 | 22.34 | 26.79 | 30.58 | 35.87 | 48.97 | 60.66 | 72.85 |
| C(g)      | 2.31 | 4.41 | 6.56 | 7.65 | 10.18 | 12.24 | 18.87 | 26.82 | 32.39 |

Put the data converted into a line chart to more intuitively study the dustproof effect of the three groups.

Figure 4. Quality variation trend diagram of the talcum powder inside low-voltage switchgear.

4. Results analysis

The experimental results were directly analyzed from the line chart and the following conclusions were drawn.

The first, as can be seen from the figure, as time goes by, quality of the talcum powder in all three experimental groups showed a trend of increase. For group A, the increase is faster and the increase is larger. However, after increasing to a certain extent, the quality of the talcum powder increase rate slows down. After observation, it is found that a large number of dust accumulations are formed at the joints of the equipment, and the accumulated dust plays a role in preventing the dust entering more. The quality of the talcum powder of group B and group C showed a stable rising trend, and the rising rate was consistent within the experimental time range. There is no obvious trend of increase or decrease.

The second, comparison of the three groups of experiments shows that the dustproof effect of group B and group C is obviously better than that of group A. It shows that the dustproof effect with sealing device is obviously better than that without sealing device.

The third, by comparing the experiments of group B and group C, the dust-proof effect of group C is obviously better than that of group B. The observation of the distribution of dust on its appearance come to a conclusion. The S-shaped material in Group C increases the length of the passage for dust to enter the inside of the equipment, and the curved passage is conducive to preventing dust from entering. A large amount of dust accumulates in the bend of the S-type material and cannot enter the inside of the equipment. At the same time, the accumulation of dust further prevents subsequent dust from entering the experiment, and further increased airtightness.
The fourth, through the data analysis, it can be seen that, with the increase of time, the quality of group C into talc powder changes little, and the maximum quality of talc powder is about 1/2 of group B, which plays a reliable dust-proof role.

The fifth, compared with the dustproof standard, both group B and group C can reach the dustproof IP5X standard.

5. Conclusion
Through this experiment, it is found that the low-voltage switchgear can effectively reduce the entry of dust by increasing the complexity of dust entry channels, and the S-shaped appearance structure can reduce more than half of the dust entering compared with the ordinary appearance structure.

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