STUDY ON THE APPLICATION OF ENCLOSURE IN CONTROLLING NOISE OF SUBSTATION

HU Sheng, ZHOU Jianfei, WU Xiaowen, PENG Jiwen, LU Ling and LI Tienan
State Grid Hunan Electric Power Company Limited Research Institute, Changsha, Hunan, China
e-mail: hbhusheng@163.com

Low frequency noise in substations usually is the main cause of the failure to meet the standards of environmental protection, especially in areas with higher requirements for acoustic environment. In this paper, in order to solve the problem which a substation noise at boundary exceed the emission limits, with considering the influence of ventilation and heat dissipation effect of main transformer room, a noise reduction comprehensive measure based on enclosure was proposed, and the noise reduction effect of the comprehensive measure based on Soundplan software was analyzed. The final implementation results showed that the enclosure was an effective means to ensure that the substation noise at boundary can meet the emission limits.

Keywords: Noise, substations, enclosure

1. Introduction

With development of social economy and quickening of urbanized progress, more and more people focus on the influence from noise produced from the operation of electric transmission and transformation equipment to life, the issue of environment protection caused by the operation noise of substation exists occasionally[1]. Therefore, many researchers have paid attention to the technique of noise treatment of substation. The noise of substation is mainly including electromagnetic noise of transformer and reactor, corona noise of substation structure, air flow and mechanical noise of cooling-fan installation. The sound-reducing facilities commonly used in noise treatment of substation have the noise barrier, soundproof cover, structure of sound absorption and damper, therein, the effect of soundproof cover is best[2-4]. This article studied the treatment of some substation exceeding the noise standard based on soundproof cover to make the noise emission reach Standard I[5].

2. Overview of substation

Figure 1: The substation without noise controlling measures
This 110kV transformer substation is a newly built station with two sets of 50000kVA main transformers running continuously for 24 hours under the normal condition. Transformers were installed in a completely sealed building with the brick-concrete structure, that the top was entirely open. Each main transformer room was equipped with a small door for routing inspection, three ventilating blinds were set at three locations in right front of transformers, there is a street between ventilating blinds and residential houses, the closest linear distance is around 10m, which is shown in Fig.1. the noise emission value of this station exceeds the requirement of Standard I of the Quality Standard of Sound Environment(GB3096-2008), namely, day 55dB(A), evening 45dB(A).

3. Status quo of substation noise

The distribution map of monitoring for the status quo of noise is shown in the Fig.2, the monitoring result of boundary noise and transformer noise are shown in Tab.1 and Tab.2 respectively. It can be known from table 1 that maximum values of boundary noise in the substation in the day and evening are 59.7dB(A) and 57.8dB(A) respectively, the monitoring result of south boundary noise in the day and evening exceeds the requirement of Standard I in Emission Standard of Boundary Environmental Noise of Industrial Enterprises(GB12348-2008).

![Figure 2: Monitoring-point distribution around the substation](image)

<table>
<thead>
<tr>
<th>Monitoring point</th>
<th>Day (dB(A))</th>
<th>Night (dB(A))</th>
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<table>
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<th>Monitoring point</th>
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<td>10</td>
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<td>mean</td>
<td>66.1</td>
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4. Analysis of standard-exceeding reason of noise of substation

Even though transformers were installed inside a completely sealed building with the brick-concrete structure, but there was nothing noise-reducing measure for the top of the main transformer rooms and ventilating vanes. Thus, the noise of transformers can be transmitted to the sensitive spots of residents through two locations said above.

Total eight sets of axial flow ventilators were set in the 110kV transformer substation. The noise of axial flow ventilators can be mainly classified into mechanical noise, noise of motor and aerodynamic noise, which can exceeds 65dB(A) from the data measured on site[6]. Especially, there were two sets of axial flow ventilators for the substations just with around 10m linear distance to the sensitive spots of residents, which still can affect the quality of sound environment of surrounding residential houses even through the distance attenuation.

The linear distance from capacitor rooms 1#, 2#, 3# and 4# to sensitive spot of surrounding residents is very close, the noise of capacitors inside them will also affect the quality of sound environment of surrounding residential houses.

5. Noise control scheme

5.1 Noise reducing measures

Considering the transmission routes and characteristics of the noise in the 110kV substation, and integrating with the evaluation index of Standard I, the following solutions of treatment were proposed:

- Ventilating silencers were installed right above transformers, and the top space of transformers was sealed.
- Doors in right front of transformers are replaced with soundproof doors, ventilating blinds are replaced with ventilating and silencing blinds.
- Eight axial flow ventilators were added with ventilator silencers.
- Doors of capacitor rooms 1#, 2#, 3# and 4# were replaced with soundproof doors, and lighting windows on the doors were replaced with double glazing soundproof windows, and ventilating blinds were replaced with ventilating and silencing blinds.

5.2 Design of noise reduction device

Two sets of ventilation silencer were installed right above transformer rooms 1# and 2# respectively, and the length and width of each set are 12m and 10m. The length of silencing vanes is 1m, the inclination is 45°, the inside of the vane is the structure of sound absorption, the outside of the vane is the rainproof structure with sound insulation. In addition, stainless steel meshes were added below the silencing vanes.

Two doors of main transformer rooms were replaced with soundproof doors, and the size of each door is 1000mm × 2100mm. Six sets of ventilating blinds were replaced with silencing blinds. Therein, the size of four sets is 1750mm × 1750mm, the size of two sets is 1400 × 1750mm, the thickness for all six sets is 600mm.

Eight sets of axial flow ventilators were added with ventilator silencers, the designing weighted sound insulation quantity Rw is 20dB(A).

Seven sets of doors of capacitor rooms 1#, 2#, 3# and 4# were replaced with soundproof doors, whose size all is 1800mm × 2400mm. Seven sets of lighting windows on the doors are replaced with double glazing soundproof windows, whose size all is 1800mm × 600mm. Two sets of ventilating blinds were replaced with silencing blinds, whose size all is 600mm × 1500mm and the thickness is 600mm.
5.3 Process of equipment and other technical requirements

In order to meeting the expected result after being implemented, the soundproof materials and the sound absorbing materials with sound insulation referred to this project should be satisfied with acoustics and other properties:

- Soundproof structure: sound insulation quantities of centre frequencies for 1/3 sound interval at the frequency of 125Hz~4000Hz are over 15dB, the weighted sound insulation quantity \( R_w \) is over 30dB(A).
- The structure of sound absorption: average sound absorption coefficients of centre frequencies for 1/3 sound interval at the frequency range of 100Hz~5000Hz are over 0.8.
- The noise reduction effect of materials can’t be affected by the atmospheric factor such as temperature, humidity, ice and snow and rain, and shall be satisfied with the requirement of stable operation under the given environmental condition.
- All noise reduction materials used in the engineering are incombustible.

5.4 Requirements of installation

Ventilation silencers were installed on eight bearing pillars of the current building, which details were shown in Fig.3. The sequence of installation was taking steel plate as supporting points—frame of silencer—components of silencer, the sequence of disassembly was inverse. For safety consideration, it needs to adjust the using time of electricity temporarily, and the main transformer shall be appropriately stopped when installing. The structural design of soundproof doors and windows, ventilation silencers, ventilating and silencing blinds and silencers of axial flow fans are considered as the permanent facilities, all investments are one-time.

![The installation sketch map of ventilation silencers](image)

5.5 Ventilation and radiation

The outlet silencer right above the transformer not only must meet the requirement of the sound insulation quantity, but also must have a good performance for ventilation. The inlet area in right front of the transformer was increased, so that the indoor environment of whole transformer rooms
are basic invariability compared with the original environment, which is consistent with the original effective inlet area.

The same case, the ventilation windows area of capacitor room 1#, 2#, 3# and 4# were increased, so that the indoor environment of whole capacitor room t are basic invariability compared with the original environment, which is consistent with the original effective inlet area.

5.6 Simulation calculation of noise reduction effect

SoundPlan which is a type of noise calculation software was used to calculate the contributions from transformer substation to surrounding noise before and after applying the measure of noise reduction, and the calculate results were shown in Fig.4 and Fig.5, which indicated that the boundary noise will decrease 11~15dB(A) after the measure was taken.

![Figure 4: The sound field plan of the substation without noise controlling measures (h=2m)](image1)

![Figure 5: The sound field plan of the substation with noise controlling measures (h=2m)](image2)

6. The effect of noise controlling measures

The substation photo that noise controlling measures had been completed is shown in the Fig.6, the test results for the engineering of noise reduction is shown in the Tab.3. The boundary noise of transformer substation decreased 10-16dB(A), which were basically consistent with the calculated
result, and can reach the functional standard of sound environment I (the boundary noise was less than 50dB(A) in the day, and was less than 45dB(A)).

Table 3: Test results of sound pressure level of the substation boundary noise

<table>
<thead>
<tr>
<th>Monitoring point</th>
<th>Type</th>
<th>Day (dB(A))</th>
<th>Night (dB(A))</th>
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</table>

7. Conclusion

In order to solve the problem which the boundary noise in a 110kV substation exceed the emission limits, the cause of over standard was analyzed in detail, and a noise reduction technology scheme based on the enclosure was build. The effect of ventilation and radiation was comprehensively considered, and the noise elimination treatment of the ventilating fan was also considered. Through Soundplan software simulation analysis, the boundary noise that noise controlling measures had been completed can reduce 11~15dB (A). The test results showed that the boundary noise reduced 10~16dB (A), which meet emission standard I. The final test results verify the effectiveness of the noise reduction scheme and the accuracy of the Soundplan software prediction.

REFERENCES