

## Application and Research on Technology of Longking Brand BEL Model ESP

LIAO Zeng'an

(Fujian Longking Co., Ltd., No.81 Linyuan Road, Xinluo District, Longyan City 364000, Fujian, PR China  
E-mail: lklza@sina.com)

**Abstract:** This paper presented the main construction and technology innovation characteristics of Longking brand BEL model Electrostatic Precipitator (hereafter referred to as "BEL-ESP") putting emphasis on the aspects of electric field plate-wire type and rapping dedusting technologies. Based on the conclusions of application and research, we have preceded practical research and industrial application improvements on the key technologies of plate-wire type, location, suspension, rapping etc, and have improved the reliability, efficiency and power-saving ability of manufacture. Meanwhile this paper pointed out that the installation quality of key points on Discharging Electrode (DE) and Collecting Electrode (CE) is important for ensuring a long-term, high efficient and stable running of ESP.

**Keywords:** Two-dimension rapping, Small DE frame Construction, Application research

### 1 INTRODUCTION

BEL-ESP is a two-dimension rapping ESP manufactured by Fujian Longking Co., Ltd. of China, which combines the technologies of side rapping the waveshape CE plate and top electromagnetic impact rapper rapping the small DE frame. The BEL-ESP obtained national patent protection in 2003, which was qualified by provincial and ministerial level institution on Jan. 8 2006. The result of qualification proved the manufacture was original invention inland and achieved international advanced stage.

This manufacture combined the advantages of top rapping and side rapping technology, gained widely attention by users in the market. However, any newborn thing would not grow up smoothly. There were some problems when the BEL-ESP manufacture initially appeared in the market, including the problems of design, manufacture, installation, testing etc. These problems majority focus on how to achieve the optimum matching between the CE system side rapping and DE system top rapping, and how to ensure rapping reliability. Recently, the development research subgroup made progress in further research effort on the aspects of improving the technical and economy ability, reliability and perfecting installation guide, meanwhile by preceded series tests and improvement, the group established a good foundation and indemnification for widely putting the BEL-ESP into application from the technical aspect.

### 2 MAIN CONSTRUCTION AND TECHNOLOGY CHARACTERISTICS OF BEL-ESP

Main construction of BEL-ESP showed as Fig. 1. In the Fig. 1: 1-Electromagnetic impact rapper, 2-Thermal insulation box, 3-Casing, 4-Outlet nozzle, 5-Side rapper, 6-Double layer access door, 7-Hopper, 8-CE system 9-Gas distribution plate 10-Inlet nozzle, 11- DE system, 12-High voltage leading-in, 13-Top serving door.

The main technology characteristics of BEL-ESP are as follows:

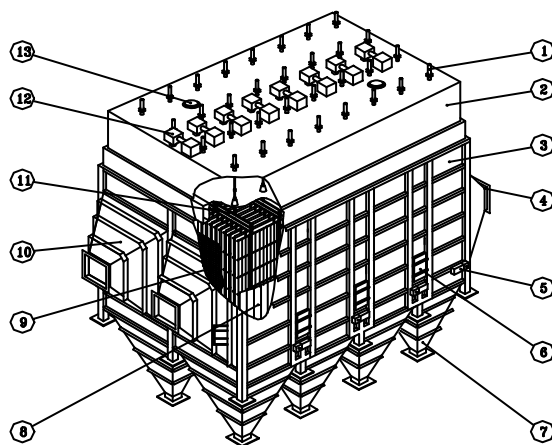


Fig. 1 Main construction of BEL-ESP

#### 2.1 Combined the Technologies of Europe and America, with Complementary Advantages, Integration and Innovation

We successfully preceded organic combination, integration and innovation between the ESP technologies of Europe and America. The DE system adopted the American technology of top electromagnetic impact rapper rapping, absorbed the advantages of top rapping technology such as compact structure, less standing, easy maintenance and so on. The CE system adopted the European technology of side mechanism hammer rapping, absorbed the advantages such as simple construction, widely application range of working conditions for the rapping force. It is an international origination to precede organic combination, integration and innovation between the two rapping technologies. The two technologies advantages are complementary to each other. The combination solved the problems such as deficient space, unstable dust collection efficiency caused by complicated and variable working conditions owing to different kinds of coal used by thermal power plants, and reducing the cost of equipments.

## 2.2 Adopted Circular Pipe Discharging Type as the Electric Field Plate-Wire Type

BEL-ESP adopted waveshape ("W" shaped) CE plate and CS series stainless DE barbed wire as the plate-wire type. Moreover, the plate-wire type has a strong integration capability to adapt to varied working conditions wind speed and depress the re-entrainment. This plate-wire type can better satisfy the characteristics of different kinds of coal for new type ESP. Every DE barbed wire is placed against the waveshape CE plate in-between position of the wave bottom, shown as Fig. 2. Adopting this plate-wire type, the DE discharging point will have an approximately equal spacing to effective surface of CE plate, and then the electric field will behave similarly to circular pipe discharging. The uniformity of current density distribution will be better than the C shaped CE plate adopted in similar products. The average operating voltage will be higher, and the ability of dust collecting will be further advanced. Under the same conditions and specifications, 10% effective area of dust collecting will be increased, 10% power consumption will be depressed and 5%~10% field operating voltage will be enhanced.

Experiments proved that under the same conditions of polar spacing and DE wire type, adopting this plate-wire type, compared with the ordinary C shaped CE plate, no matter under no-load cold condition or load hot condition, the current voltage curve is more gentle (refer to Fig. 3). This plate-wire type has advantages of power saving, decelerating the occurrence of back corona and improving the efficiency of dust collecting.

## 2.3 Adopting the Technologies of Single Mast Type Small Rigid DE Frame Structure and Top Electromagnetic Impact Rapper Rapping

Researchers have successfully developed the technology of single mast small rigid DE frame structure. This structure innovation not only realized the optimistic combination between the top and side rapping technologies, but also advanced the acceleration of DE rapping and the uniformity of rapping force, meanwhile, enhanced the structure ability of accommodation to temperature fluctuation by improving the insulator and hanging type of DE. Additionally it also depressed the steel consumption of DE system about 10%.

2.3.1 Adopted the technology of subzone structure, in which the rapping unit is smaller, the dedusting efficiency is better. Compared with the ordinary side rapping big DE frame structure, adopting the single mast type small rigid DE frame structure, the space of rapping force transmission will be reduced as a half, which will greatly enhance the uniformity of rapping acceleration distribution. There are two ESP of three fields in Fig. 4, and in Fig. 4(a), the ESP adopts the ordinary side rapping big DE frame structure. This structure has a bad uniformity of rapping acceleration distribution; owing to the large rapping acceleration nearing the rapping point, it is easy to cause the problems of DE frame structure such as shearing failure, deformation and broken wire etc. In Fig. 4(b), the DE system of ESP adopts top rapping and small

rigid DE frame structure, in which every field was divided into at least two-subzone structure. This structure has a good uniformity of rapping acceleration distribution, so a smaller rapping force will satisfy the dedusting requirements.

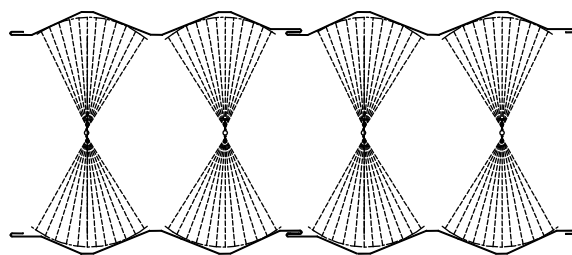


Fig. 2 Diagram of BEL-ESP plate-wire type

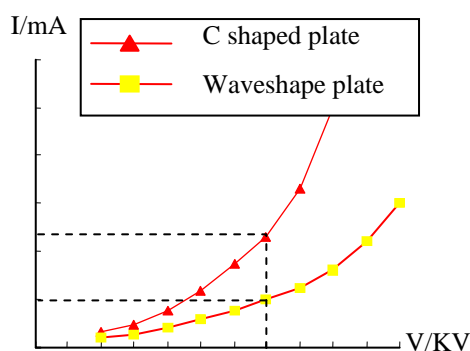
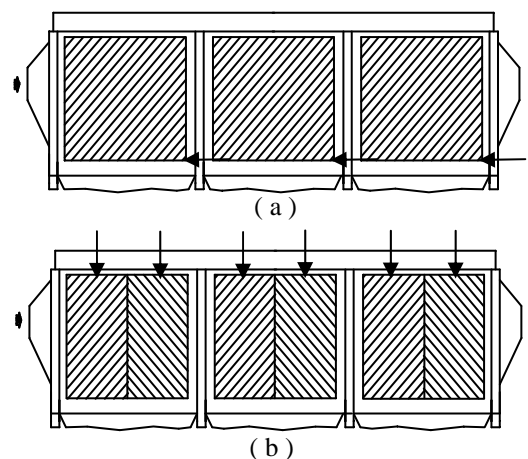


Fig. 3 Current voltage curve in hot condition



→: Show the direction of rapping force transmission

Fig. 4 Subzone DE structure and rapping contrast

2.3.2 BEL-ESP adopting the technology of mast small rigid DE frame structure, which is a patented technology. The mast small rigid DE frame structure is a symmetry structure, which has the advantages of fluent transmission for top rapping force, having a high value of the smallest acceleration and a good uniformity of rapping acceleration distribution. In a rapping test of full size small DE frame with the height of 15m, when the lifting height of top electromagnetic impact rapper is 300 mm, the value of smallest rapping acceleration

can achieve more than 100 g, and the acceleration distribution relative root-mean-square value is 0.2 which is far less than 0.40 as the industry standard required. Adopting this structure can completely solve the problems of ordinary side rapping big DE frame such as shearing failure, deformation, broken wire, broken shaft and insulator ignition etc. These problems are owing to bad uniformity of rapping acceleration distribution or too large rapping acceleration at some part of the frame.

2.3.3 BEL-ESP adopting the technology of top electromagnetic impact rapper rapping dedusting. There are no moving parts in gas flow, and no problems such as broken shaft or ignition. The equipment can run safely and reliably and be conveniently maintain and administrate. The rapping strength, frequency, sequence can be on-line adjusted. The direction of top rapping force is along the axial direction of DE wire, and the strength of DE in axial direction is larger than in radial direction, therefore, the wire is not easy to break, so the problem of wire broken can be solved efficiently and the operation reliability of ESP can be enhanced. The rapping device can also be repaired on-line.

2.3.4 BEL-ESP adopting the CS series stainless DE barbed wire, which has a good characteristic of force transmission. The DE wire is composed of round steel, stainless needle or coppering bur. The bur arranged on the round steel in a certain distance, which can adopt different length according to the requirements of design. For example, if the dust concentration is high, choose the CSA type needling wire with a strong ability of discharging; while the dust resistivity is high choose the CSB type bared wire whose discharging ability is not so strong.

2.3.5 The DE system adopting the top electromagnetic impact rapper rapping model, then the space occupied by the equipment of side rapping can be omitted, which increases the utilization ratio of electric field inner space, makes the structure of electric field more compact, easily arrange and less standing. Compared with the traditional side rapping ESP, the standing length of every field can be shortened about 1m.

#### **2.4 Optimistically Arrange the Dimension Chain of Inner Electric Field**

Through calculation and experiment, researchers precisely designed the dimension chain of inner electric field, which combined the technology of top rapping and side rapping together and established the position relationship among the main structure parts such as DE and CE system etc, as well as precisely calculated the structure dimension of inner components. The design reserved the compact advantage of American structure, in which the length of standing along the gas flow can be reduced, and the length of ESP can be shortened by 15%.

#### **2.5 Adopting Improved Design & Plan such as the New Style Penthouse Type of Insulator Box**

Completed optimized design, innovation and improvement of inner components such as platform of CE rapping device, anti-swing devices for DE and CE, shrinkable style penthouse

type of insulator box, baffle device and gas distribution plate etc. As a result, it effectively enhanced the economic and reliability.

#### **2.6 Rapping Dedusting Mode of CE Plate**

According to the structural feature and particular suspension mode of waveshape CE plate, CE rapping equipment adopted the technology of side integral modeling hammer rapping dedusting, which has the advantages of concise mechanism, few loose parts and high reliability. The improved side rapping force is transferred by the double declining wedge block which is arranged at the wave bottom of lower waveshape CE plate, therefore the problems of ordinary side rapping CE plate such as shearing failure and deformation can be solved efficiently and it also can advance the force transmission efficiency.

#### **2.7 Adopting Digital Control Electric Power Supply**

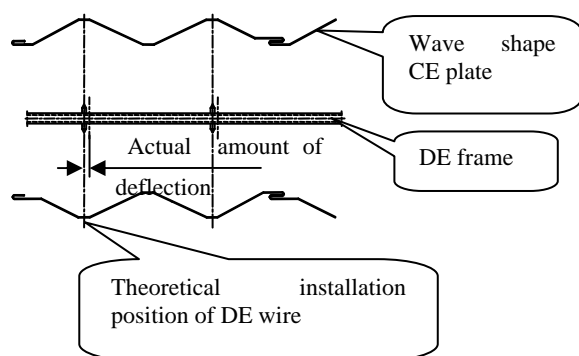
BEL-ESP adopting the digital control chip, which was independently researched and developed by Longking Co., Ltd. On the aspect of control function BEL-ESP, we adopted advanced hardware and software double sparkle detecting control technology. Based on the multi-control modes such as sparkle tracing, Max. average voltage, double half-wave interval impulse power supply etc., our company expanded and perfected several control technologies such as: back corona automatic detection, power down or power-off rapping etc., and also increased the functions such as: single half-wave interval impulse power supply, automatic detecting dynamic current voltage curve series, collecting and storing voltage current waveform. On the aspect of security function, we increased the measures for special overvoltage and overload current limiting besides the functions such as: short circuit protection, open circuit protection, overflowing protection, leaning excitation and exceed oil temperature detection security function etc.

### **3 PRACTICAL RESEARCH AND INDUSTRIAL APPLICATION IMPROVEMENT**

#### **3.1 Research on Influence of Dust Collecting Owing to Deviation of DE Barbed Wire, Which Should be Placed Against the Wave Bottom position of the Waveshape CE Plate**

Site operators found that the DE barbed wire in some electric fields deviated and was not placed against the wave bottom position of the waveshape CE Plate. The deviation occurred because of the factors in design, manufacture or installation. Some of the wire deviation amount (a) achieved above 15mm (shown as Fig. 5). The deviation influenced the original design requirements. The DE barbed wire, which had been considered to behave similarly to circular pipe discharging having a high field intensity and high uniformity, behaved with depressing onset voltage, decreasing run voltage and dust collecting efficiency etc. In order to get further reorganization of the behavior, we immediately carried out the

special topic on experimental investigation of current density, obtaining the data with the mean of guidance.



**Fig. 5** Position relationship between CE plate and DE wire

The experiment was executed on the current density detecting device in our laboratory. There were a group of waveshape CE plate and DE barbed wire, the position of which can be adjusted. Under the condition of 450 mm gas passage spacing, detecting the onset voltage, impact voltage, current voltage characteristic, plate current density and the distribution, while the DE wire position with 15 mm, 30 mm, 45mm deviated from theoretical position along the gas flow. The experiment results were as follows:

- [1] According to the experiment results of DE wire deviated from the theoretical position, if the deviation was zero, 15 mm and 30 mm, the max voltage can increase above the nominal rating of transformer without flashover, however, if the deviation adds up to 45mm, the flashover occurred when the voltage was increased to 78 kV. The results indicated that the deviation will be larger while the impact voltage is lower.
- [2] As the testing results, while the deviation increasing, the influence to plate current density is small, but the influence to uniformity of plate current distribution is big. Every 15 mm deviation added, the relatively root-mean-square deviation added about 20%.
- [3] No-load current voltage curve showed that, the current voltage curves are almost the same even under the different deviations, However, while the deviation added up to 30 mm, the onset voltage decreased obviously. Every 15 mm deviation added, onset voltage decreased 3 kV-5 kV.

### 3.2 Application Research on CE localizer

Generally, there was no localizer on the middle of CE plates. However, owing to influence of material, manufacture, installation and bad working conditions, the CE plate deflect easily in practical industrial application. The deflection caused a series of bad influence such as the heteropolar spacing declining, operating voltage and dust collecting efficiency decreasing. Based on experimental investigation and contrastive analysis, the research group adopted an improved design to guarantee the space distance of CE plates,

and developed a localizer for CE plates. The device had the advantages of legerity and utility, which made by intermediate or small size round steel forming into “U” shape. Putting the device at the edge of CE plates, Not only limit the CE plate but also satisfy the requirements of not influence the rapping force and thermal expansion.

### 3.3 Computational Analysis and Improved Research on CE Rapping Platform

Based on adopting the technologies of aboard homogeneous structure for reference, by methods of structure calculation, finite element analysis on structure strength and experiment testing, we researched and developed the lattice type platform for BEL-ESP CE rapping device base, which has a good quality and price ratio. The platform compared with the former structure (the main beam is composed of two large size channel steel), can reduce about above 30% composite cost.

### 3.4 Developed and Applied the Unit Equipment of Drag Line Type CE Suspending Beam

The weight loads that the BEL-ESP CE suspending beam beard includes the weight of CE system and ash. To suspend the CE plates reliably and without deflection, the section of suspending beam should not only satisfy the strength requirements, but also the requirements of deflection. Usually, the deflection should be controlled below  $L/800$ . In the former design, the suspending beam should use a large size I-beam in large project. Meanwhile it may also bring some problems: firstly, the ash deposition would increase; secondly, the structure can be easy to discharge to the mast of discharge electrode; thirdly, it is diseconomy. To solve these problems, the researchers preceeded a special research. After analysis, calculation and sample equipment testing on site, the research group developed the unit equipment of dragline type CE suspending beam. Compared with the former structure, the new structure not only solved the problems of ash deposition and discharging, but also disposes the problem of steel consumption. The steel consumption can be reduced above 40%, though the cost of manufacture and installation increased, the composite cost can be reduced above 30%.

### 3.5 Developing the Lifting Procedure of CE and DE System, Perfecting the Complete Machine Quality

According to the structure characteristics and installation requirements, we organized a special topic on technical verification of site installation. Based on the verification, we mapped out technological documents for BEL-ESP installation guidance. Such as: “*executive regulations of specification for lifting of CE and DE system*”, “*installation requirements on key points of CE and DE system*” and perfected the complete machine quality assurance provision for the new type ESP.

## 4 BEHAVIOR OF THE MARKET APPLICATION

BEL-ESP is a new type Product, which was developed

independently by Longking Co., Ltd. at June 2001 and had national patent protection. By the end of 2007, BEL-ESP had been applied more than 300 sets in industrial project. From the results reflected from the users of BEL-ESP, which were put into commercial operation, most of the users were satisfied with the effect. For examples: 4×300 MW project of Nayong power plant, 2×300 MW project of Guixi power plant, 2×300 MW project of Kunming power plant and 2×600 MW project of Fuyang power plant etc.

## 5 CONCLUSIONS

BEL-ESP has broken the traditional technology limitation, scientifically combined the rapping technologies of Europe and America, and formed the technology characteristics such as electric field plate-wire type similar to circular pipe discharging, subzone structure of DE, single mast small rigid DE frame structure, top electromagnetic impact rapper rapping for DE system and side hammer rapping dedusting for CE system. The equipment has the advantages of compact structure, power saving, less standing, good quality and low cost. The BEL-ESP, which has a large market potential application, is fit for old ESP's rebuilding and beneficiating and new ESP building.

Industrial application and experiment indicated that the installation of CE and DE system has a high requirement and which is the link that easily to occur problems of quality. Whether the ESP-BEL has a good installation quality directly influences the long-term, high efficiency and stable running of equipment. Pay special attention to establishing a reasonable procedure for CE and DE lifting, ensuring that placing the DE wire against the waveshape CE plate in the position of the wave bottom (the Max. deviation should control in 15 mm).

Additionally BEL-ESP adopts the unit equipment of dragline type CE suspending beam, which perfectly solves the problems of discharging and ash deposition. Meanwhile the composite cost of equipment can be reduced more than 20%, which further improved the quality and price ratio.

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