

The Application Strategy of Three-phase HV Power Supply for Special Working Condition

—The Whole Solution of H&L Voltage Integrated Control

XIE Youjin

(Xiamen Leadyoung Electric Co., Ltd., Xiamen 361101, PR China)

Abstract: Breaking through below $50\text{mg}/\text{Nm}^3$ emission, has become an important issue that the ESP technology must resolve. This paper elaborates the whole solution of three-phase H&L voltage integrated control, and it's successful applications in different industries, to share with every expert on meeting. The promotion and application of this whole solution technology will enable the majority ESP in-service satisfying the new emission standard. It provides powerful technical support to realize the target of energy saving and emission reduction in "The Eleventh Five-Year Plan".

Keywords: Three-phase power supply, H&L voltage integration, whole solution

1 INTRODUCTION

Since the china reform and open up, the Chinese economy was continuous to develop rapidly, and it has brought enormous developing opportunities for environmental protection industries. The ESP has been in charge of important mission of energy saving and emission reduction in atmospheric environmental protection government. When the emission quantities and requirements reduced to below $50\text{mg}/\text{Nm}^3$, the regular ESP control technology instant feels lack of ability. Especially in some special working condition, such as the high-resistivity dust, coherent dust, flocculence tiny dust, the dust collection effect is very bad.

Otherwise, the fabric filter is much easier to achieve and realize the goal of $50\text{mg}/\text{Nm}^3$. Although the fabric filter occur unfavorable factors, such as larger system resistance, higher operation and maintenance cost etc, however, the trend of fabric filter occupying ESP market is growing rapidly.

Even so, for many major projects, the fabric filter is still difficult to replace ESP. For example: the 300MW, 600MW above generating units, sintering machine head projects etc., Because the smoke's wind volume in power projects is very large, and the sub pressure in sintering machine head is very large, these projects will still be the main market of ESP.

Facing the new environmental protection situation and new emission standard. We should optimize the design of ESP, applying the new product and Ethernet technology. Enhancing the ESP control and management content comprehensively, and breaking through below $50\text{mg}/\text{Nm}^3$ emission, have become the important issue of ESP that must resolve.

As everyone knows, after a new ESP is installed, we generally make a V-I curve for each electric field through HV power supply, This is an ideal ESP V-I curve, and also the original record of this ESP. But after the ESP Operation, if the V-I curve is more close to the unload curve, then the dust collection efficiency will be more. Because of the influence of

dust characteristics and dust accumulation on the electrode and plate, after run some time, the actual operational V-I curve will deviate from unload V-I curve, the greater the deviation, the worse the ESP operation status.

In some special working condition, such as high-resistivity coal-fired boiler, FGD boiler and sintering machine head project, this phenomenon is more common. No matter to increase extra electric field in front or post of ESP, or to heighten and widen ESP, it is hard to meet the designed result. Even in some back corona operation status, the power of back corona also has some negative effect. As shown in Fig. 1: The V-I curves in two kinds of special working condition.

In the Fig. 1, the thick line is the actual operation curve; the thin line is the ideal curve for comparison, Fig. 1(a) is a high-voltage low-current curve, the output power is only about 10% of rated power. Fig. 1(b) is a typical back corona curve, the current is very high and the voltage is very low. These two phenomena are very common during ESP operation. If you can't improve the operational V-I curve, the collection efficiency will be very difficult to improve.

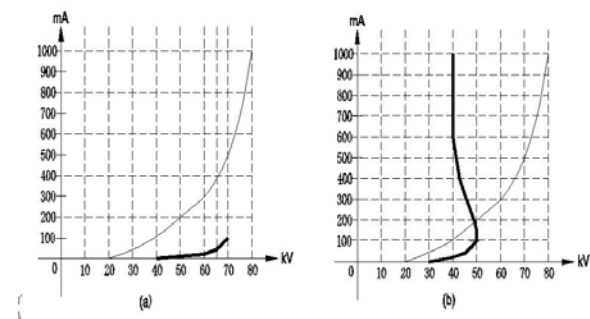


Fig. 1 the V-I curve in two kinds of working condition

How to amend the operational V-I curve, is the foundation to improve the collection efficiency. This paper will discuss from these two kinds of operational V-I curve, through comparison and analysis the collection efficiency, to explain the importance of improving the dust collection

efficiency of single electric field. This paper Elaborates several new kinds of controlling strategy of three-phase and the whole solution of H&L voltage integrated control and its successful application data in different industries, to share the latest tendency of three-phase with experts on meeting together.

2 SEVERAL NEW CONTROL STRATEGIES AND CONCEPTS ILLUSTRATION

Along with the promotion and application of High-frequency and three-phase power supply, some control theory is changing quietly. In the past, it is generally considered that the HV signal having pulse is more favorable to discharge and dust removal. But now, for the high-frequency switch power supply and three-phase power supply, the output HV signal is almost close to pure DC, and the collection efficiency has been increased largely. It seems not comply with the original theory, but not in fact, the high-frequency and three-phase power supply provide higher average voltage to electric field and more charging opportunities to dust particles. Just like the front analysis to the V-I curve, as long as the running V-I curve is closer to the ideal unload curve, the dust removal efficiency will be higher, the output corona power and the dust removal efficiency will be more proportional. Therefore, in normal working condition, the high-frequency power supply and three-phase power supply can obtain higher collection efficiency compare with the single-phase power supply.

Whether the three-phase power supply or single-phase power supply, the V-I curve is in ideal running status as the electrodes and plates are in completely clean circumstances. But the actual V-I curve is in running status that the electrodes and plates are not clean. Therefore, the cleanliness of electrode and plate is the important factor affecting the collection efficiency. If the electrodes and plates can be maintained clean, the higher output corona power and dust removal efficiency will be obtained. We will discuss and share some control strategies for several special running statuses.

2.1 The control strategy overcoming back corona

Back corona is a phenomenon of running status deterioration and the result of high-resistivity dust re-discharge on the dust layer of plate.

As mention in Fig. 1, the V-I curve in two kinds of special working condition, the back corona running status is caused by high-resistivity dust. As the normal control mode, it automatically find the “inflection point” of V-I curve through HV power supply controlling software and then let the HV power supply run nearby the “inflection point” stably. Transfer the back corona running status in Fig. 1(b) to the low-power operation status in Fig. 1(a). It is clear that in Fig. 1-(b), because of the false current caused by back corona, the dust collection efficiency is low. In Fig. 1(a), although the output voltage increases, but the corona current is low, the actual output Corona power is only about 1/10 of rated power.

How can the collection efficiency be guaranteed? The answer is of course not. Therefore, the above two kinds of running status, regardless of any condition, the dust removal efficiency is very bad. The way to resolve back corona is not looking for the “inflection point”, this control method is obviously not scientific enough. The matter is how to avoid “inflection point”, and how to avoid back corona. After the practice proved at different working condition, we believe that: Adopting the H&L voltage integrated control, the HV operational parameters were mapped in PLC of LV rapping automatically, PLC automatically optimize the rapping cycle according to the dynamic impedance of HV running V-I characteristic, rap with dropping voltage or power off when necessary, to maintain the electrode and plate in relative clean condition, Let the thickness of dust layer on the plate be not able to achieve the back corona condition, to avoid dust layer back corona discharge which caused by the dust accumulation on the plate, and avoid the emergence of back corona.

2.2 The difference of “energy saving” between intermittent pulse and three-phase

“Energy saving and emission reduction” has been common concerned, especially the “energy-saving” of ESP is the goal of this industry.

The intermittent pulse power supply is a kind of control mode which was designed aiming at the high-resistivity dust characterizes, as shown in Fig. 2.

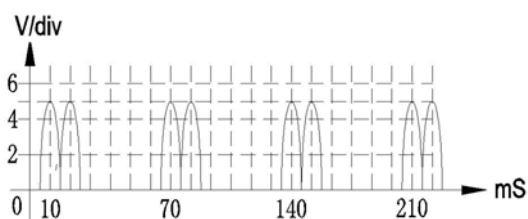


Fig. 2 The oscillogram of intermittent pulse power supply

The oscillogram of intermittent pulse power supply, the duty ratio of intermittent pulse waveform is 2:4, two half-wave outputs, and four half-wave stops. Their working status: the transient output current of two half-wave is correspondence with the rated output current. Stop four half-wave, even though no current output, but only one phase with no output instantaneous, the others still output possibly. Only the instantaneous electrical network supply the single-phase power, the current shown on the meter only indicate the average value of 6 half-wave in one cycle of one phase electrical network. So the current shown on meter less 2/3, but not indicate save energy 66%. Because factories distribution system is configurated as the rated total power of H&L voltage power supply, it can't adjust the power when the intermittent pulse stops output. Not only cannot use, otherwise, may cause the transient locally unbalance, and reduce the electrical network power factor. Therefore, the intermittent pulse power supply can only be as one way of

control characteristic, the intermittent pulse power supply may not be regard as the energy saving directly. The way to overcome back corona is combining the H&L voltage integrated control and intermittent pulse power supply, the purpose of intermittent pulse power supply is to improve the collection efficiency rather than energy saving.

The High-frequency switch power supply and three-phase HV power supply adopt three-phase input balance, it can reduce the primary rated current effectively, and reduce the load of power configuration, so the total power it reduced can be regard as energy saving compare with the single-phase power configuration. The energy saving of high frequency and three-phase power supply refers to that: in similar ESP system, the actual power distribution rank is less than single-phase, so it can reduce the total capacity pay to the electricity bureau. For example, adopting single-phase power supply needs 1000 kVA transformer, but adopting three-phase power supply only needs 800 kVA transformer, it can save 200KVA capacity electricity charges.

2.3 The concept of H&L voltage integrated control

The H&L voltage integrated control is collecting new type three-phase HV power supply, PLC intelligent LV system and new DCS network system to constitute one kind of software integrated control management, not the hardware integrated control which only assembly the HV and LV spare parts in one control cabinet. The HV power supply regards one power supply district as a unit, and generally one HV power supply controls an electric field. The LV PLC system regards one gas channel as a unit and one LV PLC cabinet controls a gas channel. (3-4 nos electric field, sometimes 5 nos electric field). Because in the same gas channel, the rapping scheduling and rapping strength are different in front and post of electric field, and also should avoid dust re-entrainment caused by rapping at the same time in front and post of electric field. Therefore, the LV control must take one gas channel as a unit, regarding synchronous clock as base, to realize the optimized rapping scheduling. The H&L voltage integrated control: map the HV running data of one gas channel to the LV PLC, then compare, analyze and optimize the rapping of each electric field, to make it compatible with V-I running dynamic impedence. But for Some products, the H&L voltage spare parts are assembled in one control cabinet; take the electric field as a control unit, the structure is relative simple. But the LV rapping scheduling is difficult to synchronize; the rapping in front and post of electric field are likely to be at the same time. This method misguides the conception of H&L voltage integrated control, and is an unreasonable control mode.

2.4 Network topology structure of H&L voltage integrated control

The DCS network system is composed of many control units. The information interactive mode, communication agreement and technical docking between each node are the key of effectively and safety.

Fig. 3 the network structure topology. The network structure form is various, what we introduce here is a network set which regards one gas channel as a unit, and take the intelligent LV PLC as the partial control terminal. The intelligent LV PLC implements independently, taking the export emission as target. Its main features are as follow:

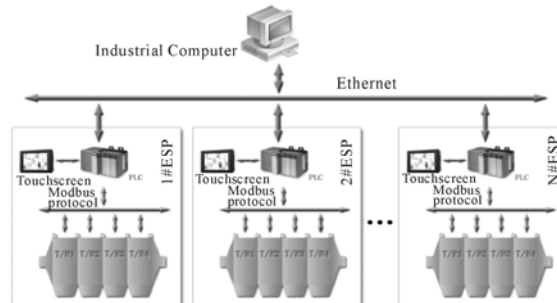


Fig. 3 the network structure topology

- Communication Interface:** The PLC accords with factory network, adopting the Ethernet form; it can be used as soon as insert.
- Communication Protocol:** PLC and HV power supply adopt the agreement such as ModBus, ProficBus etc.
- Information interactive:** The data regarding LV PLC as control terminal was mapped in the upper computer automatically, there is no need any technical docking and network maintenance. The upper computer is only as database and analyzes the dynamic data, feedbacks the analyzing result and external signal (gas volume, pressure, turbidity signals) to the LV PLC, and form a closed-loop control management system.
- Wireless Network:** expand in PLC directly, interactive text message with mobile. Can build a stronger central controlling machine, using GPRS to achieve long-range wireless network monitoring.

3 THE APPLICATIONS OF H&L VOLTAGE INTEGRATED CONTROL

The three-phase HV power supply: Adopt three-phase common frequency SCR phase-shifting technology, the product structure, manufacturing technology and on-site operation method are extremely same as single-phase HV power supply.

Since the three-phase HV power supply was used in Henan Zhongzhou Aluminum industry in April 2006, it was much concerned by industry counterparts, now more than 100 sets are in operation, and the application effects are surprising.

The followings list the applications of three-phase power supply and its H&L voltage integrated control system in different industries.

3.1 Application one: aluminum dust removal project

The project started from April 2006. We have done 5 months trial operation; and started the formal reform until September 25. The 5# kiln started reform from December. In

2007, we reformed the first electric field of 3#, 4# kiln according to the ESP. The test result is as follows (the testing data is provided by the technical center of this Company):

Before reform	Option 1: single-phase HV + ordinary LV control, Test result: 97.57%, Export emission : 675 mg/Nm ³ .
After reform	Option 2: three-phase HV + ordinary LV control, Test result : 99.38%, Export emission : 171 mg/Nm ³ .
Integrated control	Option 3: three-phase HV + intelligent LV control, Test result : 99.80%, Export emission: 52 mg/Nm ³ , Average reduce: 500 mg/Nm ³ .

3.2 Application 2: the power boiler dust removal project.

The project was put into use in 9# generating unit of Guangdong Shaoguan power generating plant, the controlling equipments adopt 1+3 mode. It was composed of 4 sets of three-phase controller + 12 sets of remaining single-phase + 4 sets of intelligent LV cabinet, and was put into use in Oct. 2007.

3.3 Application 3: the sintering machine head in iron and steel factory.

The project was used in the 180M² sintering machine head in Hangzhou steel company. The ESP was double-rooms, four-electric fields. The controller adopted 2+2 mode, it was composed of 8 sets of three-phase + 8 sets of three-phase + 4 sets of intelligent LV cabinet + 2 sets of DCS system. From Dec. 2007, it was put into operation. The test result: ≤ 30 mg/Nm³

4 CONCLUSIONS

Facing the below 50mg/Nm³ emission requirement, the ESP must enter into fully integrated control stage of product and technology; the introduction of new product and new technology is the only way. The three-phase HV power supply + intelligent LV control + DCS system form the whole solution of H&L voltage integrated control. It gathers various advantages of electrically controlled system; takes export

emission as the goal. While giving full play to advantages of three-phase HV power supply, endow the LV PLC system more management content. The node of control and management is designed in PLC cabinet; take one gas channel as a monitoring unit, regard touch-screen as the human-computer interaction interface. Using the HV running dynamic impedance optimizes the rapping scheduling; the rapping scheduling improves the HV running status. In the condition of high-resistivity coal-fired boilers, sintering machine head, aluminum industry, electric Tar precipitator etc, it can overcome the back corona and reverse the V-I operational curve, to satisfy the export emission requirement.

The three-phase common frequency HV power supply has been promoted nearly 3 years, and it has successful applications in different industries, the trend of three-phase power supply promoted in large-scale ESP is inevitable. For some in service projects, as the result of location, it is impossible to increase the length of electric field (increase the electric field length will be more troublesome). The whole solution of three-phase power supply and its H&L voltage integrated control is the most economical and practical choice. At present, the new generating unit projects are basically four or even five electric fields. For these projects, we propose the combination model of single-phase and three-phase power supply, adopt the "1 + 3" or "2 + 3" model. (i.e, the first and second electric fields use three-phase, the post three electric fields use single-phase). This will ensure the electricity supply balance and less the power configuration rank, but also increase the collection efficiency, ensure both environmental protection and energy saving. But for some projects with relative poor working condition, the environmental requirement is strict, we propose to use the whole solution of full three-phase power supply and HV voltage integrated control, the effect will be better.

For the in service ESP, the reform to overall solution of three-phase power supply and its H&L voltage integrated control normally need not more than five working days, only a week of repair cycle can complete. But the reform to ESP need at least 20 days, generally 35 days overhaul time is must.

Therefore, for some projects with complex working condition and too bad running status, we suggest to reform the electrical control first, according to the reform result of three-phase power supply and its H&L voltage integrated control overall solution, to decide whether increase the collection area, so that ensure the reform successful rate of old equipment and the reasonable investment.