

**SONIC HORNS HAVE FULLY REPLACED THE TUMBLING  
HAMMER RAPING IN AN ESP FOR THE SIEVING SYSTEM OF IRON  
ORE SINTER MACHINE**

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**ABSTRACT**

In China, firstly using sonic horn fully instead of tumbling hammer to rapping down the dusts from the ESP electrodes of a sinter band sieving system in Jiuquan Iron and Steel Company was carried out in May 2004.

This one chamber three fields ESP have a flowing cross section area of  $60 \text{ m}^2$  with a design collection efficiency of 90%. Its tumbling hammer rapping devices encountered a lot of troubles, so that it must be fixed through about every one month with a spare parts expense of 70~80 thousands Yuan RMB for one year. After the first overhaul in August 2002, the dust emission has been  $120 \text{ mg/Nm}^3$ .

Therefore, it was tried to use the sonic horn solely instead of the original tumbling hammers for rapping down the dust from both of the corona and collecting electrodes. The horns were put into operation since May 2004. Till now, the once year smooth operation shown that satisfying result given a emission of  $80 \text{ mg/Nm}^3$  have been reached. Because of the non-contact rapping does not injure any ESP inner parts, the spare parts expense and the repair fee were saved.

The principle of sonic rapping and the design features are also explained shortly.

## **INTRODUCTION**

Sonic-wave cleaning technology is embodiment of applied acoustics in the electrode cleaning of ESP. Application of it in No.3 ESP of the sinter band of Jiuquan Iron & Steel Company, using sonic horn as a substitution for the original tumbling hammer rapping was put into running in May of 2005. Its application on-site guaranteed the normal running of ESP and improved its efficiency.

## **WHY SONIC HORN BEING USED IN ESP?**

### **Improve ESP Performance**

Electrode cleaning is very important for the normal operation of ESP. Dusts clogging on the corona wires, collecting plates, gas distributing plates will reducing the working current, hence also the collection efficiency. In many cases the mechanical rapping systems, either bottom tumbling hammer or top electro-magnetic rapper, have not been enough to clean the corona wires and collecting plates effectively, especially at their far ends. By adding acoustic wave cleaning----sonic horns to increase the rapping cleaning at weak points is more often helpful.

### **Increasing ESP Operation Period**

Dust build up in hoppers will cause short-circuit and electric field shut down. Sonic horn is very efficient to induce the dust pile running down from the hopper's outlet, avoiding interruption of normal ESP working.

### **Reducing ESP Maintenance Cost**

Very intensive rapping may induce failures to mechanical parts. Side mechanical rapping has many trouble points, such as links cracking, hammer or anvil falling, disalignment rapping. In top electric-magnetic rappers there may occur coils overheating or even burning. All of these troubles keep the maintaining costs up. By the help of sonic horn, mechanical rapping systems can work in normal intense. Increasing operation periods of rapping system means saving maintenance cost.

## **PRINCIPLES OF SONIC WAVE CLEANING**

### **Sonic Wave Is the Propagation of Energy.**

Sonic is a kind of mechanical wave. The propagation of sonic wave is a small change of a density, pressure or speed in the air, solid, or liquid. This change can propagate in elastic medium. It is the propagation of energy instead of elastic medium itself, the propagation of energy is sonic wave.

### **Sound Oscillator and Sound Fatigue**

Sonic wave can alternatively tap the particulate when it propagates in the medium. Particulates in sound field will be forced to tap and to displace under the excitation of sonic wave. Adhesive force between particulate molecules is damaged because of continuing tapping. So ash falls into hopper from collecting plate under the function of the gravity or air flow, when the adhesive force reaches the fatigue of certain degree.

### **Cohesive Function of Sonic Wave**

Sonic wave can produce the tapping of particulates of different size or different density and therefore produce the different moving speed. Small dust particles will tap with sonic wave and collide with big dust particles difficult to tap, cohesion under the function of static electricity makes the dust particles become big, which brings good performance of ESP.

Sonic horn applied to ESP should pay special attention

- Selecting appropriate type, quantity and install position of sonic horns.
- Guaranteeing the working air source and air consumption.
- Sound intensity or frequency radiated by the sonic horn should match with the ESP.

### **APPLICATION OF SONIC HORNS AS A SUBSTITUTION OF MECHANICAL RAPPING SYSTEM**

#### **General Situations On-site**

Jiuquan steel and iron group is a major company of metallurgical industry, which sintering systems were equipped with many ESPs. ESP No 3 is used for sieving system. It has a flowing sectional area of 60 m<sup>2</sup> with single chamber and three fields, 480C collecting plates, barbed corona wires for the first and second fields and star wire for third field and tumbling hammers. Gas temperature is 208. Design collection efficiency is 99%.

The ESP was founded in 1988. Both corona and collecting electrodes as well as the tumbling hammer rapping system were totally exchanged during the first overhauling in August of 2002. The air load and gas load secondary current are 500 mA and 300mA respectively. The particulates emission concentration was 120mg/Nm<sup>3</sup>. . ESP was stopped to overhaul for once a month because of the third field often had wire broken and the tumbling hammer often had problems. Dust on the wires and plates continually collect together. dust from the thinness to thickness fell to hopper and finished to task of collecting through dedusting of periodicity Because of the components of very high glutinosity of quicklime included in dust, Collection efficiency was basically guaranteed during the first running. But increasing gradually of the collecting ash on plates made itself become heavy as the time went on, the accelerate of rapping became small and attenuated quickly and the efficiency continually deteriorated. Dust particles of second and third field are thin relatively, they attached to plates were difficult to clean. Malfunction rate of mechanical rapping was very high and machining was stopped to repair as soon as malfunction existed. So, in May of 2004, it was decided to use sonic horn for electrodes cleaning.

#### **Selection of the Type, Quantities and Installing Position**

Sonic wave cleaning includes sonic horns, pressed air supplying and control systems. Main factors have the scope of sonic wave action, ESP structure and size, collecting plates height, etc. Different kinds of dust need different frequency, sound intensity and different install position.

The type, quantity and the install position of the sonic horns are shown in Figure 1 and Table 1.

Table 1: List of sonic horns installed on the No.3 ESP

Position	Quantity of sonic horns	Type	Erecting model
Top of the first electric field	2	SQ-75	Installed on top
Top of the second electric field	2	SQ-75	Installed on top
Top of the third electric field	2	SQ-75	Installed on top

Correct installing position is very important to effective running of sonic horn. It will directly influence the radiant scopes and transmitting efficiency of sonic wave, thereby it will influence the effectiveness of cleaning.

### **Making-Up of Sonic Horns**

Sonic wave cleaning system consists of sound generating devices and its control. Sound generating includes sound generator and resonance casing. Control system includes air control and electric control. Air control consists of air filter, air pressure reducing valve, electro-magnetic valve and globe valve. Electric control is realized by an in-situ controller, in this project, it is an SQX-P type PLC controller (Figure 2). This PLC controller can adjust the time sequence and on-off rule by set up the man-machine interface.

PLC system adapts the logical programmed controlling devices with the stable performance. Powerful functions and convenient configuration and communicates with upper machine point by point and realizes the data exchanging.

### **Effect of Application**

The sonic wave cleaning system is put into running as the only cleaning device of No.3 ESP. After erecting and adjusting in May of 2004, in one year operation, its cleaning effect was obvious, giving ESP normal running. During the initial running of sonic horn, the workers found that the collected dust quantity in hoppers was obviously increasing. Time for dust dislodging was fast twice as before.

At initial stage, the PLC programmed control system selected high intensity cleaning generally, it went into the stable state through further adjusting and test after certain periods of running, ESP voltage and current increased slightly. After several months running, workers found out that the upper parts of the corona frame and wires were very clean. Dusts on the collecting plates were within the scopes of allowance. Practicing proves that the cleaning effects of sonic wave were the same as the effects of the original rapping devices.

Table 2: Comparison of electrical readings between sonic and mechanical rappings

Field	Second voltage, KV		Second current, mA	
	Mechanical rapping	Sonic rapping	Mechanical rapping	Sonic rapping
1 <sup>st</sup> field	49	51	310	320
2 <sup>nd</sup> field	43	45	290	300
3 <sup>rd</sup> field	51	52	240	280

ESP still sustained good performance within the testing periods and dust emission has already fallen to 80mg/Nm<sup>3</sup> through repeated monitoring of environmental protection department in company.

Because sonic wave cleaning belongs to non-contact way, it did not damage the inner parts of ESP and had the advantages of free-maintenance. Yearly spares parts costs of 70-80 thousands Yuan RMB were saved. Maintenance of once a month also has been saved including costs for 20 labors.

#### SUMMARY

- Application of sonic-wave cleaning technology in No.3 ESP of Jiuquan iron ore sintering plant further proved its effectiveness.
- It was also proved at some special situations, sonic cleaning can be used as an independent cleaning.
- Properly selection of the type, quantity, and install position of sonic horn is important. As well as proper choosing working schedule, air supplying and control is critical. This will bring convenience to the maintenance of ESP and daily management.

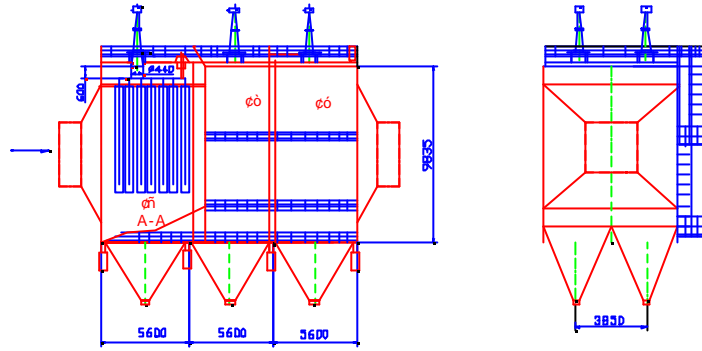


Figure 1: Position of sonic horns installed on the No.3 ESP

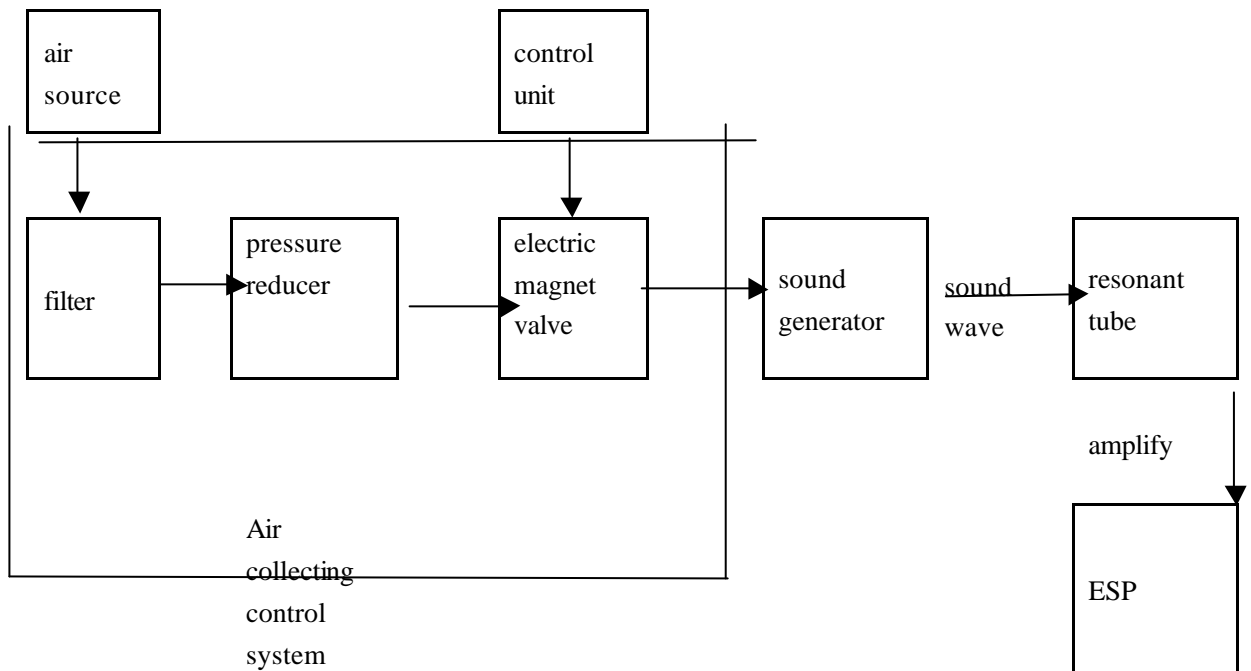


Figure 2: Sonic wave cleaning system