# AL08 - Development and Application of Intelligent Control System of Crust Breaker in Aluminum Reduction Cell

**Qing Wei[1], Zhuan Song[2], Jun Wu[3], Xu Yang [4] and Caiqun Zhou[5]**
1. Senior Engineer
2. Engineer
3. Professor, vice director
4. Engineer
5. Engineer
Zhengzhou Non-ferrous Metals Research Institute Co. Ltd of CHALCO, Zhengzhou, China
Corresponding author: zyy_songzhuan@rilm.com.cn



**Abstract**

In the production process of aluminum electrolysis, the chisel of the crust breaker occasionally become sticky and blocking, which leads to the failure of crust breaking and the feed hole blocking. Hence, to maintain the stable operation and the optimization of technical indicators, more efforts should be made. To crack the problem, the intelligent control system of crust breaker of the aluminum reduction cell has been developed in Zhengzhou Non-ferrous Metals Research Institute Co, Ltd of CHALCO. The privileged algorithm of correlation analysis of trajectory trend of chisel head is applied in self-optimizing controlling the crust-breaking frequency and breaker depth with the status of the feed opening detected in real time. Consequently, the alumina is added smoothly without feedhole blocking and the sticky hammer head problem. On average, the total anode effect frequency is decreased by 0.3/cell-day. The system plays a positive role in energy saving, reducing labor intensity and improving intelligent control of aluminum electrolysis potlines.

**Keywords:** Aluminum electrolysis, intelligent crust breaker, energy saving, crust breaker chisel, feedhole blocking.

## 1. Introduction

With the consumption of materials, aluminum oxide and fluoride in the cell shall be supplemented constantly during production of electrolytic aluminum. Before feeding, the crust surface is often broken by the crust-breaking cylinder to ensure the smooth feeding and promote dissolution of materials. However, due to the viscosity of electrolyte and poor solubility of aluminum oxide, feeding problems such as chisel head blocking and swelling and material blocking often occur during actual production and result in more anode effects, original aluminum degradation and deterioration of key performance indicators (KPIs). At present, the aluminum electrolysis control system has no effective means to monitor the state of feed hole but only keeping it unblocked through manual inspection and treatment, which leads to such problems as high workload and bad working environment. Therefore, it is hard for the enterprise to recruit and retain workers.

To solve the above problems, Zhengzhou Nonferrous Metals Research Institute Co., Ltd. of CHALCO has developed the intelligent control system of crust breaker of the aluminum reduction cell. The system can detect the blocking state of feed hole accurately by tracking the motion trajectory of cylinder, adjust the crust-breaking and feeding strategy dynamically, reduce the blocking of feed hole and bath accumulation on chisel head and greatly reduce the labor intensity.

## 2. System Composition

The intelligent crust breaker system includes field control equipment and upper computer management system. The field control equipment includes intelligent control box, solenoid valve, sensor and gas circuit elements. The intelligent control box is installed beside each electrolytic cell, which monitors the state of feed hole with sensor, adjusts the crust-breaking strategy according to the state of the feed hole and realizes intelligent crust breaking. The upper computer management system is installed in the workshop office, which receives the data of field control equipment through field bus, analyzes, collates and stores the data and realizes centralized display and management of feed hole state of electrolytic cell in the working area. The system structure is shown in Figure 1.

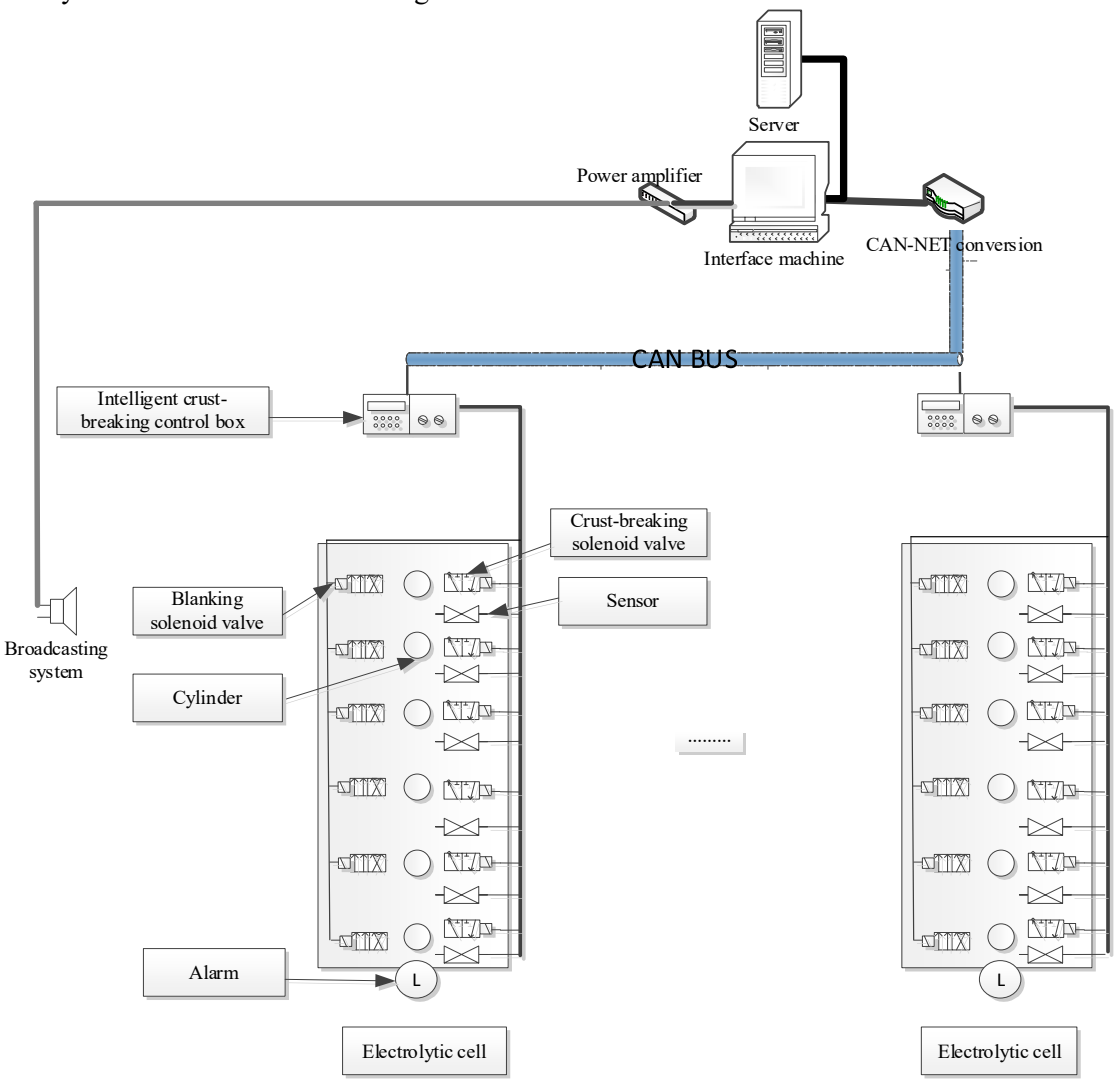


**Figure 1. System structure diagram.**

### 2.1. Main Functions of Field Control Equipment

Intelligent control box is the core of field control equipment, the appearance of intelligent control box and field installation situation is shown in Figure 2. It has the following functions:

(1) The equipment can analyze the action rule of cylinder by tracking the pressure signal of compressed air of each crust-breaking cylinder, and accurately judge the state of feed hole of electrolytic cell.

The anode effect frequency of experimental cells before installing the equipment was 0.6 /cell-day on average, but it was 0.3 /cell-day after the experiment, which is reduced by 0.3 /cell-day. After installing the equipment, the anode effect times of electrolytic cell can be reduced obviously.

## 5. Conclusion

The blocking detection accuracy of system is up to 94 %, the daily treatment need of chisel head bath accumulation is reduced by 52 %, the anode effect frequency is reduced by 0.3 /cell-day, and the equipment can operate stably. Therefore, the system can effectively solve the problems of blocking and chisel head bath accumulation.

Moreover, the system fills the gaps of accurate and real-time detection of feed hole state and intelligent crust-breaking technology. By tracking the motion trajectory of cylinder and using the neural network algorithm, the system can accurately monitor the state of feed hole in real time. The traditional stationary crust-breaking mode is transformed into on-demand crust-breaking mode, which realizes intelligent control, effectively ensures the openness of feed hole, inhibits the chisel head bath accumulation, reduces the anode effect frequency and labor intensity and guarantees stable operation of electrolytic cell. So far, the system has been applied to many electrolysis aluminum smelters and has been remarkably successful.

## 6. References

1. Qiu Zhuxian, *Aluminum Metallurgy with Pre-Baked Cells* [M], Metallurgical Industry Press, Beijing, January 2005.
2. Feng Naixiang, *Electrolytic Aluminum* [M], Chemical Industry Press, May 2006. *Operation Manual of Intelligent Crust-breaking and Feeding System,* Zhengzhou Nonferrous Metals Research Institute Co., Ltd. of CHALCO.