

Study of Technology and Equipment on Magnetic Induction Intensity Weaken for Aluminum Reduction Cells Welding in the Condition of Pot Line Current

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Abstract

To solve the welding with powerful magnetic fields in overhauling of cells, a kind of technology and equipment which is used for weakening magnetic induction intensity of welding position just like between collector bar and flex or among the bus bars of 160 ~ 500 kA aluminum reduction cells in the condition of pot line current was devised. The principle of magnetic field recouped was adopted by the technology. The magnetic induction intensity of welding position can be weakened from more than 100 Gauss to less than 50 Gauss by the technology. According to the technology, magnetic induction intensity weaken equipment which is including magnetic recouped equipment, testing system online of bus bars and expert system of welding process was designed independently by GAMI. Five 350 kA cells have been welded by using the technology and the equipment in Zunyi Aluminum Co., Ltd. and Chinalco Guizhou Aluminum Plant, the welding voltage drop is less than 7.0 mV.

Introduction

It is well known that the connection between collector bar and flex of aluminum reduction cells is the welding or the crimping. Contrasting with the crimping, the connection quality of the welding is better, the welding voltage drop is lower and the current distribution of cathode is more uniform. But the magnetic induction intensity between collector bar and flex is about 120~240 Gauss, so that the position between collector bar and flex cannot be welded in the condition of pot line current. Additionally, the bus bars which were damaged by accident also cannot be welded in the condition of pot line current because of the powerful magnetic fields.

The method of welding in the condition of pot line current has been studied by several authors^[1-3]. It was suggested that method of thermal reaction, method of magnetic fields shielded and method of casting with liquid aluminum, etc. There are several problems in the above methods. For example, cost of the method of thermal reaction is too high; effect of weakening magnetic induction intensity of the method of magnetic fields shielded is not distinguished and so on.

To solve the welding with powerful magnetic fields in overhauling of cells, a kind of technology and equipment which is used for weakening magnetic induction intensity of welding position just like between collector bar and flex or among the bus bars of 160 ~ 500 kA aluminum reduction cells in the condition of pot line current was devised by Guiyang Aluminum Magnesium Design Research Institute Company Limited(GAMI). The magnetic induction intensity of welding position can be

weakened from more than 100 Gauss to less than 50 Gauss by the technology and the equipment. Five 350 kA cells and one 230kA cells have been welded by using the technology and the equipment in Zunyi Aluminum Co., Ltd. and Chinalco Guizhou Aluminum Plant, and the welding voltage drop is less than 7.0 mV.

In this paper experimental results concerning the principle of the technology which weakened magnetic induction intensity and the application of the equipment which is designed independently by GAMI, are presented.

Experimental

Principle of technology

Magnetic fields are vectors and there is direction of magnetic line of force. If there is an opposite magnetic field to the original magnetic field, the summary of the two vectors will be decreased. The effect of superposition is shown in Fig. 1.

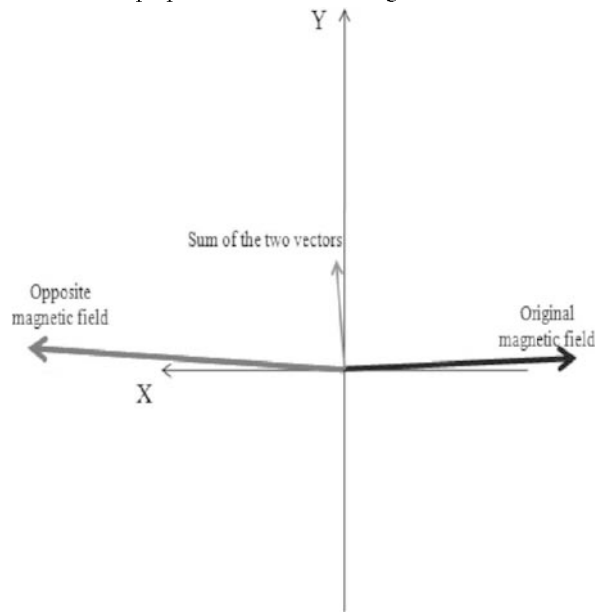


Fig. 1 Effect of superposition of vectors

Design of equipment

The magnetic induction intensity weaken equipment is including magnetic recouped equipment, testing system online of bus bars and expert system of welding process. The magnetic recouped equipment just like hands of human, it can adjust the magnetic induction intensity through adjusting the current. The testing system online of bus bars just like eyes and ear of human, the current and temperature of bus bars can be tested by it and the

alarm signal can be sent when the current or temperature exceed the limit. The tactics of magnetic induction intensity weakened is

decided by expert system through the distribution of current. The components of the equipment are shown in Fig. 2.

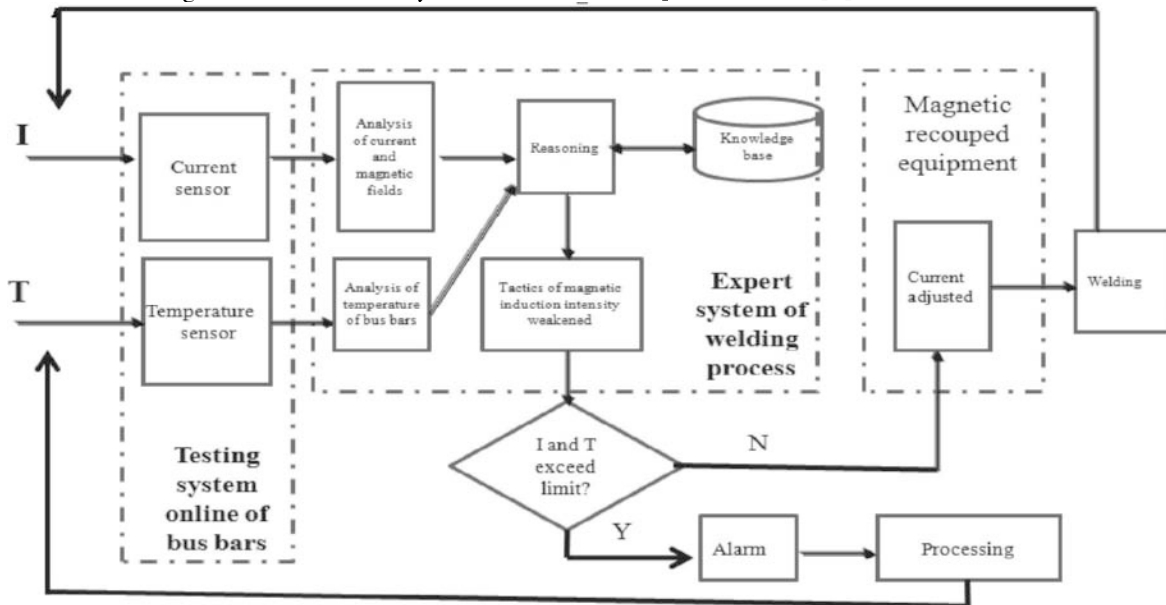


Fig. 2 Components of the equipment

The magnetic recouped equipments are installed between anode beams of overhauling cell and anode risers of downstream cell. It consists of the hydraulic opening and closing mechanism which is provided with opening and closing automatically and the current distributor. The current through it can be adjusted by adjusting its volume resistance. The expert system adjusts the current through the magnetic recouped equipments to compensate the magnetic

induction intensity of the welding position according to the results of testing system. By the application of the equipment, the magnetic intensity of the welding position can be lowered down. The quality of welding can be well in the condition of pot line current. The structure of magnetic recouped equipments is shown in Fig. 3.

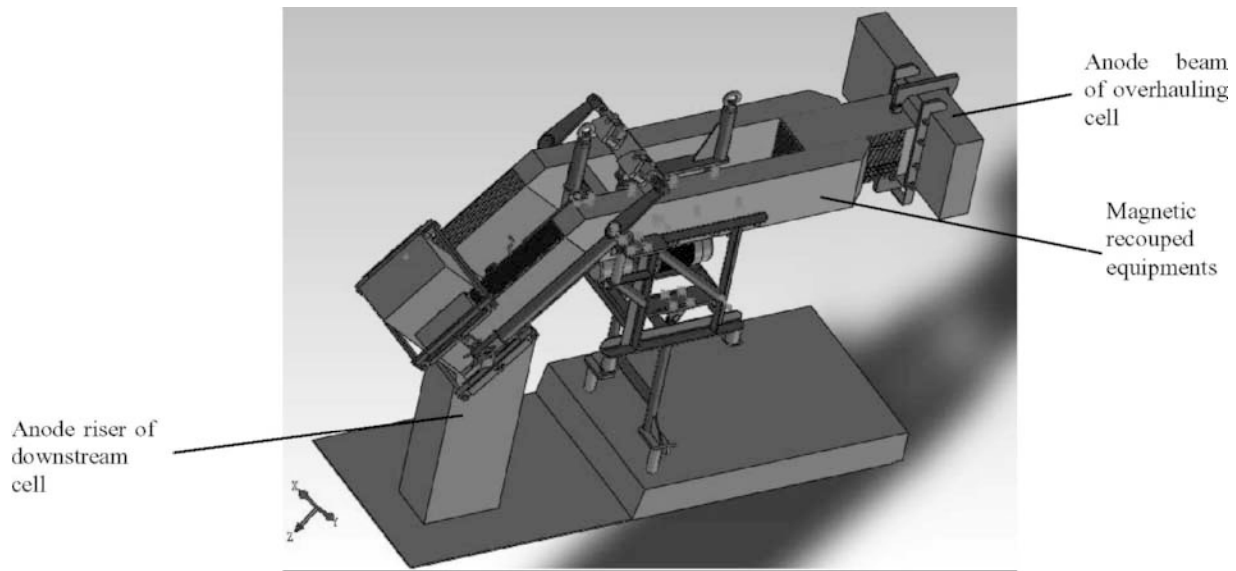
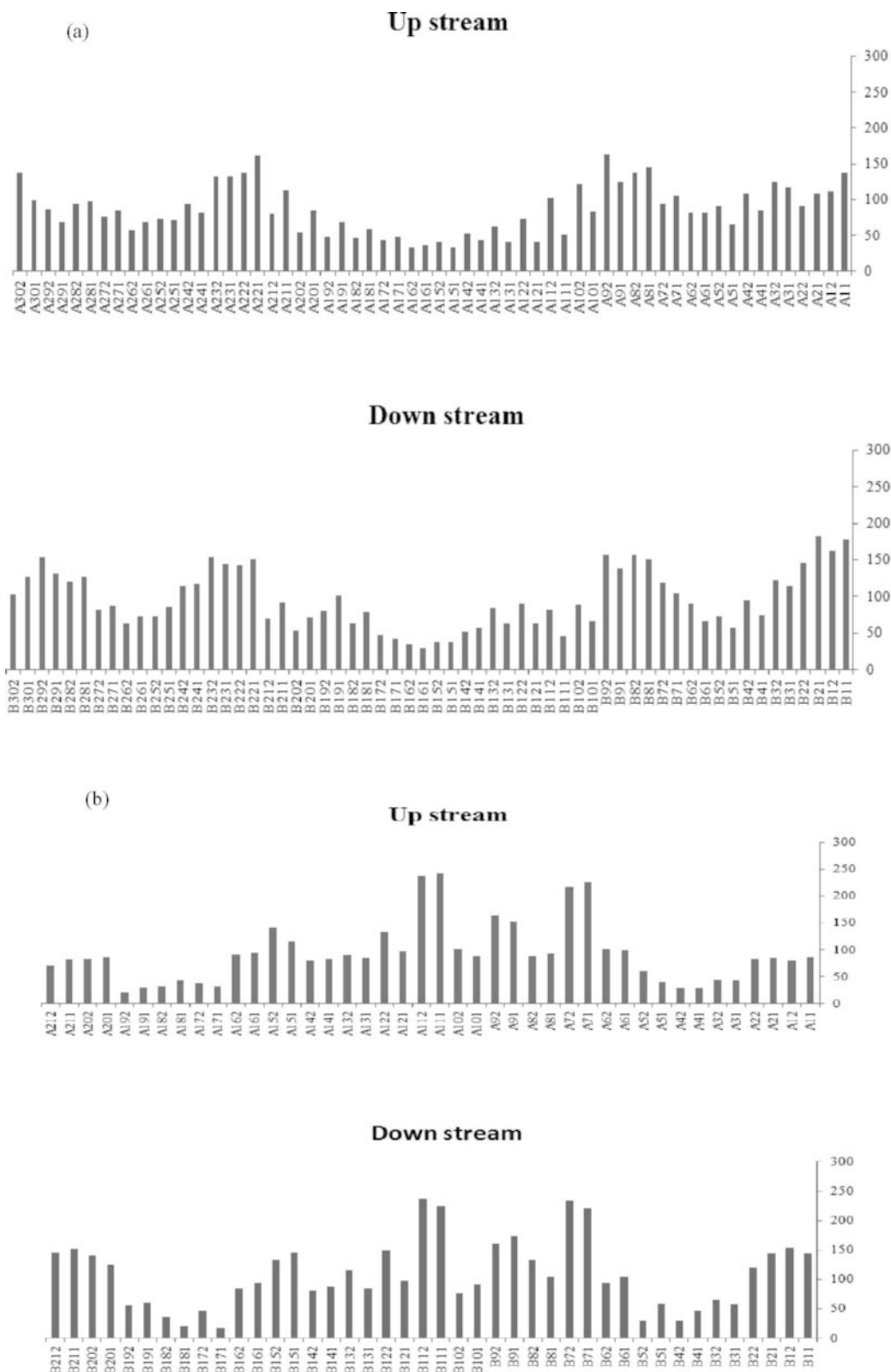


Fig. 3 Structure of magnetic recouped equipments

Analysis of experimental results

Study of the effect of weakening magnetic induction intensity of welding position

The original magnetic induction intensity between collector bar and flex of 350 kA and 230 kA aluminum reduction cells were measured. The measurements are shown in Fig. 4.



F ig.4 Measurements of magnetic induction intensity between collector bar and flex

(a) — 350 kA pot line ; (b) — 230 kA pot line

The weakened magnetic induction intensity between collector bar and flex by the technology and equipment of 350 kA and 230 kA

aluminum reduction cells were measured. The measurements are shown in Fig. 5.

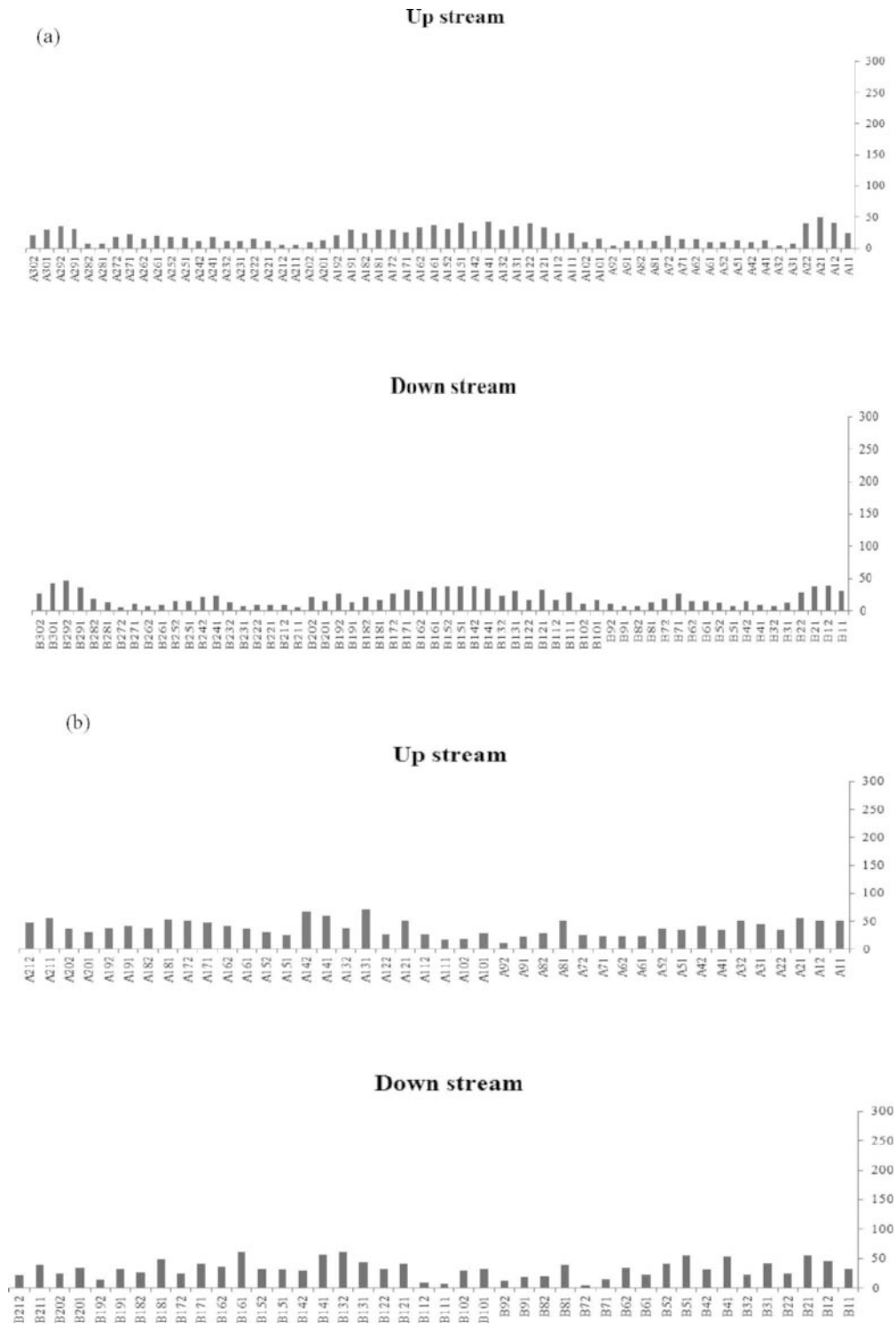


Fig.5 Measurements of weakened magnetic induction intensity between collector bar and flex (a) — 350 kA pot line ; (b) — 230 kA pot line

The mean original magnetic induction intensity between collector bar and flex of 350 kA pot line is 112 Gauss, the maximum is 172 Gauss. The mean original magnetic induction intensity between collector bar and flex of 230 kA pot line is 121 Gauss, the maximum is 246 Gauss. Because the distance between bus bars and collector bars of 230 kA pot line is closer than that of 350 kA pot line, the original magnetic induction intensity between collector bar and flex of 230 kA pot line is more powerful than that of 350 kA pot line. The maximum of both 230 kA pot line and 350 kA pot line is on the position that above the bus bars.

The mean weakened magnetic induction intensity between collector bar and flex by the technology and equipment of 350 kA is 21 Gauss, the maximum is 49 Gauss. The mean weakened magnetic induction intensity between collector bar and flex by the technology and equipment of 230 kA is 35 Gauss, the maximum is 60 Gauss.

Experience has shown that the quality of welding between steel and steel can be good in the condition of magnetic induction intensity less than 80 Gauss. So in the condition of the weakened magnetic induction intensity by using the technology and equipment, the quality of welding will be better.

Study of welding voltage drop and current distribution of cathode

Because of the powerful magnetic fields, the connection between collector bar and flex of 350 kA aluminum reduction cells in Zunyi Aluminum Co., Ltd. is the crimping. The mean crimping voltage drop of the pot line is 20.0 mV, the deviation of current distribution of cathode is 25%. The connection between collector bar and flex of 230 kA aluminum reduction cells in Chinalco Guizhou Aluminum Plant is welded. But when the welding between collector bar and flex is carrying out, the pot line current must be lowered down to less than 130kA. The productivity of aluminum will be decreased and the reactive power consumption will be increased by this operation. Even so, the mean welding voltage drop is 25.0 mV; the deviation of current distribution of cathode is 26%. By using the technology and equipment, the mean welding voltage drop is 6.8 mV; the deviation of current distribution of cathode is 9.8%.

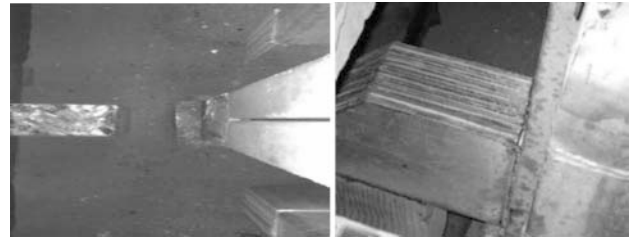
Application effect

It has been complied the welding between collector bar and flex and the welding among the bus bars of 350 kA and 230 kA pot line. The application effects are shown in Fig. 6.



Before application

After application



Before application

After application



Before application

After application

Fig. 6 Application effects

Analysis of benefits

Taking aluminum plant that the capacity is 250 kt per year as an example, the energy saving is 11 million kWh per year, CO₂ emissions reducing is 5600 t.

Conclusions

- (1) The magnetic induction intensity of welding position can be weakened from more than 100 Gauss to less than 50 Gauss by the technology.
- (2) the welding voltage drop is less than 7.0 mV by using the technology and equipment.
- (3) The deviation of current distribution of cathode is less than 10% by using the technology and equipment.

References

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