Optimisation of the Performance of Cathode Risk Pots

Luo Xianqing[1], Chen Shiyue[2], Kang Zihua[3], Cao Bin[4], Ron Etzion[5], David S. Wong[6], Cha Kefu[7] and Aswin Narayanan[8]

1. Deputy manager
2. Metallurgical Engineer
3. Metallurgical Engineer
4. Professor

Guiyang Aluminium Magnesium Design and Research Institute Co., Ltd., National Engineering and Technology Research Centre for Aluminium Magnesium Electrolysis Facilities, Guiyang, P.R. China;

5. Manager Research & Development
6. Manager Project Delivery
7. Automation Engineer
8. Computer Modeller

Light Metals Research Centre, The University of Auckland, Auckland, New Zealand
Corresponding author: kangzihua@126.com

Abstract

The initial response in a smelter which suffers from multiple damaged cathode pots was to increase metal levels to cool cathodes and reduce the chance of pot failure. However this strategy led to reduced performance as cooler cathodes led to dissolution problems, higher sludge formation, increase in cathode voltage drop (CVD), and high heat dissipation from the sidewall requiring higher voltage to maintain heat balance. An optimisation plan was carried out on six test pots over a year which included improved anode change/cavity cleaning practices and more accurate liquid level measurements. In addition to improved work practices, a revised process control strategy was tested, including a new cryolite ratio (CR) control regime and use of data from multiple pot parameters to perform weekly analyses of heat balance on individual test pots. This weekly analysis led to decisions aimed at maintaining heat balance and improved pot performance. During the program, metal level on test pots was reduced gradually in order to reduce heat dissipation from the sidewall, improve alumina solubility and prevent the increase of CVD; this measure, in conjunction with voltage optimisation, CR control and new operational practices, offered an improved performance in terms of energy consumption, stability and high current efficiency (CE).

Keywords: Aluminium electrolysis cells; heat balance analysis; CR control; liquid levels measurement.

1. Introduction

An aluminium reduction smelter in China was started in October 2013. Following this potline initiation, the majority of the pots showed different levels of cathode damage, mostly as transverse cracks in the carbon block upper surface (Figure 1) and high concentrations of iron (Fe) and silicon (Si) in the molten aluminium metal (Figure 2).

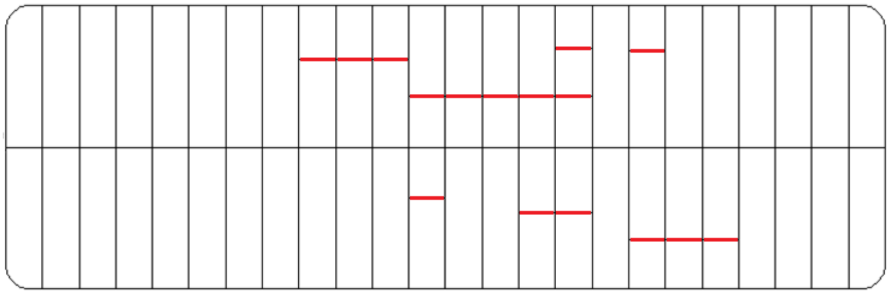

Figure 1. Diagram of the cathode surface with transverse cracks (shown as horizontal red marks).

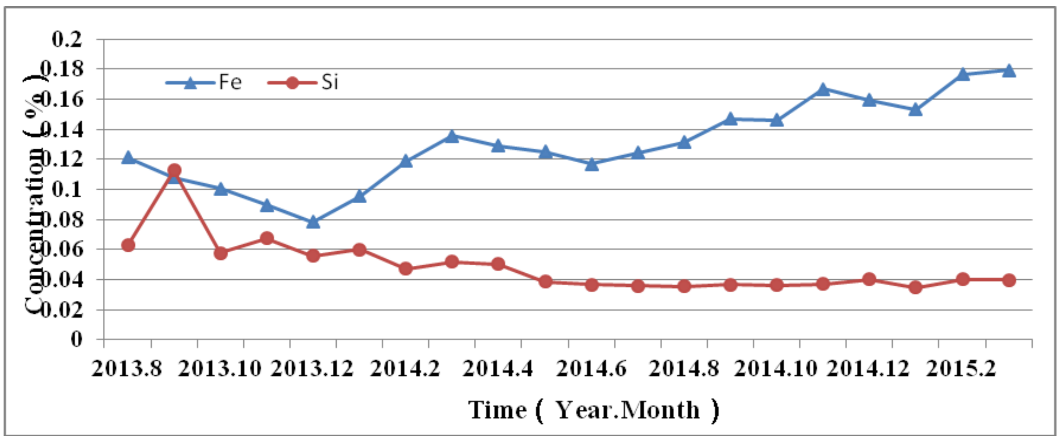

Figure 2. Average Fe and Si % concentration in metal in a section of pots.

Any pot with obvious cracks and high Fe and Si content is defined as a damaged pot. Each section has 19 – 46 % damaged cathode pots, which adds up to 35.5 % of the entire potline (as seen in Table 1). Because all the pots in the potline share the same design, building method, material, baking-start up process and management technology, the remaining 64.5 % of pots are considered as pots with high potential of developing cathode damage.

In order to reduce risk of further damage to cathode and metal leaks / tap outs, the smelter raised metal level gradually a few months after the stat up from the original design level of 25 cm to 30 – 33 cm. By doing so, more heat is dissipated from the sidewall, which causes longer ledge toe and cooling of the cathode surface, which prevents cathode failure. In addition, the higher

4. Conclusions

The test results showed that the strategy and method used to optimise the performance of pots which suffer from high risk of cathode damage were correct. Reduced variations in AlF_3 feed with combination of improved operational procedure and better informed decision making process leads to more stability and offers the ability to optimise metal level and reduced energy consumption while maintaining high CE when compared to other pots in the section. However, as seen in the case of pot 1129, pots which already had cathode damage created challenges to optimise their performance as their noise levels were higher than other pots and there was a need to keep their metal level higher as a safety measure. Additionally, as a lesson learned from the performance of pot 1133, metal inventory had critical effect on pot stability and the ability to reduce metal level, hence sufficient metal inventory is precondition to successful optimisation of metal level and energy consumption. The effect of changed alumina supply and alumina purity led to a decrease in CE and increase in DC energy consumption over the entire potline which illustrate the need of high purity raw material to maintain high performance.

5. Acknowledgements

The authors gratefully acknowledge the financial supports from International S&T Cooperation Program of China (ISTCP) (No. 2013DFB70220) as well as from the test team and the test smelter, especially the section leaders.

6. References

1. A. Solheim, S. Rolseth, and E. Skybakmoen, Liquidus temperature and alumina solubility in the system Na_3AlF_6-AlF_3-LiF-CaF_2-MgF_2, *Light Metals* 1995, 451−456.
2. R. Keller, Alumina dissolution and sludge formation revisited, *Light Metals* 2005, 147−150.
3. X. Luo, Z. Kang et al., Using SPC Method to Design an Aluminum Fluoride Addition Strategy for Aluminium Electrolysis, Paper to be presented at 34th *Conference and Exhibition ICSOBA-2016*, 3 to 6 October 2016, Quebec, Canada.