IoT-Based Safety Monitoring and Display System for Aluminium Electrolysis Cell Bypass Shunts

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Abstract

The cell bypass shunts of an aluminium electrolytic cell are used for shutting down a cell when it needs relining. In normal operation the bypass shunts are insulated from anode risers so that the cell current can flow from the cathode busbars to the anode beam of the downstream cell. When the voltage across the bypass shunt becomes excessive or when the insulation performance deteriorates, it may trigger electrical arcs, leading to, in severe cases, melting of the bypass shunt and potline open circuit. Therefore, real-time monitoring of the bypass shunt condition is an indispensable aspect of the electrolytic production process. However, in actual production, the inspection of bypass shunts primarily relies on manual efforts, which not only involves high labor intensity but also poses significant safety risks.

To address this issue, the Zhengzhou Nonferrous Metals Research Institute of Chinalco has successfully developed an intelligent monitoring and display system for aluminium electrolytic cell bypass shunts, based on Internet of Things (IoT) technology. This system consists of three components: a wireless network transmission unit, a bypass shunt detection unit, and a visual display unit. The bypass shunt detection unit utilizes partial discharge detection technology and acoustic fingerprint recognition to continuously and real-time monitor the insulation status and discharge conditions of each bypass shunt. The detected data is transmitted to the visual display system via the wireless network unit. The wireless network unit employs a multi-hop MESH network based on Zigbee communication technology, effectively addressing the complex and harsh communication conditions in aluminium electrolytic production environments. The visual display unit supports visualization on various digital terminals, including PCs and mobile devices. In the event of anomalies, it promptly issues warning messages to assist in rapid fault diagnosis, thereby effectively preventing bypass shunt explosions.

The application of this system enables digital and intelligent real-time monitoring of the bypass shunt status in aluminium electrolytic cells, improving greatly smelter operation safety and reliability.

Keywords: Aluminium electrolysis, Cell bypass shunts, Internet of Things (IoT), Safety monitoring.

1. Introduction

As the core equipment in aluminium electrolysis production, the insulation status of aluminium reduction cell bypass shunts directly impacts both, production efficiency and operational safety. All Chinese cell technologies have the bypass shunts at the base of anode risers (Figure 1).

Figure 2 is schematic representation of bypass shunts in PC software interface. During normal operation, insulation failure at bypass shunts can cause partial current leakage to adjacent cells, resulting in energy loss. During cell preheat, poor contact at bypass shunts may lead to uneven current distribution, potentially causing potline current fluctuations that affect the entire potline efficiency. More critically, when a pot tap-out occurs or anodes are pulled out of the bath, an open circuit occurs and the potline voltage can appear at bypass shunts, potentially triggering explosive accidents with significant economic losses and safety hazards.

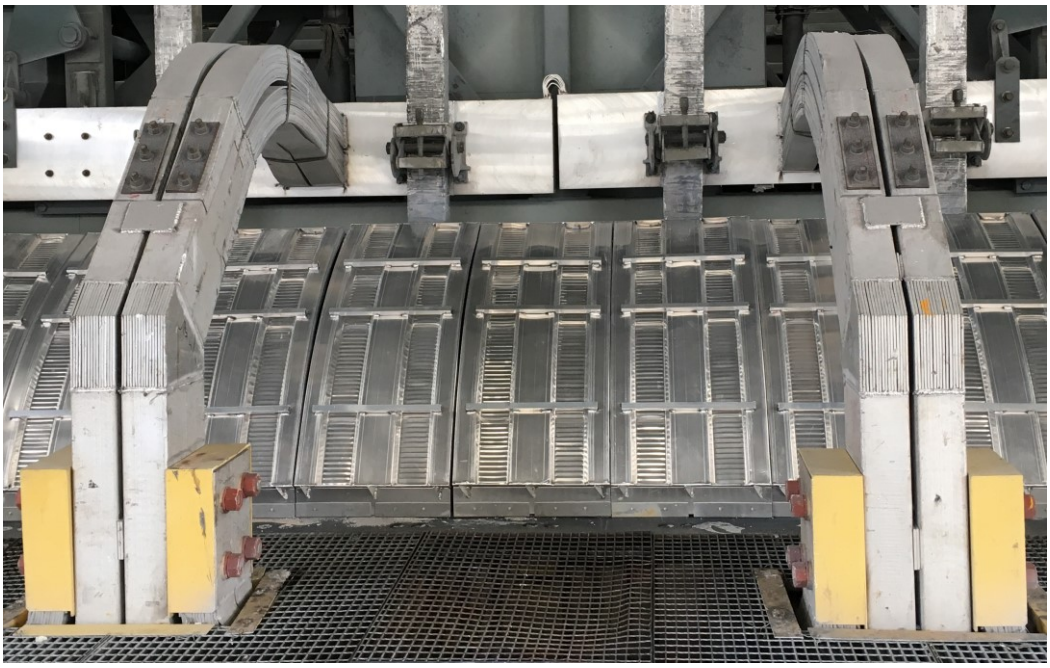

Figure 1. Anode risers and bolted bypass shunts at the base of the risers in a Chinese cell technology. Shunt insulation is yellow.

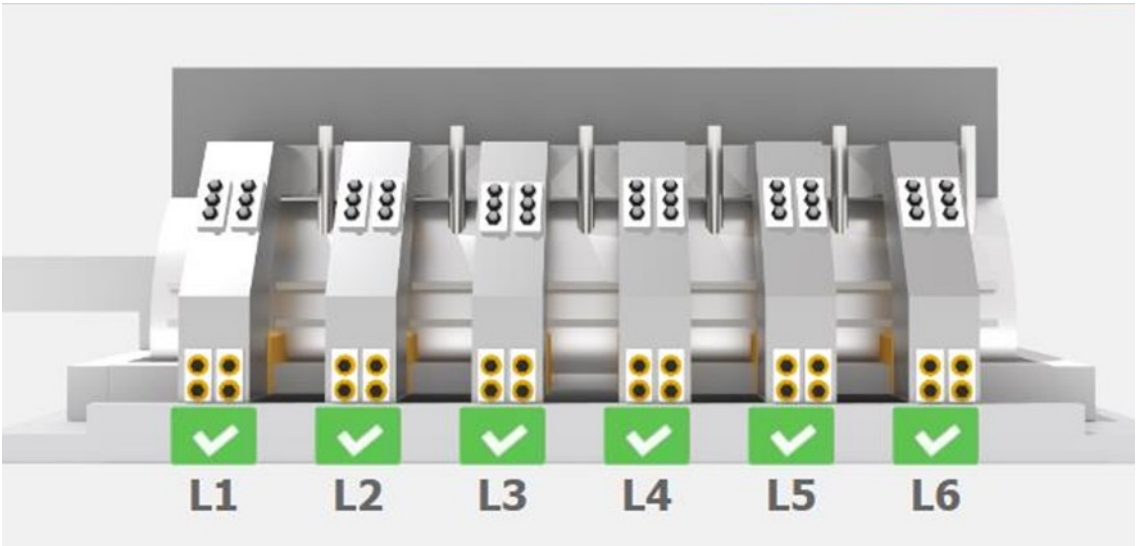

Figure 2. Schematic representation of anode risers and bypass shunts at the base of the risers (shunt is yellow, bolts are black) for a cell with 6 risers, as displayed in PC software interface. Green squares with checkmarks show that the shunt have no problem.

Figure 3 shows statistics of bypass shunt failures [1].

6. References

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