Application of Intelligent Safety Technologies in Aluminium Electrolysis

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Abstract

The domestic work safety situation is severe, particularly in high-risk industries like aluminium electrolysis, where safety management faces significant challenges. To enhance safety performance, investment and application of intelligent safety technologies are urgently needed. The introduction of intelligent safety technologies like 5G and IoT facilitates automation in production and remote maintenance. The use of Virtual Reality (VR) and Augmented Reality (AR) enables intelligent education and training. Using big data technology for risk identification, hazard investigation and governance eliminates repetitive issues and effectively implements the dual prevention mechanism. The use of intelligent platforms has enhanced safety information sharing among workshops and teams in smelters, while also easing supervisory inspections by management departments. The use of intelligent safety technologies has enhanced convenience and real-time capabilities in safety management, making work safety more efficient and precise.

Keywords: Intelligence, Safety technologies, Big data, Intelligent platforms, Efficient and precise.

1. Overview of Work Safety in Aluminium Electrolysis

1.1 The Important Role of Aluminium Electrolysis in the National Economy

Aluminium electrolysis represents a vital foundational industry within the national economy and serves as a key pillar in the pursuit of manufacturing excellence. Aluminium products, characterized by their diverse types, extensive applications, and significant strategic value, constitute an essential sector for ensuring national resource security and industrial security. Since the implementation of "The 13th Five-Year Plan", the production of aluminium in China has greatly increased to beyond the rest of the world since 2013 as shown in Figure 1.

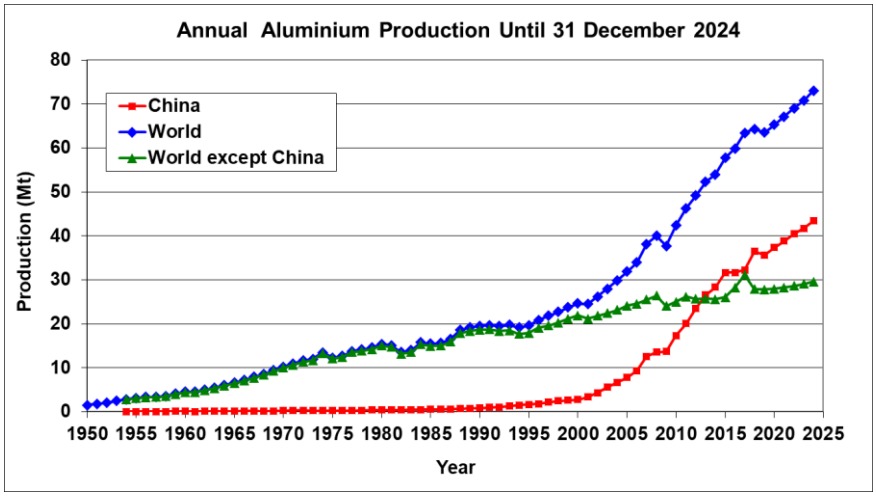

Figure 1. Chinese and World primary aluminium production, IAI statistics [1].

1.2 Existing Risks in Aluminium Electrolysis Production

1.2.1 Major Risks

In the field of aluminium electrolysis, the production process entails the handling of molten metal, which necessitates various methods for transferring or transporting the molten metal between different steps of the process. The occurrence of high-temperature molten metal leakage poses significant risks, potentially leading to burns, fires, or even explosions [2, 3].

Leaks, slag overflow, or splashing during the processes of molten metal smelting and casting can result in explosions when molten metal comes into contact with water. Particularly in the processes of aluminium processing, such as deep pit casting, the leakage of molten aluminium into the casting pit and its subsequent contact with water can lead to explosive reactions. These accidents will result in severe consequences.

Aluminium smelters utilize natural gas across various processes, supported by extensive pipeline networks. In the event of a leakage or flashback, such incidents may result in fires or explosions. Table 1 gives a list of smelter's major risks.

Table 1. List of smelter's major risks.

1. Electrolysis process		
Risk Point	No.	1
	Type	Electrolytic cell
	Name	Aluminium tapping operation in electrolytic cell
Step	S/N	3
	Name	Aluminium tapping
Hazard Source or Potential Incident		Abnormal cell voltage during aluminium tapping
Assessment Level		1
Risk Classification		Major Risks
Potential Accident Type and Consequence		Equipment Damage
Control Measures	Engineering Technical Measures	High voltage alarm set by cell control unit
	Management Measures	Strict inspection and assessment
	Training and Education Measures	1. Conduct regular training on technical procedures for safe operations for operators; 2. Carry out regular emergency training
	Personal Protective Measures	Operators must wear safety helmets, face masks, protective clothing, gloves, and safety shoes.
	Emergency Response Measures	1. Immediately stop the aluminium tapping operation; 2. Switch the cell control unit to manual mode and adjust the voltage.
Management Level		Company
Responsible Unit		Company department
Person in Charge		Smelter branch or potroom
Remarks		

4.3.2 Risk Warning and Emergency Response

Potential risks associated with aluminium electrolysis production are monitored in real time, and emergency response plans are automatically activated to improve the capacity for managing emergencies.

4.3.3 Compliance Management

Operation logs and data flows are recorded to meet audit and compliance requirements.

5. Conclusions

Intelligent safety technologies facilitate targeted management of work safety in aluminium electrolysis through the integration of multiple technologies. This approach effectively and precisely addresses various safety management challenges encountered during the production process, thereby advancing the aluminium electrolysis industry towards a more sustainable, efficient, and safer development trajectory. Future efforts should further integrate AI and IoT technologies to achieve intelligent management throughout the process. Through optimization of technical means, this will promote safe, stable, efficient and sustainable development in aluminium electrolysis production.

6. References

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