Wireless and Automated Preheat Monitoring of Aluminium Reduction Cell

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Abstract

This paper discusses the transformation from a manual preheat monitoring system to a wireless automated one in the potlines at EGA's Jebel Ali site, improving the monitoring and control of aluminium reduction cell preheat. Aluminium is produced in reduction cells, where the cathode is made from a combination of lining materials and carbon. The cathode has a limited lifespan of 5–7 years and needs to be relined after its service life. Proper preheating of the cell is essential for both smooth operation and maximising the cell lifespan. Gradual and controlled preheating of the lining material and cathode carbon is necessary before adding liquid bath at approximately 960 °C. If cell temperature is too low when the bath is introduced, thermal shock may cause cracks in the cathode, which shortens the cell life. Traditionally, the temperature during the preheating process was measured manually. However, the conditions for measurement are challenging due to high heat and fumes, and manual temperature measurement is labour-intensive and prone to error.

This paper describes how EGA developed and implemented a wireless automated preheat monitoring system. The new system tracks the real-time temperature of the cathode and directly transfers the data into Pot Monitoring System (iPots) and allows live monitoring from the supervisor control room. The system can detect temperature deviations, check the uniformity of preheat temperatures across the cathode surface, and trigger alerts and voice alarms through EGA's Pot Control System. By measuring the temperature at a higher frequency than manual methods, the system can detect abnormalities in real time, enabling faster corrective actions. This not only increases the accuracy of the data but also reduces human error and the resources required for manual temperature measurement and data entry. Overall, the shift to an automated, wireless system has improved preheat monitoring and control, enhancing the efficiency of the potline and contributing to the longer lifespan of the cells.

Keywords: Cell preheating, Aluminium reduction cell, Wireless preheating monitoring, Potlife, Live preheat monitoring.

1. Introduction

Emirates Global Aluminium is the world's largest 'premium aluminium' producer and the biggest industrial company in the United Arab Emirates outside oil and gas, producing 2.69 million tonnes in 2024. The company operates a bauxite mine, an alumina refinery, two aluminium smelters and two aluminium recycling plants. In the two aluminium smelters, located at Jebel Ali and Al Taweelah, EGA operates seven cell technologies, developed inhouse since 1990, given in Table 1.

Table 1. EGA cell technologies and 2024 hot metal production.

Smelter and Location	Technology	No of Cells	Production in 2024
Jebel Ali, Dubai	CD20, D20, D18+, D20+, DX, DX+ Ultra	1577	1.13 Mt/y
Al Taweelah, Abu Dhabi	DX, DX+, DX+ Ultra	1266	1.56 Mt/y

An aluminium reduction cell has a limited operational lifespan of 5 to 7 years, after which it must be relined—primarily involving the replacement of the cathode—before being returned to service. Each year, approximately 15 % to 20 % of the total EGA cells undergo the relining, preheating, and startup process as they reach the end of their service life.

2. Preheating of Aluminium Reduction Cells

Aluminium reduction cell has to be preheated before start-up. The preheating stage slowly raises the cell materials from room temperature to operating temperature of 960 °C. Proper preheating of the cell ensures smooth transition from power-on to the normal cell operating condition to minimise the risk of an early cell failure caused by thermal stresses within the cathode materials [1–2]. Preheating and start-up of aluminium reduction cells have been estimated to contribute to about 25 % of all the factors that affect cell life [3]. The other main factors here are design, materials, construction, and operation.

EGA uses electrical preheat of cells where a coke or graphite resistor bed on top of cathode blocks generates the required heat [4] The quality of preheated cathode is evaluated by many factors, such as the final average cathode surface temperature, the final cathode surface temperature distribution, the vertical temperature gradients down through the cathode materials, the heat-up rate during the preheating and the anodic current distribution.

The duration and final temperature of the preheating are determined by the heat loss from the cell and the energy input to the preheating equipment. A significant portion of the input energy is typically lost as heat to the surroundings. By improving the cell insulation, the preheating time could be reduced by several hours with the same results and faster metal production.

2.1 Challenges of Manual Measurements

Traditional methods of temperature monitoring during aluminium cell preheating involve manual measurements taken every two hours from the start of preheat until bath-up. This process is labour-intensive, time-consuming, and exposes workers to health and safety hazards, including high temperatures and potentially harmful gases (Figure 1). Manual readings are also prone to several challenges such as misread values, misplaced data logs, and delays in data recording. These issues can result in inefficiencies, missed anomalies, and delayed corrective actions, potentially compromising the quality of the preheat process and the longevity of the cell.

2.2 Limitations of Wired Sensors

Wired monitoring systems, such as data logger-based devices used in EGA potlines, present several operational and safety challenges. These systems require an external power supply, introducing a significant risk of electrical hazards. Additionally, data must be manually retrieved and transferred to the reporting system, limiting real-time visibility from the control room. The process of routing cables from the cell to the data logger not only creates unsafe working conditions but also increases setup time, costs, and labour demands. Wired configurations also lack flexibility, making them less adaptable to evolving operational needs.

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10. References

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