How the CPC Specification and Smelter Strategies Impact Performance and Anode Quality

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Abstract

In this paper, an in-depth analysis of the effects of calcined petroleum coke (CPC) specification on the performance of aluminium smelters is conducted, mainly focusing on anode quality, energy efficiency, and environmental impact. First, historical trends of raw material petroleum coke are explored, examining the evolution of its properties over time and the factors affecting its quality. Then, to tackle the challenges and complexities of modern smelters, strategies employed by the industry, such as continuous supply management, supplier collaboration, and the implementation of process corrective measures, are investigated. Using the Emirates Global Aluminium (EGA) smelter as a case study, the impact of these strategies on anode quality and pot performance is discussed. Furthermore, a model that segregates the process and specification effects on anode quality is proposed, providing valuable insights for optimising smelter operations. Finally, a way forward is outlined, emphasising the importance of linking CPC specifications to potroom indices and financial key performance indicators (KPIs).

Keywords: Emirates Global Aluminium, Petroleum coke specifications, Calcined petroleum coke, Anode quality, Cell performance.

1. Introduction

Emirates Global Aluminium (EGA) owns and operates two smelters; the older Jebel Ali smelter, formerly known as Dubai Aluminium or DUBAL, is in the Jebel Ali Industrial Zone, Dubai. The newer Al Taweelah smelter, formerly known as Emirates Aluminium or EMAL, is in the Khalifa Port and Industrial Zone in Al Taweelah, Abu Dhabi, approximately 80 km east of Abu Dhabi.

1.1. EGA Background on the Aluminum Smelting Process

The production forecast of Jebel Ali smelter, Al Taweelah smelter and combined are listed in Table 1, highlighting the CPC consumption rates for both smelters.

Table 1. EGA's approximate production forecast for 2023.

	Hot metal production (tpa)	**CPC consumption** ±5 % (tpa)	**Number of purchased anodes**
Jebel Ali smelter	1 127 000	300 000	138 000
Al Taweelah smelter	1 519 000	585 000	-
EGA	2 665 000	885 000	138 000

While EGA produces almost 2.7 million tonnes per annum of hot metal, the actual production from EGA's own anode production is 2.3 million tonnes per annum; the remainder of EGA's hot metal production is from anodes purchased externally due to current limitations in the Jebel Ali plant. This capacity constraint is due to a significant amperage increase over the last 15 years in Jebel Ali smelter, exceeding its anode baking capacity. This paper will focus solely on in-house anode production and the metal made from these anodes.

2. Global Sourcing of EGA Coke Requirement.

EGA sources its 900 000 tpa (Figure.1) of coke from China, the USA, Germany, Brazil, Kuwait, Oman, and the United Arab Emirates. However, to obtain the required specification for EGA, nearly all these suppliers also source at least part of the GPC globally.

EGA's typical coke sourcing includes all three types of calciners: rotary, shaft, and minor amounts from rotary hearth calciners(Table 2)

Table 2. Coke type vs calcination process.

→	Rotary Kiln	Shaft	Rotary Hearth
High-density (HD) coke		F & G	D &E
Standard density (SD) coke	A, B & C		

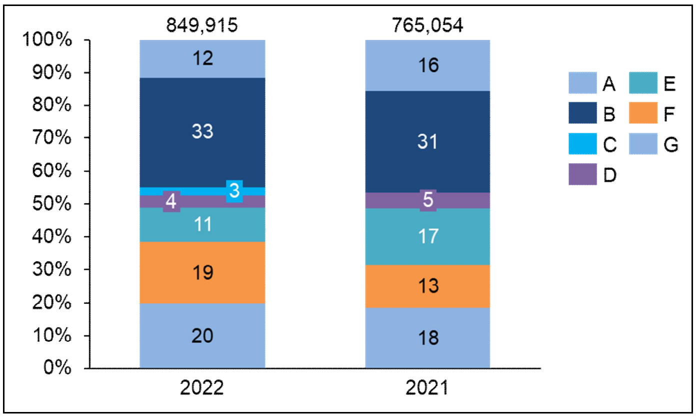

Figure 1. Coke requirements 2022 vs 2021.

3. CPC Coke Specifications and Historical Trends

The importance of CPC quality on smelter performance and anode quality must be balanced, with numerous CPC qualities having different and, at times, conflicting impacts on the final anode quality. The typical qualities, as shown in Table 3, are monitored and controlled in the EGA CPC specification, including:

Over the past decade, EGA has continuously improved its CPC specifications as part of a continuous improvement process to enhance overall anode quality. These improvements were made to meet the demands of reduction, mainly as the amperage increase necessitates EGA to operate some of the industry's highest anode current density potlines.

However, competing with the trend to tighten out CPC specification is the deterioration of various coke characteristics/properties by our suppliers due to changes in their GPC supply chain, including upgrades and other changes at their feeder refineries. Figure 2 demonstrates the variability of chemical and physical properties over the last ten years.

9. Linking Coke Specifications to Potroom Indices and Financial KPIs

Leveraging the OCC model, different coke blends could be assessed, changes in their specifications simulated and sensitivity analyses developed. For example, Figure 16 depicts how standard coke density (SD) C outperforms other SD cokes (A &B) irrespective of the high density (G, F, E) with which it is blended.

A gap of approximately 4 kg C/t Al between the best coke combination C+E vs B+F (highest value) is observed. Given the assumption that 1 kg C/t Al is equivalent to 2 million USD at the scale of EGA, there is an 8 million USD per annum incentive if the CPC differences are minimised.

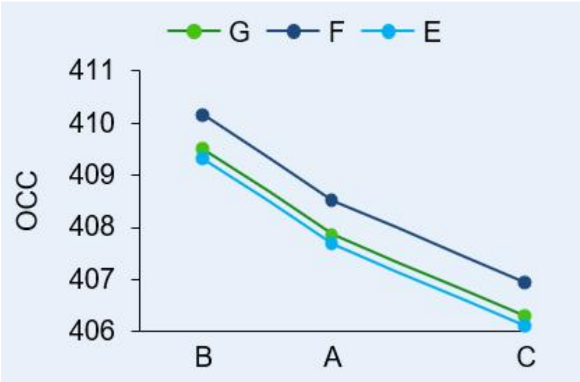

Figure 16. Carbon consumption vs coke blend type.

10. Investing in Research and Development for Alternative Raw Materials

Given the size of EGA's smelters, acquiring the infrastructure for in-depth research and development is recommended for carbon anode manufacturing.

Anode pilot plant facilities are being explored and are listed in the capital expenditure program.

11. Conclusions

This paper provides an in-depth analysis of the effects of calcined petroleum coke (CPC) specifications on the performance of aluminium smelters, focusing on anode quality. It covers historical trends of raw material petroleum coke, strategies employed by the industry to tackle challenges, and the impact of these strategies on anode quality and pot performance using the Emirates Global Aluminium (EGA) smelter as a case study.

This study detailed steps to enhance smelter performance, reduce costs, and improve environmental sustainability through better coke specification and process optimisation. By adopting these recommendations, aluminium smelters can achieve higher anode quality, increased energy efficiency, and reduced environmental impact, contributing to the overall growth and sustainability of the industry.

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