Reduction of Auxiliary Energy Consumption in an Aluminium Smelter

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Abstract

In today's global landscape, where Environment, Social and Governance (ESG) considerations wield increasing influence over corporate decision-making, the aluminum industry is undergoing a profound transformation. Embracing the imperative of sustainability, Vedanta Aluminium Limited has embarked on a journey towards producing environmentally friendly aluminum while prioritizing energy efficiency and social responsibility.

This paper underscores Vedanta's commitment to ESG principles through the implementation of energy-efficient measures in its smelting operations, with cell technology provided by GAMI, China. Traditional aluminum production involves electrolytic cells powered by direct current (DC), alongside auxiliary energy consumption for other processes. Vedanta aims to reduce this auxiliary energy consumption in its electrolytic reduction processes, thereby advancing sustainable development while safeguarding the environment and benefiting society.

Key initiatives outlined include the installation of a pot cooling system, hydro jetting of secondary alumina conveying pipes in the Fume Treatment Plant (FTP), and the adoption of belt conveyors to replace pressure vessel systems for alumina transport. Additionally, process enhancements such as fume flow balancing and compressed air optimization are highlighted, demonstrating Vedanta's commitment to minimizing auxiliary energy consumption in aluminum smelting. This paper underscores the pivotal role of environmental stewardship and social responsibility in fostering sustainable innovation and operational excellence in the aluminum industry.

Keywords: Environment, Social and Governance (ESG), Smelter auxiliary energy consumption, GAMI cell technology, Sustainable practices, social responsibility.

1. Introduction

The Hall-Héroult process to produce primary aluminum consists of electrolysis of aluminium oxide dissolved in molten cryolite. Direct current (DC) is used as the energy source for electrolysis process. This method is currently the key industrial process to produce aluminium, independently developed by Charles Martin Hall in USA and Paul Héroult in France in the late 19^{th} century. The primary reaction involved in the Hall-Héroult process is stated below (1):

$$2Al_2O_3 + 3C \rightarrow 4Al + 3CO_2 \quad (1)$$

Here, the overall energy required for the electrolytic reduction of aluminium is calculated in terms of energy required to produce one metric tonne of aluminium which is known as Specific Energy Consumption (SEC). Specific Power Consumption (SEC) comprises of specific DC energy consumption which is the DC energy used for electrolysis and specific auxiliary energy consumption that accounts for the energy consumed by other auxiliary equipment. This paper outlines some of the energy saving initiatives and process enhancements at Vedanta Limited, Jharsuguda towards the journey in the reduction of specific auxiliary energy consumption from 407 kWh/t Al to 386 kWh/t Al. The reduction in specific energy consumption not only poses a financial benefit, but also plays a major role in reduction of greenhouse gas (GHG) emissions and environmental sustainability.

2. Specific Auxiliary Energy Consumption

The Vedanta Aluminium Limited located at Jharsuguda consists of two smelters that jointly has an annual production capacity of 1.75 Mt/a (million tonnes per annum) of aluminium. The utilised by auxiliary equipment to produce one tonne of hot metal of aluminium is known as specific auxiliary energy consumption of potline. The major contributors of auxiliary energy consumption in potline consists of induced draft fans in FTP, fans and blowers of FTP, rectifier, rectifier pump house, compressor house and other miscellaneous equipment. The specific auxiliary energy consumption is calculated by the formula (2),

$$Aux. Energy = \frac{Total\ MCC\ Energy + Rectifier\ energy + 60\ \% \times Utility\ energy}{Gross\ metal\ Production} \quad (2)$$

where:

Aux. Energy	Specific Auxiliary Energy Consumption, kWh/t Al
Total MCC Energy	Energy consumed by ID fan and other auxiliaries of potline, kWh
Rectifier energy	Energy consumed by rectifier, kWh
Utility energy	Total energy consumed by utility, kWh
Metal Production	Total metal produced for a given period, t

2.1 Journey of Vedanta in Auxiliary Energy Reduction

The Vedanta Aluminium Limited marked its journey in the reduction of auxiliary energy consumption with the implementation of various energy saving initiatives since the full phase plant production in 2011. The Figure 1 shows the yearly auxiliary energy consumption to produce hot metal of aluminium in the potlines of Vedanta Aluminium Limited. The Figure 1 also demonstrates the Vedanta's commitment in producing environmentally friendly aluminum while prioritizing energy efficiency and social responsibility.

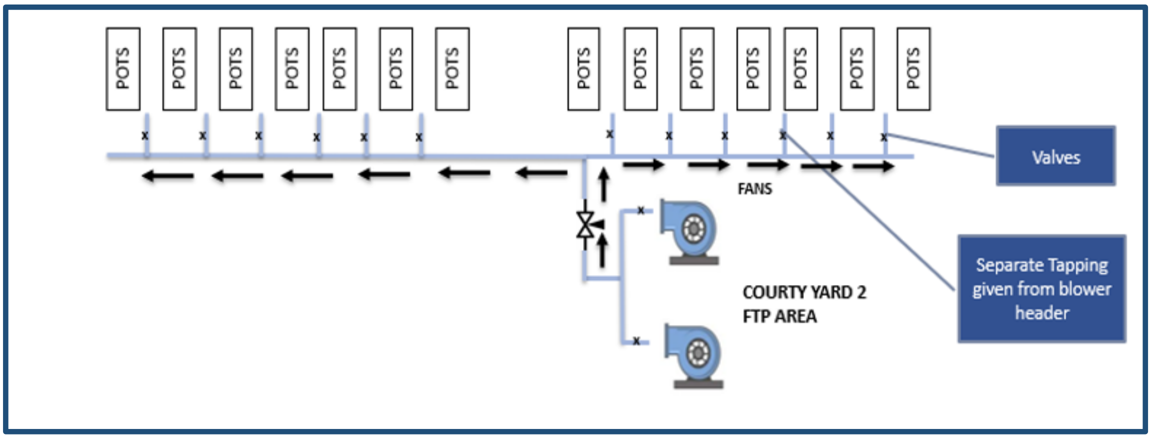

Figure 9. General layout of pot cooling system.

The trail phase installation of pot cooling system in one section has reduced the energy consumption of one HP compressor by 27 %, that accounts for about 1.4 kWh/t Al in the auxiliary energy consumption. In the way forward, on implementing the same throughout the smelter will have a potential saving of 25 to 30 kWh/t Al in the overall auxiliary energy consumption. This project is a major step in Vedanta that underscores the environment and social responsibility fostering operational excellence in GAMI potline.

6. Conclusions

In conclusion, this paper focused on the reduction of auxiliary energy consumption through various energy saving initiatives and process enhancements with the integration of Environmental, Social and Governance (ESG) principles has demonstrated significant progress and impactful results. This paper also underscores the importance of incorporating ESG principles into our operations, resulting in cost savings, enhanced operational efficiency and a stronger reputation among stakeholders. Our commitment to ESG principles will remain a cornerstone of our strategy, driving us towards a more sustainable and responsible future.

7. References

1. A. Smith, B. Johnson, Hydro-jetting technology for the removal of scales in pipelines, *Journal of Petroleum Technology*, 35, 123–130.
2. S.L. Brown, R.C. White, Energy Management Strategies for Auxiliary Power in Aluminium Smelters, *Journal of Industrial Engineering and Management,* 22 (3), 456–467.
3. X. Wang, L. Zhang, Y. Wang, Numerical Analysis of Airflow in Duct Systems Using Computational Fluid Dynamics, *Energy and Buildings,* 43 (5*),* 1238–1243.
4. S.N. Mahmud, A.K. Datta, P.P. Banerjee, Balancing fume extraction and energy efficiency in modern aluminium smelters, *Metallurgical and Materials Transactions B,* 49 (1), 259–269.
5. J. Smith, E. Johnson, D. Wang, Optimization of Side Shell Temperature Control in Aluminium Smelters Using Advanced Cooling Systems, *Journal of Materials Processing Technology,* 123 (4), 567–578.