

# Revised Interpretation of Energy Consumption Per Unit Product of Electrolytic Aluminum and Alumina

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**Abstract:** To meet the needs of China's green, low carbon and high quality development combined with the revision of the unit energy consumption standards for electrolytic aluminum and aluminum oxide products in the relevant industries, energy consumption levels, statistical scope and other content, in accordance with enterprise research, departmental regulations, industry needs to integrate and revise the original standards. It is conducive to guiding the aluminum smelting industry to increase energy saving and carbon reduction efforts, eliminate backward production capacity and process equipment, promote the research and development and promotion of energy-saving technology for aluminum smelting, and provide technical support for the implementation of energy-saving and carbon reduction goals for the aluminum smelting industry.

**Keywords:** Electrolytic Aluminum; Alumina; Energy Consumption; Energy Saving and Carbon Reduction

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## 1. Introduction

During the "14th Five-Year Plan" period, in order to strictly enforce energy efficiency constraints to promote energy conservation and carbon reduction work in key areas, thereby driving the green low-carbon transformation of the whole industry and ensuring the realization of the target of carbon peak on schedule. The relevant state departments have successively issued the "Standard Conditions for the Aluminum Industry", the "Notice on Improving the Ladder Electricity Price Policy for the electrolytic Aluminum Industry" and the "On the release of energy efficiency benchmark levels and benchmark levels in key areas of high energy consumption industries (2021 edition)". Notice <sup>[1][2]</sup>, set the ladder electricity price according to the comprehensive AC power consumption of liquid aluminum, set the benchmark level of electrolytic aluminum AC power consumption of 13,350 KWH/ton, the benchmark level of 13,000 KWH/ton and other requirements; In the "Industrial carbon peak Implementation Plan" released in August, it is more focused on key industries, formulate carbon peak implementation plans for steel, building materials, petrochemical chemicals, non-ferrous metals and other industries, study the low-carbon development road-map for consumer goods, equipment manufacturing, electronics and other industries, implement policies by industry and continue to promote, reduce carbon emission intensity and control carbon emissions.

According to the document requirements of the National Standards Commission "Notice on Issuing the Conclusion of the integration and Simplification of Mandatory standards" (the comprehensive letter of the National Standards Commission [2017] No. 4) : The energy consumption standards of electrolytic aluminum, magnesium smelting and industrial silicon products are integrated and revised; After discussion, it was finally determined that the original "energy consumption quota of electrolytic aluminum enterprises per unit product" <sup>[3]</sup> and "energy consumption quota of alumina per unit product" were merged and revised, and the integrated name was intended to be "Energy consumption quota of Aluminum electrolysis and alumina per unit product", which was released in December 2022 and implemented in January 2024.

The mandatory energy consumption quota standard mainly stipulates the maximum energy consumption allowed in the production process of the enterprise unit product and the requirements of different energy consumption levels. With the gradual development of China's "double carbon" work, energy saving and carbon reduction have become the focus of the non-ferrous metal industry. As a basic mandatory standard for energy consumption in the non-ferrous metals industry, GB

21346-2022 will play a leading role in strictly controlling and restricting key areas, implementing ladder electricity prices, eliminating backward production capacity, and implementing the "energy efficiency leader" system, providing strong support for the energy conservation and carbon reduction of China's non-ferrous metals industry, especially aluminum smelting enterprises.

## 2. Revised Ideas

### 2.1 Task Sources

According to the document requirements of the National Standards Commission "Notice on the Issuance of the Conclusion of the integration and Simplification of Mandatory standards" : The energy consumption standards of electrolytic aluminum, magnesium smelting and industrial silicon are integrated and revised; After discussion, it was finally determined that the original GB 21346-2013 "The norm of energy consumption per unit product of electrolytic aluminum" and GB 25327-2017 "The norm of energy consumption per unit product of alumina " were merged and revised, and the integrated name was intended to be "The norm of energy consumption per unit product of electrolytic aluminum and alumina ".

## 2.2 Modify content

### 2.2.1 Level of energy consumption

Table 1 Energy consumption levels of electrolytic aluminum and alumina

Levels	Energy consumption limits		
	Level 1 (Advanced value )	Level 2 (Admittanc e value )	Level 3 (Limit value )
Electrolytic aluminum (bold italic part is the 2013 version of the indicators, the following is the revised indicators)			
Ac power consumption of liquid aluminum,kW·h/t	<b><i>≤12650</i></b> ≤12950	<b><i>≤12750</i></b> ≤13000	<b><i>≤13700</i></b> ≤13350
Combined AC power consumption of liquid aluminum,kW·h/t	<b><i>≤13050</i></b> ≤13250	<b><i>≤13150</i></b> ≤13350	<b><i>≤14050</i></b> ≤13700
Aluminum ingot comprehensive AC power consumption,kW·h/t	<b><i>≤13100</i></b> ≤13300	<b><i>≤13200</i></b> ≤13400	<b><i>≤14100</i></b> ≤13750
Aluminum ingot integrated energy consumption,kgce/t	<b><i>≤1660</i></b> ≤1670	<b><i>≤1680</i></b> ≤1680	<b><i>≤1760</i></b> ≤1720
Alumina (bold italic part is the 2013 version of the indicators, the following is the revised indicators)			
Bayer process energy consumption,kgce/t	<b><i>≤370</i></b> ≤310	<b><i>≤400</i></b> ≤360	<b><i>≤470</i></b> ≤430
Bayer method comprehensive energy consumption,kgce/t	<b><i>≤400</i></b> ≤340	<b><i>≤430</i></b> ≤390	<b><i>≤500</i></b> ≤460
Other process energy consumption,kgce/t	<b><i>≤650</i></b> ≤500	<b><i>≤700</i></b> ≤550	<b><i>≤750</i></b> ≤650
Other comprehensive energy consumption,kgce/t	<b><i>≤700</i></b> ≤550	<b><i>≤750</i></b> ≤600	<b><i>≤800</i></b> ≤700

### 2.2.2 Statistical range

New electrolytic aluminum related aluminum liquid AC power consumption, aluminum liquid comprehensive AC

power consumption, aluminum ingot comprehensive AC power consumption, comprehensive single consumption and alumina 4 energy consumption indicators related to the production system and auxiliary production system division, clear its corresponding electrolysis, casting, power supply, power, purification and other workshops, conducive to enterprises in the calculation of energy consumption more clear statistical boundaries.

### 2.2.3 others

Delete the expression of calculation principle and calculation range, and increase the statistical range; Added the related GB/T 1196, YS/T 803 two product quality standards; Deleted terms and definitions other than GB/T 2589 and GB/T 12723; The interpretation of some indicators has been added, paragraphs and formulas unrelated to the calculation of sub-indicators of energy consumption have been deleted, and the text of the standard has been greatly reduced (from the original 21 pages to 9 pages), which has improved the readability of the standard. The energy, power and thermal discount coefficient and energy consuming working medium that are not used in the energy consumption calculation of electrolytic aluminum and alumina enterprises are deleted, and the pertinence of the standard is enhanced.

## 2.3 Basis for revision

### 2.3.1 Enterprise survey data

Based on the energy consumption data of electrolytic aluminum and alumina enterprises in 2020, the enterprises are sorted in the order of energy consumption from low to high. With the output of each enterprise as the horizontal coordinate and the energy consumption level as the vertical coordinate, the 3-level energy consumption interval of 80% cumulative percentage is selected as the reference, and the top 10% (30% for alumina) is selected as the reference of the 2-level energy consumption interval. The first 5% refers to the level 1 energy consumption interval. See Figures 1.

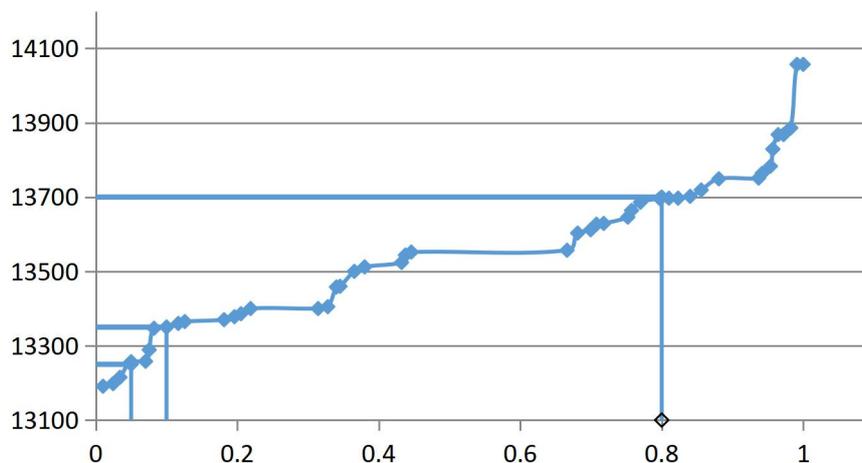


Figure 1. The cumulative percentage of output of domestic electrolytic aluminum enterprises corresponds to the comprehensive AC power consumption of aluminum liquid

### 2.3.2 Department Regulations

According to the requirements of document No. 723 of Development and Reform Industry, the energy efficiency benchmark level of electrolytic aluminum in key industries is 13350 kW·h/t, and the benchmark level is 13000 kW·h/t, corresponding to level 3 and level 2 of energy consumption levels respectively. According to the requirements of the Ministry of Industry and Information Technology's "Aluminum industry Standard Conditions", the comprehensive AC power consumption of aluminum liquid in electrolytic aluminum enterprises should not be more than 13,500 KWH/ton (excluding desulfurization and denitration), and the final determination of level 1 is set as 5% of the national production level in accordance with advanced and binding considerations.

### 2.3.3 Industry requirements

- (1) Through the continuous application of advanced technologies such as large-scale, low temperature and low voltage

in recent years, the energy consumption level of domestic electrolytic aluminum is far lower than the global average energy consumption, and the overall energy consumption level has been in a leading position, and there is little room for improvement through new technologies in the future;

(2) As the country and the industry vigorously develop digital and intelligent factories, increasing equipment will inevitably bring about an increase in related energy consumption, in addition, the continuous investment of enterprises in environmental protection and emission reduction equipment will also bring more energy consumption than the original;

(3) For traditional enterprises with relatively mature and stable process processes, if only the control of too low energy consumption level is emphasized, it will not only bring inconvenience to on-site operation and fine management, but also affect the overall stability of electrolytic aluminum production, as can be seen from the disorder of aluminum electrolyte system of enterprises in recent years.

## 2.4 Comments and Suggestions

The impact of production restriction, shutdown and secondary start-up caused by environmental control or natural disasters on the AC power consumption of liquid aluminum and the comprehensive AC power consumption of liquid aluminum and how to deduct it?

Explanation: The influence of all these factors can be understood as the fluctuation of energy consumption caused by the abnormal environment, and the ratio of the normal production of the entire enterprise should be low, so the production enterprise can choose the normal period of processing when calculating energy consumption or providing data.

The concept of converting the deducted conductive bus, short junction loss, and DC electricity consumed during the roasting and start-up of the electrolyzer into AC is not explicitly proposed, and whether it is explained by other means.

Explanation: From the standard formula, the conductive bus that needs to be eliminated, the AC power lost at short intersections and the AC power lost by the corridor bus are adopted in the formula in the form of the AC power of the eliminated part = the total AC power  $\times$  the ratio, and there is no need to convert the direct flow of AC. The subterms of the ratio and the bus bar are the ratio of the accumulated voltage and the total voltage corresponding to the corresponding part of the electricity that needs to be removed.

## 3. Conclusion

To sort out the energy consumption data of domestic electrolytic aluminum and alumina enterprises in recent years by conducting on-site research, sending letters and soliciting opinions at meetings, etc., to summarize the data and solicit the opinions and suggestions of production enterprises, research institutes and government departments; The revision or formulation of the standard must be combined with the actual situation in China, the system is based on a scientific and rigorous basis, and actively solicited the opinions and suggestions of the National Development and Reform Commission, the Ministry of Industry and Information Technology and other ministries, and formulated energy consumption indicators combined with the benchmark level, benchmark level and the actual level of the industry issued by the National Development and Reform Commission in 2021 and 2023.

As a social public welfare project, the release and implementation of standards can better guide the research and development of energy-saving processes, equipment and technologies in the aluminum electrolysis industry, promote the industry to eliminate backward production capacity and gradually solve the problem of overcapacity, provide technical basis for the government and third-party verification agencies to verify the energy consumption of enterprises, and promote the development of the entire industry to a more energy-saving and healthy direction.

The transition period is determined to be one year, during which the promotion and specific interpretation of the standard will be strengthened to achieve a smooth transition of the calculation method and statistical scope in the new standard, and ensure the smooth implementation of this standard in the country and the whole industry; In addition, through the establishment of mandatory statistical analysis points for the implementation of national standards, various opinions and suggestions feedbacks from the government, enterprises and research institutes can be continuously tracked to lay the data foundation for future revision and improvement.

This revision will also further guide the aluminum smelting industry to increase energy conservation and carbon reduction efforts, eliminate backward production capacity and process equipment, promote the research and development and promotion of energy-saving technology for aluminum smelting , and provide technical support for the aluminum smelting industry to implement the "double carbon" target requirements.

## **References**

[1] NDRC. Notice on improving the ladder electricity price policy of electrolytic aluminum industry [EB/OL] NDRC Price (2021) No. 1239.

[2] NDRC. Notice on the Release of Energy Efficiency Benchmark Levels and Benchmark Levels in Key Areas of High Energy Consumption Industries (2021 version)[EB/OL]NDRC Price (2021) No. 1609.

[3] GB 21346-2013, The norm of energy consumption per unit product of electrolytic aluminum[S].