RESEARCH ARTICLE

Improvement of Anode of Prebaked Cell in Aluminum Electrolysis

Junmin Li
China Aluminum Corporation Liancheng Branch, Lanzhou, Gansu, 730335, China

Abstract: Compared with the previous self-cultivation anode electrolyzer, the current prebaked anode electrolyzer has advanced technical and economic indexes, high degree of mechanization and automation, and relatively little environmental pollution, which has achieved great development. However, the continuity of aluminum electrolysis production and the limited economic height of anode constitute two contradictory opposites. In order to solve this contradiction, the processes of replacing anode periodically, cleaning the residual electrode and electrolyte, pressing off the residual electrode and phosphorus-iron ring, crushing and grinding the residual electrode have been produced, which has increased the investment and labor cost per ton of aluminum. Moreover, when the anode is replaced, the operator can say that the working environment is harsh and dangerous directly in front of the high-temperature electrolyte, and a large amount of fluorine-containing flue gas is discharged out of order and pollutes the environment due to the opening of the slot cover plate and the placement of the high-temperature residual electrode during the anode replacement. At the same time, pole change has great interference on electrolytic production. At present, inert anodes can't be put into industrial production, and the continuous preparation anodes in Germany have high power consumption, so it is of great practical significance to perfect or improve the existing anode structure. This paper discusses how to solve this problem.
Keywords: Aluminum electrolysis; Prebaked cell anode

Citation: Junmin Li, 2021. Improvement of Anode of Prebaked Cell in Aluminum Electrolysis. *Advances in Material Science*, 5(1): 1-3. http://doi.org/10.26789/AMS.2021.01.001

1. Problems of Existing Prebaked Cell Anode in Aluminum Electrolysis Production

When the anode is replaced, the electrolyte level is exposed, resulting in a large amount of heat loss, and many materials fall into the tank, which greatly interferes with the stability of the electrolytic cell;

When the anode is replaced, the operator is exposed to high-temperature electrolyte, and the operating environment is extremely harsh and dangerous;

The following treatment process of residual pole is complicated, requiring various equipments, such as electrolyte cleaning, crushing of residual pole and iron ring, crushing of residual pole and returning to batching, etc.

When the anode is thin, the electrolyte fills the anode, scouring the upper surface to lead to anode carbon slag, and rinsing the steel claw affects the quality of primary aluminum;

Steel beam and steel claw deformation and bending caused by stress caused by temperature change must be repaired regularly; anode service time is strict,

2. Alteration of Electrolyzer

2.1 anode bus bar

The contact surface between the anode busbar and the guide rod is made into a concave surface suitable for the surface of the guide rod, and the distance between the anode lugs should not hinder the free rotation of the guide rod. The purpose of this is: 1. The guide rod can rotate at a certain angle on the anode busbar; 2. Increase the contact area between the guide bar and the bus bar and reduce the contact pressure drop.

2.2 Modification of anode

The anode is divided into carbon block, steel claw, the connection between carbon block and steel claw, and the guide rod is described separately.

2.2.1 carbon block modification

2.2.1.1 carbon block shape change

The convex groove on the lower part of the 2.2.1.2 corresponds to the groove on the upper surface of the anode, and the groove on the upper surface is slightly larger than the protrusion on the lower surface, so as to facilitate mutual engagement during anode replacement. After the adhesive added in the groove is softened, it will spread all over the anode under the pressure. With the increase of anode temperature, the adhesive will gradually sinter and coke, so that the new and old anodes can be integrated into a whole, and the purpose of continuous use can be achieved.

The upper and lower sides of the anode of the 2.2.1.3 are respectively provided with two V-shaped grooves. After the anode is replaced, an adhesive is added to the adjacent anode pole gap, and gradually softened, sintered and coked with the increase of temperature, so that the newly replaced anode and the adjacent anode are integrated. After the adjacent anode is replaced and the steel claw guide rod is pulled out, the weight of the residual electrode at the replaced part is borne by the adjacent anode, so that the residual electrode can be prevented from being put into the electrolytic cell due to the weight of the residual electrode and the pressure of installing a new anode.

Aluminum is sprayed on both ends of 2.2.1.4 anode to prevent anodic oxidation.

The modification of 2.2.1.5 anode carbon bowl is as shown in the figure, the upper surface is slightly wider than the lower surface, so that it is convenient to pull out the steel claw. The inner side of the carbon bowl is molded with multi-thread grooves to improve the bonding strength and reduce the torsion of the steel claw, which is the stress on the anode and prevents the anode from breaking.

2.3. Modification of steel claw

The material of steel claw is changed to copper, perhaps it is more accurate to call it copper claw. For the convenience of understanding, this paper still uses steel claw to express it, so that the pressure drop of steel claw can be reduced by 2/3. Because of the high thickness of residual electrode, the rinse steel claw is eliminated, so there is no need to worry about the life of steel claw and the fluctuation of primary aluminum quality.

The shape of the steel claw is suitable for the carbon bowl. The upper end is slightly larger than the lower end, and the surface is machined with thread-like protrusions.

The steel claws in the middle part are welded together with the guide rod, and the steel claws on both sides are pressed together with screws at the guide rod in the middle part through the pressing blocks at the ends of the copper soft belt respectively.

2.4. Anode assembly

After the anode delivered from the carbon block warehouse and the guide bar produced by electrolysis pass the inspection, the middle steel claw is vertically put into the middle carbon bowl and tamped with carbon paste rich in graphite fragments and then tamped on both sides. Then, the temperature at the carbon bowl is increased by the annular heating and heat preservation device to sinter and coke the carbon paste. After coking, the heating device is removed, and the cleaned pressed pieces of the steel claws on both sides are connected with the cleaned middle guide bar by screws.

2.5 Anode insulation and oxidation prevention

The shape of the anode end baffle is shown in the figure.

The pull rod is hooked on the inner side of the guide rod, the support plate is fixed on the outer side of the guide rod, and the stop plate overlaps with the end part of the anode, thus forming a space for holding thermal insulation coke particles.

The upper surface of the anode is uniformly covered with coke particles with a certain particle size by the multifunctional unit, and the thickness and particle size range of the coke particle layer are determined by the requirements of the electrolysis process.

3 Matching Changes

3.1 Modification of multifunctional unit

A hydraulic twisting and pulling mechanism and a hydraulic wrench should be added. When changing poles, the unit or the manual will first loosen the screw of the steel claw pressing block on the guide rod, and then the twisting and pulling device of the multifunctional unit will rotate the middle guide rod and the steel claws on both sides to separate them from the anode body.

Add a set of coke particle cloth suction device to the unit. Before pole change, coke particles are sucked into the unit bin. After pole change, the coke particles can be evenly distributed on the anode surface, which can be screened to remove impurities as required.

The unit shall be equipped with a set of adhesive distribution device. After the steel claw of the guide rod is pulled out, the adhesive is added to the groove on the surface of the residual pole and the carbon bowl, and the adhesive of the pole gap can be supplemented as needed

after the new pole tightening fixture.

Add a tool cage to the unit, and put the steel claw of the guide rod after pole change into it to reduce the running time of the unit.

3.2 Modification of green anode molding

The surface shape of the new anode is complex, the contact surface between the lower surface and the cooling cage is small, and the green anode may be deformed. To prevent this, a template is added in the molding process, and removed after cooling.

4 The Use of New Anode

4.1 Replacement of anode

Manually uncover the slot cover plate, the coke particle cloth suction device of the unit absorbs coke particles, and the operator removes the baffle plates at both ends of the anode;

The fixture of multi-function unit will lift the guide rod and loosen the fixture; Start the connection between the 1# and 3# steel claws (copper claws) of the hydraulic twisting and pulling mechanism and the guide rod to separate them. Then, the twisting and pulling mechanism wrenches out the 1# and 3# steel claws and puts them into the tool cage. Next, the unit wrenches the steel claw where the guide rod is located or directly rotates the guide rod to pull out the guide rod and the No.2 steel claw;

The unit adds adhesive to the residual electrode groove and the carbon bowl. Due to the high temperature of the residual electrode, the adhesive quickly liquefies and covers the surface of the residual electrode;

Install the new pole slowly at the height required by the unit safety. The grooves and convex grooves of the new and old anodes are engaged, and the liquefied adhesive is squeezed into the contact surface and pole gap of the new and old anodes and the slotted gap of the new anode, so that the new and old anodes are integrated;

Fit the fixture, and the baffle plates at both ends of the new pole, and add the pole gap adhesive properly by the unit or manually, so as to fill the coke particles.

5 Prospect Analysis

The current efficiency is expected to increase, because the current density of anode decreases and the actual charge rate of anode in the cell increases;

The adsorption of asphalt smoke generated during the coking of adhesive through the coke particle layer will not have great influence on the purification system. The asphalt smoke particles will not be brought into the electrolytic bath like the dry purification of self-baking bath, which will affect the current efficiency;

If the steel claw is made of copper, the anode voltage drop can be greatly reduced. It is completely possible to offset the voltage drop caused by the bonding layer between the new and old anodes;

Because only part of the binder sintering in the pole gap and anode slot gap does not affect the discharge of anode gas. Even the sintered part is consumed quickly because of its different chemical reactivity with the anode body, which is also beneficial to the discharge of anode gas.

Fundamentally put an end to the phenomenon of electrolyte rinsing steel claw, and improved the quality of primary aluminum. Moreover, the steel claw is not connected with the steel claw by rigid steel beams, which avoids the inner bending of the steel claw caused by stress.

The investment of anode production system can be saved by about 30%, and the cost of electrolysis production can be reduced by about 260 yuan /tal.

Reduce the labor intensity of employees.

The new anode combines the advantages of continuous use of self-baking cell anode and timely gas discharge of prebaked cell anode to avoid the disadvantage of high integral bonding voltage of continuous prebaked cell anode, which is a new exploration.

References

[1] Study on influencing factors of current efficiency of aluminum electrolytic cell [J]. Liu Kunpeng, Han Jianwen, Wang Xingyun, Ren Jingyun. Enterprise technology development .2015 (03)