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Aluminum Electrolysis Anti-Oxidation Coating Carbon Anode

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Abstract

Anti-oxidation coating for carbon anode in aluminum electrolysis was studied in this paper. Different compounds of the anti-oxidation coating had different effects on carbon anode. The results showed that hot weight loss rate of coated anode was lower 10-30% than that of uncovered anode. The compounds of the anti-oxidation coating were optimized by SEM and tests of hot weight loss. It was proved that the anti-oxidation coating had great inoxidizable effects on carbon anode, and it was no influence on normal aluminum electrolysis.

Introduction

About 15% productive cost of aluminum electrolysis is on carbon anode consumption, and this is important quota to be controlled strictly by aluminum plant. Many carbon anodes are consumed without any meaning in China, which is the first on primary aluminum production in the world. There are three main consumptions of carbon anode in aluminum electrolysis process, electrochemical consumption is necessary, mechanical consumption is associated with ordinary operation, chemical oxidation consumption is promising to be reduced at low stage. In another word, oxidative reaction between carbon anode and oxidizing gas including oxygen, carbon dioxide is the main reason for over-consumption of carbon anode[1-3]. At present, some steps are taken to reduce the loss of chemical oxidation on carbon anode in prebaked anode cell, alumina is usually used to cover anode. But, safeguard cover of alumina is loose, uneven and big pore, and the side of anode is still exposed on oxidizing atmosphere, the effect of alumina safeguard on carbon anode chemical oxidation is limited[4-6].

The poor ability of anti-oxidation for carbon anode can bring many problems in aluminum electrolysis, such as amount of carbon granule is dropped into cell, and this can influence on normal electrolytic condition. The main disadvantages of poor ability anti-oxidation for carbon anode are shown as following:

- To increase productive cost;
- To increase resistance of electrolyte because the dropped carbon granule has poor conductivity;
- To reduce current efficiency for raising cell temperature;
- To promote labor intensity for fishing carbon granule in cell;
- To waste electrolyte because amount of electrolyte is brought out cell;

Abnormal atmospheres occur because of poor ability of anti-oxidation for prebaked carbon anode, it may influence seriously on operation of aluminum electrolysis. The main abnormal atmospheres are such as more carbon granule, over-heated cell, over-consumption of materials, low current efficiency and low cell life[7-8].

In this paper, anti-oxidation coating for carbon anode in aluminum electrolysis was studied. Compared experiments were carried out between anti-oxidation coating and no coating on carbon anode in resistance furnace. The objection was to reduce chemical oxidation of carbon anode on condition that it had no influence on normal aluminum electrolysis.

Experiment

Experimental apparatus and agents

Al_2O_3(analytic agent), NaF(analytic agent),AlF_3(analytic agent),MgF_2(analytic agent), Epoxide resin(chemical agent),Acetone(chemical agent);Solidified agent(chemical agent) Resistance furnace(2kW);Temperature controller(DWK-702); Balance(BP110S);

Experimental installing

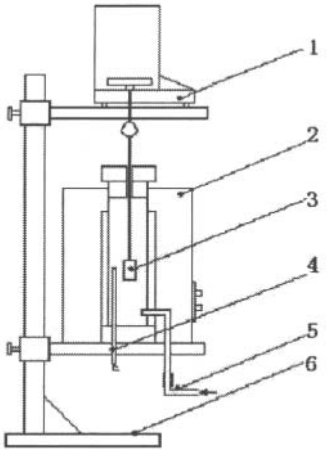

Figure 1 Installing of anti-oxidation experiments

1-Balance; 2-Resistance furance; 3-Sample; 4-Thermocouple; 5-Gas; 6-Elevator

Process of experiments

All the agents ware dried at 400℃for two hours. According to calculated ratio, the agents were weighed accurately on balance,

and grinded in mortar. Epoxide resin was solved into acetone, and mixed solidified agent and power. The material was overlain on prebaked anode surface. The samples were placed into resistance furnace, and the experiments were carried out according a temperature rule. All the samples were in resistance furnace about 4 hours. Components of electrolyte were as given in Table 1:

Table 1 Components ratio of coat

Number	Components
a1	12wt% Al_2O_3-40wt% Epoxide-30 wt % Acetone-18wt% Solidified agent
a2	2wt% Al_2O_3-10wt%MgF_2-40wt% Epoxide-30wt% Acetone-18wt% Solidified agent
a3	2wt% Al_2O_3-10wt%Na_3AlF_6-40wt% Epoxide-30wt% Acetone-18wt% Solidified agent
a4	2wt% Al_2O_3-10wt% Na_3AlF_6-40wt% Epoxide-30wt% Acetone-18wt% Solidified agent
a5	2wt% Al_2O_3-10wt% Na_3AlF_6-40wt% Epoxide-30wt% Acetone-18wt% Solidified agent
a6	2wt% Al_2O_3-10wt% Na_3AlF_6-40wt% Epoxide-30wt% Acetone-18wt% Solidified agent

Where: the number a3, a4, a5, a6 were different with molecular ratio, they were 2.0, 2.4, 2.8 and 3.2, respectively.

Ratio of oxidation weightless

Ratio of oxidation weightless was calculated as following formula:

$$W\%=(W_1-W_2)/W_1$$

Where: W is ratio of oxidation weightless, W_1 is weight of sample before oxidation, and W_2 is weight of sample after oxidation.

Results and discussion

Properties of anti-oxidation for different samples

Properties of anti-oxidation for different samples were evacuated by ratio of oxidation weightless, and the results were shown as Figure 2:

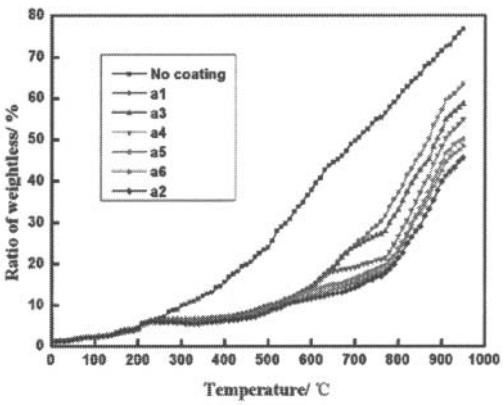

Figure 2 The curves of oxidation weightless for different samples

The Figure2 showed that anti-oxidation coating had effect on protecting prebaked carbon anode against oxidation. All the ratios of oxidation weightless with coating on carbon anode decreased about 10-30%. Under 800℃ temperature, the decreased values were 30%. There was a temperature gradient from anode immersed electrolyte to upper of anode, so, the coating might have better effect on protecting oxidation. The effect with alumina as single anti-oxidation material was the worst in all samples, this might own to big particle of alumina, and the result might be improved by using pulverous alumina. The higher molecular ratio of materials, the better of anti-oxidation effect might be with volatilization of aluminum fluoride. Volatilization of aluminum fluoride was serious at high temperature when the material contained much content of aluminum fluoride, this reduced the compactability of coating, and lowed ability of anti-oxidation. It was very interesting that a2 sample had the best effect on ratio of oxidation weightless, and this might be with stability of magnesium fluoride.

Gap between surface of anode and anti-oxidation coating

A gap between surface of prebaked anode and coating was found after experiments, it was shown as Figure 3:

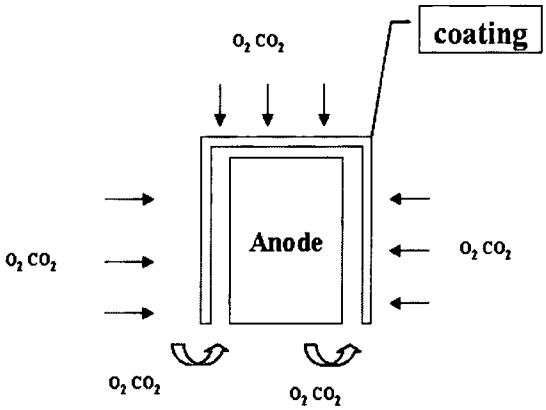

Figure 3 Schematic drawing for anti-oxidation coating

The cell side and upper were protected by anti-oxidation coating, and effects of anti-oxidation were good. But, there was a gap between side of cell and coating, this could damage to the effect of coating. On condition that practical aluminum electrolysis, gas generated from cell bottom was released through anode side, so the gap might be negative effect on normal production. How to diminish the gap between anode side and coating is further studied for the research team.

Conclusions

Anti-oxidation coating for carbon anode in aluminum electrolysis had some effect on protecting anode against oxidation. The oxidation weight loss rate of coated anode was lower 10-30% than that of uncovered anode. The higher molecular ratio of materials, the better of anti-oxidation effect might be with volatilization of aluminum fluoride.

There was a gap between surface of prebaked anode and coating, this might have negative effect on anti-oxidation, and this point would be further studied.

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