Analysis and Solution of Problems in Early Alumina Conveying System

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Abstract

Early alumina conveying system uses dense phase pipes to transport alumina to the alumina silo, which consumes high energy and has a high alumina attrition rate, which directly affects the production efficiency of electrolysis pot. Nowadays, in order to reduce energy consumption and reduce the rate of alumina attrition, alumina conveying systems often use air slide or belt conveyor to transport alumina. Based on the analysis of the defects of early alumina conveying system, this article introduces the current popular conveying systems, providing a certain reference for the design of alumina conveying systems.

Keywords: Electrolysis pot, Alumina conveying system, Air slide, Belt conveyor.

1. Introduction to Early Conveying Systems

Under the current situation, energy conservation and environmental protection are eternal topics for national and global development. Especially in China, in recent years, under the policy of tiered electricity prices, various aluminum smelters have made great efforts to save energy and reduce its consumption, striving to reduce the production cost of aluminum per tonne and maximize profits. For established and operating aluminum smelters, in addition to local optimization design of electrolytic pots, the transformation and optimization of supply and auxiliary systems cannot be underestimated, such as anode assembly, crushed bath transportation and storage systems, and alumina conveying systems. If the above supply and auxiliary systems are well transformed and optimized, it will greatly reduce the production cost per tonne of aluminum and achieve the goal of energy conservation and consumption reduction for the smelter. This article focuses on analyzing the shortcomings of the early alumina conveying system, and introduces several typical cases of alumina conveying transformation based on the mature alumina conveying technology at home and abroad.

1.1 Dilution Conveying Technology

When the material to gas ratio in the pipeline is such that bulk density (ρ) is smaller than 10 kg/m^3, solid particles form a suspended dilute phase in the fluid and are carried out together with the fluid from the fluidized bed; this process is called dilute phase transportation. Dilute phase transportation is a traditional method for transporting alumina in aluminum smelters and belongs to the dynamic pressure technology in pneumatic transportation. It requires high air speed (the material flow rate in the conveying pipe is around 35 m/s), so some energy is lost during the energy transfer process. Therefore, the energy consumption is high and the material-to-gas ratio is low, so that generally ρ = 7-10 kg/m^3. The pipeline is severely worn, and the transported alumina suffers severe attrition. Currently, dilute phase transportation of alumina has been mostly replaced by dense phase transportation.

1.2 Dense-Phase Conveying Technology

In pipelines, when the material to gas ratio is such that bulk density ρ = 10-30 kg/m³, it is called dense phase transportation [1]. The dense phase conveying system is a system with a special structure that generates static pressure to push the material plug to transport materials. The dense phase transportation pipeline is composed of an inner tube and an outer tube, with a specially designed inner tube welded to the upper wall of the outer tube. The use of inner tubes is the key to dense phase transportation, and the opening distance of the inner tubes and the airflow speed during the transportation process have a great impact on the process. The entire transportation process is carried out based on the principle of minimum resistance.

2. Current Status of Alumina Conveying Systems

At present, domestic aluminum smelters in China mostly use dense phase conveying systems. Taking an aluminum smelter with an annual production of 200 000 tonnes of aluminum as an example, the maximum distance between the alumina warehouse and the fresh alumina silo is as far as 200 meters. The unloading platform inside the alumina warehouse uses manual bag cutting to unload the material, and then the fresh alumina is transported to the new fresh alumina silo through a dense phase pipe. The entire transportation process has a long distance and a large height difference (up to 30 meters), and the maximum transportation capacity of the dense phase pipe is only 50 t/h. This method not only has a long working time and high energy consumption, but also increases the attrition rate of alumina materials. To address this situation, we have combined the actual production of the factory to renovate the alumina conveying system. Through the transportation method of hyper dense phase conveying and bucket elevator lifting, we strive to reduce the cost of alumina conveying and achieve the goal of energy conservation and reduction of energy consumption.

3. Transformation of Alumina Conveying System

3.1 Introduction Transformation Plan

The transformation plan is shown in Figures 1 and 2. A new unloading funnel is built in the original alumina warehouse. After the bagged alumina is unloaded from the unloading funnel, it is transported to the bucket elevator through an air slide. Once being lifted to the buffer bin, it crosses the potroom through the air slide and ultimately reaches the number 1 and number 2 alumina silos. This plan is designed as two lines, located at the east and west ends of the alumina warehouse.

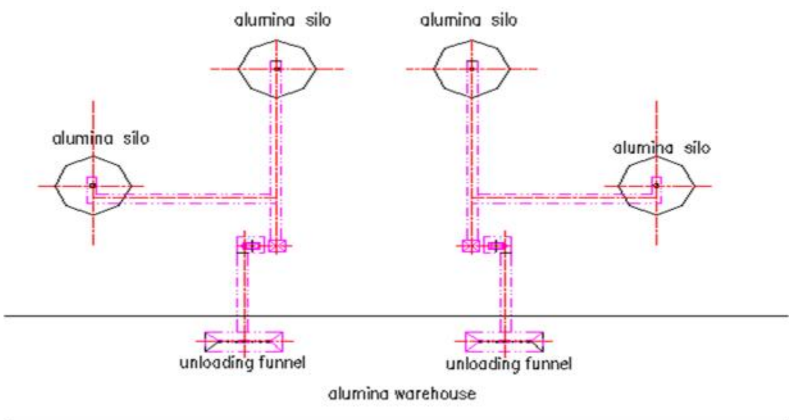

Figure 1. Layout of transformation plan.

4.2 Characteristics of this Transformation

1) Compared with the above transformation case, after this transformation, alumina is directly transported to the unloading room next to the alumina silo by car containers, and the material is directly dumped and unloaded in the unloading room, eliminating the process of manual bag cutting and greatly saving labor costs.
2) Only the air slide is used between the unloading funnel and the bucket elevator, and the air slide is only 3 meters long. There is no need to add a centrifugal fan for the air slide, and it only needs to be connected to the compressed air pipeline network of the potroom, which not only saves energy but also reduces the attrition rate of alumina.
3) The process flow of the conveying system is simple, and the main electrical equipment is a bucket elevator, greatly simplifying the control system, reducing the failure rate of the system, and facilitating its maintenance and repair.
4) The power consumption for dense phase transportation is about 35 kWh/t Al. The transformed conveying system consumes about 15 kWh/t Al, down from previous 20 kWh/t Al. Additionally, compared to the original dense phase transportation method, it can effectively reduce the attrition rate of alumina, improve current efficiency by about 0.5 %, and reduce energy consumption by about 60 kWh/t Al. The total energy saving of the above two items is estimated to be 80 kWh/t Al.
5) Based on the annual production capacity of 320 000 tonnes of the factory, and considering electricity price of 0.5 yuan/kWh, the annual cost savings can be approximately 12.8 million yuan. Namely: 80 × 0.5 × 320 000 =12 800 000. Note that the cost of truck logistics was not considered in this saving.

5. Conclusion

Energy conservation and consumption reduction have become the trend, and for aluminum smelters, transforming and optimizing the alumina conveying system is an important step in achieving these goals. The original alumina conveying system had technical limitations and high energy consumption. For smelters, reasonable transformation and optimization of the alumina conveying system, based on their own production situation can effectively reduce the energy consumption of the alumina conveying system.

6. References

1. Lingzhi Dai， Analysis of causes and preventive measures for wear of alumina dense phase transportation pipeline, *Gansu Metallurgy*, 2007 Volume 29 (5), 86-87.