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OPERATIONAL EXPERIENCE OF ADVANCED ALUMINA HANDLING TECHNOLOGY IN A RUSSIAN SMELTER

JAN PAEPCKE[1], ARNE HILCK[1], SERGEY V. MARSHALKO[2]
[1]Claudius Peters Technologies GmbH, Schanzenstr. 40, Buxtehude 21614, Germany
[2]RUSAL / Moscow, Russia

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Abstract

In 2006 Rusal UC started its new potline in the Khakas Region at the Sayanogorsk Smelter. For this new potline Rusal has chosen two - at that time - new innovative technologies for the alumina handling.
The primary alumina is transported pneumatically via the unique and most efficient FLUIDCON conveying system with 135 t/h and 390 m distance from the receiving station to the storage silos.
The secondary alumina is distributed via two Aerated Distribution Systems (ADS), each for 168 pots from the day silo to the individual cells based on fluidized aersolide conveyors.
In this article these technologies are briefly described to show the uniqueness's and advantages.
The main focus in the article is set on experienced operation and maintenance aspects during the first years of aluminum production and the corresponding measures taken.

This paper concludes technical features presented on earlier TMS Annual Meetings [1, 2, 3, 5] and compares them with results from practice.

Introduction

Installation of the plant in Russia started in the year 2005. The first electrolysis cells were started at the end of 2006 and commissioning was concluded in 2007. The new potline was designed for a total of 336 electrolysis cells and the systems had to be commissioned and installed under extreme ambient conditions. In the plant two conveying systems were installed that were at that time new in the market:

- The transport and distribution of the secondary alumina from the two day silos to the pot superstructures via the ADS system.

- The transport of the primary alumina from the existing alumina receiving and storage area to the newly installed alumina storage silos close to the pot rooms using the FLUIDCON® conveying system.

The current paper compares the different options for these tasks and highlights the operational experience with these systems.
An evaluation is made whether the expectations have been met.

Alumina Distribution System

The Alumina Distribution System (ADS) is distributing the Alumina from the Secondary Alumina Silo at the Fume Treatment Plant to the different cells in the potrooms. The ADS consists of aeroslides with inclination. The transport to the prebins before pot superstructure is realized by aeroslides with 1° inclination. The transport on the superstructure is realized by aeroslides with 0.5° inclination. Compared to a horizontal aeroslide or a horizontal pipe the inclined aeroslide installation has a higher installation cost, but results in a more reliable operation.
In Table 1 the different options of the basic design are compared.
The ADS is in terms of operation of the system divided into two Levels. (See Fig. 1.) Level 1 is starting at the outlet of the day silo at the FTP with a level control box and is leading the alumina to a distribution located at the potroom wall. From there the alumina is transported via the distribution aeroslides to the buffer silos upfront each pot.
Level 2 comprises the level control box underneath the different buffer silos, the insulation aeroslide and the pot superstructure aeroslide.
Both Levels are controlwise interlocked with each other to avoid uncontrolled flow of aerated alumina. Level 2 can only be operated, if Level 1 in the respective area is not in operation. The system is operated by controlling the airflow of the aeration of the different parts of the system. When the aeration air is switched off, the material flow stops. The system is deaerated via the pot superstructure to the gas collecting ducts.

Control of the ADS

The control system is the key component of each ADS-system.
Fig. 2 shows an operator screen.
Two different operation modes are possible:

- Operation by timer
- Operation on material demand

With the operation by timer the system is starting when the adjusted time has elapsed. Then at first Level 1 is operated filling the different prebins of one branch. When one branch is filled the system switches to another branch and starts the operation of Level 2 of the branch filled first. The cycle continues until the system is filled up completely. Then the operation is paused until the adjusted timer has elapsed again.

The operation on material demand is triggered by the level switches in the system. When a certain number of level switches are signaling a low level, the operation of the system is started, first filling up the areas of low material level and then operating in one complete cycle as described before.

The level indicators in the system allow for a comprehensive picture of the operation of the ADS system at any one time. (see Fig.3)
As the system is operated intermittently and not continuously the air consumption is kept very low.

Operation of the system

Up to now the ADS system did not even have the slightest negative effect on potroom operation.
As there is no screening of coarse particles these particles will be collected in the first area of the aeroslide system.
These particles have to be drained out on a regular basis.
An installation of a coarse particle separator either before the ADS-System or before the inlet of the day silos could prevent this effect.

Wear and Maintenance

As the different parts of the system are not always in operation the maintenance work on the system is made easy.
The material velocity in the aeroslide is low compared to a standard pipe conveying, and all movable parts are installed outside the material flow reducing the wear rate.
Table 2 shows a statistic of the parts that had to be replaced during the early years of operation.
It can easily be seen, that the wear rate is very low and that the system needed only very little attention.

Influence on material properties

While with a horizontal aeroslide the coarse material fractions will be found more likely in the first part of the system (Fig. 4) the inclined aeroslide will have a more even material distribution over the entire conveying length.
Compared to this a pipe conveying will have high velocities and higher pressure drops over conveying distance, resulting in scaling or material attrition.

Evaluation table

In Table 3 the expectations and the achievements of the ADS system are listed. It can be clearly seen, that the ADS system did easily meet all the targets.
In terms of low wear rate the ADS-system has proven to be an extremely reliable and long-lasting system.

Conclusion and outlook for future installations

The ADS system has proven to be a reliable and efficient system allowing a smooth material distribution, giving to the operator full control over the conveying process.
As the system did collect some coarse material, the next installation should have a coarse particle separator upfront the system allowing for a screening of the coarse particles.
The ADS system is now serving 336 pots in two pot rooms at the Sayanogorsk Smelter without problems.

FLUIDCON Conveying System

The FLUIDCON system is a simple dense phase conveying system that combines the low velocities of aeroslide conveyance with the versatility of pneumatic pipe transport. The characteristics of the FLUIDCON conveying system are extremely low transport velocities and low power consumption. At the time of the first operation the FLUIDCON system was the largest installation of its type. It was selected because of its slow transport velocities and consecutively low attrition rate.
The selection criteria are shown in Table.4.

Design data from Sayanogorsk

- One FLUIDCON system conveys the primary alumina from the receiving and storage area to the storage silos close to the pot rooms.
- Conveying distance: 390 m including 40 m height difference.
- Design transport capacity. 135 t/h

The delivery starts behind the outlet flanges of eight primary alumina silos close to the old smelter and ends at the inlet openings of two new alumina storage silos located between the two pot rooms. The material is fed to a Claudius Peters X-pump serving as a pressure lock to the FLUIDCON conveying system. Compared to a pressure vessel system the X-pump provides a more continuous conveying.

The features of this system have already been described comprehensively in [5], so this time the main focus is set on the operation of the system.

Operational experience

During the first commissioning phase three problem fields did show up.

1. The wear on the X-pump was higher than expected during the first operation
2. The filter load at the receiving silo had been underestimated
3. The amount of foreign particles in the product was higher than expected

The first problem was tackled by exchanging the material of some wear parts and adjusting the air flows in the system.
For the second item the filter system had been slightly modified.
Item 3 did only produce problems in the beginning, but it appeared to be that foreign particles in the FLUIDCON-pipe did reduce the free space, but did not affect the conveying too much, only a slightly higher conveying pressure could be seen.

Wear Rate

After the operation parameter had been thoroughly adjusted, the wear rate on the parts of the system was quite low.
The operation of the system is still under evaluation. As all the different parts of the installation are easy to maintain, downtime of the different parts of the system are minimized. The lifetime of the different parts of the plant did exceed the expectations.

Conclusion

The Claudius Peters FLUIDCON system is an appropriate solution for the described task. An improved wear protection of the screw feeder was necessary. The higher pressure loss of the inclined pipe part due to accumulation of alumina was not expected.

Summary

The installed ADS system has fully met the expectations and is working perfectly. For future installations a screening of coarse particles and a mass flow silo design should be taken into consideration.

At the FLUIDCON conveying system some unexpected problems occurred. These problems were not related to the FLUIDCON conveying process itself but resulted from the used bulk solid feeder. But with some adjustments and minor modifications these problems could be mitigated.
The experiences with both systems will be used as basis for improvements of future plants.

References

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Table 1: Options for ADS

		Version A	Version B	Version C
Description		Pipe conveying with seperate valves	Horizontal aeroslides	Inclined aeroslides
Installation cost				
	Supporting Structure	Only piping small size	Horizontal more easy to install, but heavy, more requirement on deaeration	Inclined aeroslide not easy to install
	Mechanical Equipment	Minor but a lot of valves	Same as inclined	
	Installation	Very easy	Easy	Easy
	Electrical Equipment	Lot of valves	Fewer valves	Same as A
Operation Cost				
	Air Consumption	High	Very high	Low
	Air Pressure	High	Low	Low
	Wear Parts	Very high demand	High demand	Low demand
Operation				
	Scaling	Very high	Low	Very Low
	Segregation	Low	Possible	Low
	Attrition	High	Low	Low
	Control of operation	Reasonable	Low	Very good
	Monitoring of operation	reasonable	Low	Good

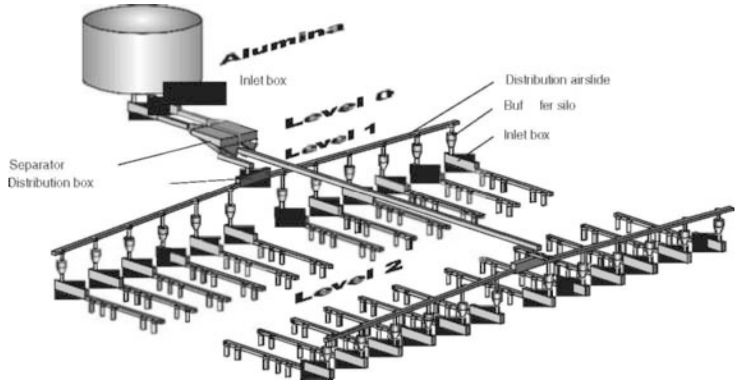

Fig.1: Principle sketch of the ADS-System

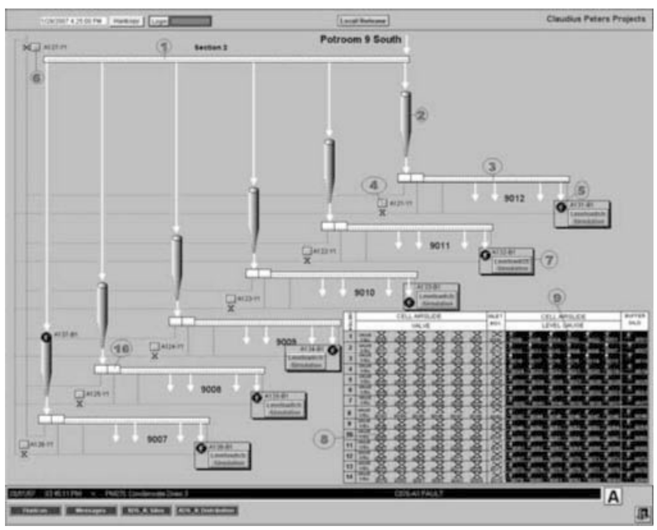

Fig.2: Screen of control system

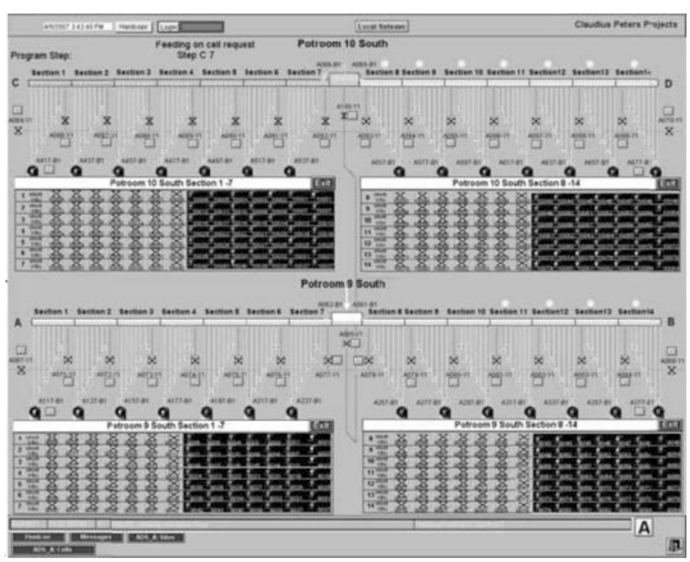

Fig.3: Screen of control system

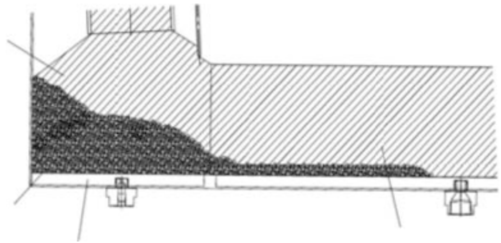

Fig.4: Collecting of coarse particles

Table 2: Wear Parts during first 3 years and Start Problems

	Days of operation	Parts installed	Parts changed	Damaged parts/pieces 1000 days
Level 1A				
Inlet Box	1000	340	0	0
Fluidizing pad at inlet box	1000	340	10	0,0294
Valve	1000	4	0	0
Solenoid Valve	1000	8	0	0
Level 1B				
Aeroslide casing	1000	356	0	0
Fluidizing pad	1000	1000	0	0
Flap		60	0	0
Level Switch		70	0	0
Compensator	1000	116	5	0,043
Level 2				
Aeroslide casing	1000	772	0	0
Insulation Aeroslide	1000	336	37 (20 during start, 2 damaged by crane) , so 15 during operation	0,0446 based on 15 damaged parts
Fluidizing pad	1000	1344	6	0,00446
Solenoid Valve1 "	1000	336	19	0,0565
Solenoid Valve ½ "	1000	62	5	0,081

Table 3: Technical Data

	Expected	Achieved
Number of ADS	2, each serving 168 cells	2, each serving 168 cells
Capacity	200 kg/cell/h	200 kg/cell/h
Capacity of Transport Aeroslide	50 t/h	50 t/h
Capacity of Cell Aeroslide	10 t/h	10 t/h
Longest conveying distance	320 m	320 m
Air consumption	25-58 m^3/min per ADS during operation	Less than 48m^3/min

Table 4: Selection Criteria for Long Distance Conveying

	Energy consumption	Operational reliability			Maintenance costs	Flexibility	Envoironmental behaviour	Investment cost
Type of conveyance		General	Risk of plugs-	Behaviour during/after power failure				
Bucket elevator and aeroslides								
Pressure vessel								
Pump conveyance								
Belt conveyance								
Pipe conveyor								
Fluidcon conveyance								