25 years of continuous improvements in TALUM smelter

Zlatko Čuš[1], Avgust Šibila[2], Branko Juršek[3], Stanislav Kores[4]
1. Member of Board,
2. Head of Strategic R&D,
3. Potline Manager,
4. Senior Development Manager,
TALUM d.d., Kidričevo, Slovenia
Corresponding author: avgust.sibila@talum.si

Abstract

TALUM is the only primary aluminium producer in Slovenia since 1954, when production in Soderberg Potline A with a capacity of 20 000 tonnes/per year was started. With the erection of the Soderberg Potline B in 1963, the total capacity was increased to 55 000 tonnes per year. The modernization program of primary aluminium production started in 1985 with the introduction of Carbon Plant in 1987 and the Pechiney AP18 technology in Potline C1 in 1988. In the same period, the Soderberg Potline B was re-constructed to pre-baked technology. During the last 25 years, with the implementation of many innovations from TALUM's Continuous Improvement Program (CIP), Talum established one of the most efficient productions of primary aluminium worldwide in energy consumption, carbon consumption and pot life. The CE of 96.30 %, a DC energy consumption of 13 000 kWh/t Al, a net carbon consumption of 392 kg C/t Al and an average pot life of more than 3 500 days are the results of technical improvements in smelter processes such as development and implementation of best practice, optimization of process control and operational parameters, improvement of cathode design, application of innovative design of anode, etc. Talum's Technology Roadmap for the next decade until 2025 is already defined.

Keywords: Technical improvements; slotted anodes; energy consumption; cathode optimization.

1. Introduction

After 125 years of operation, Hall-Heroult process cell productivity has improved dramatically through the development of high amperage cells. However, energy efficiency improvement levelled off after the seventies [1]. The long-term demand outlook for aluminium has been strong and is likely to remain so. Significant growth in demand will be driven primarily by the continued urbanisation and industrialisation of emerging economies, particularly those of China and India. Aluminium demand is expected to grow by four to five per cent a year over the next two decades [2].

Reducing the production cost is an ongoing process in every smelter. To remain competitive continual improvement in efficiency, cost and productivity is necessary. Prebaked anodes contribute as the biggest variable impact to the aluminium production cost [3]. Optimization goals may focus on the anode plant to produce cheaper anodes with the same performance in the pots or on the potrooms to use anodes of superior quality to produce metal at reduced cost [4].

The technologies of aluminum electrolysis include cell design technology, potline building technology, operation technology and cell preheating and start-up technology. These technologies play important roles as they influence cell life, energy consumption, potline current and current efficiency [5].

Since the beginning of the aluminium industry great efforts have been made to improve energy consumption. In the first half of the 20th century, energy consumption was halved. This effort was particularly important in Europe where energy was already more expensive and less available than in North America at that time. At the beginning of the nineteen seventies the most energy efficient smelters were able to operate below 13 DC kWh/kg Al [1]. It is widely accepted that the service life of an aluminium electrolysis cell is mostly limited by the performance of the pot sidelining [6,7].

In this paper some technical improvements in the TALUM AP 18 potline processes, which have influenced energy consumption, net carbon consumption, average pot life, current efficiency and also metal quality are presented.

2. Technical improvements of potline processes

Main goals of technical improvements have been:

- ♦ Increase of productivity,
- ♦ Decrease in the level of impurities in primary metal,
- ♦ Decrease of the specific consumption of sources (energy, raw materials, manpower hours),
- ♦ Decrease of the negative impact on working conditions and local environment.

The factors that influence pot productivity are potline current and current efficiency. The potline current is limited by thermal stability. To increase the potline current some modifications are needed (cathode design, anode dimensions, pot operation parameters). Low levels of impurities in primary aluminium are very important for companies such as Talum, which are trying to improve their market competiveness with managing the optimal amount of secondary aluminium in their products. Higher productivity and low level of impurities are very much preferable, but specific consumption of sources needs to be considered, too. As part of the sustainable development of the production process and Talum's social responsibility we also include the continuous improvement of working conditions and our impact on the local environment.

2.1. Anode quality and geometry optimization

High anode quality by Talum definition meets the following criteria:

- ♦ Chemical purity and homogeneity,
- ♦ Thermal shock resistance,
- ♦ Resistance against air and CO_2 oxidation,

on assumption that the production costs per unit (raw material, energy, maintenance, etc) are low.

High quality anodes are not a guarantee for good results of the potline operation. On the other hand, with poor anode quality, good results are not achievable. In Talum, conversion from Soderberg paste plant to prebaked anode plant was realized in 1987 (reconstruction of green anodes production tower, new closed type baking furnace, new rodding shop). The production of Soderberg paste was terminated in 1991 when an old Soderberg potline (53 kA) was stopped. Since then, Talum produces two types of prebaked anodes only (for 180 kA and 75 kA pots). At the early stage of prebaked anode production, activities were focused more on availability and stability of the process (doing by learning) but since the last ten years the quality issue has been the highest priority. Based on its own experience and available knowledge, several improvements of existing concepts and applied practice of the prebaked anode production process were realized:

Quality issues:

- ♦ Decrease of level of impurities (catalytic elements) in anodes recycled material,
- ♦ Fines homogenization,
- ♦ Conversion from solid to liquid pitch,
- ♦ Introduction of intensive mixer/cooler,
- ♦ Erection of slots at vibro compactor,
- ♦ Automatic control system in green anode production,
- ♦ Laboratory analysis portfolio,
- ♦ Informatization.

4. Summary

During the last 25 years, with the implementation of many innovations and continuous improvement, TALUM established one of the most efficient productions of primary aluminium worldwide in energy consumption, carbon consumption and pot life. Most important improvements in recent years are the prolonging of pot life to more than 3 500 days and the carbon net consumption of 392 kg C/t Al. With the innovative shape modification of the anode a decrease of pot instability of more than 20 % was achieved. The new innovative anode shape also decreases energy consumption by 50 - 100 kWh/t Al. With the metal treatment station for primary aluminium, we ensure high aluminium purity for production of high quality aluminium products. Content of Na, Ca and Li in aluminium is decreased to a minimum.

Our efforts in the future will be focused on higher levels of automatization and will include controls with expert knowledge. Further improvements of particular production lines are possible, especially transport of anode paste from mixer to vibro-compactor. Also optimization of anode shaping processes is possible.

A lot of effort is made to improve the heat distribution inside the baking furnace. Over-bending of anode baking furnace heating walls with negative impact on baking quality and costs, is still an unsolved problem.

The highest quality is not our highest priority. Our goal is an optimal balanced combination between technical, quality and economical parameters. Our challenges in the future are the increase of potline current for increased productivity (while keeping the same technical parameters) and improved supervision of all processes in the potline.

5. References

1. O. Martin, B. Allano, E. Barrioz, A. Escande, Y. Caratini, and N. Favel, Low Energy Cell Development on AP Technology, Light Metals 2012, 569-574.
2. J.Côté, A bright and sustainable future for Aluminium, American Market Aluminium Summit, New York, June 2011.
3. M. Meier, T Müller, Influence of Anode Quality on Aluminium Production Cost, 3rd Rodding Conference, Iceland, 2005.
4. R. Perruchoud, Carbon Plant Optimization and Control, Carbon Symposium XX, New Orleans, 2005.
5. N. Feng, J. Peng, Y. Wang, Y. Di, J. You, and X. Liao, Research and Application of Energy Saving Technology for Aluminum Reduction in China, Light Metals 2012, pp 563-568.
6. J.G. Peacey and G.W. Medlin, Cell Sidewall Studies at Noranda Aluminium, Light Metals 1979, pp 475-492.
7. M. Benjamin Dell, Potlining Failure Modes, Light Metals 1985, pp 957-965.