Equipment Improvements on Existing Anode Paste Plants

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Abstract

Due to the worldwide overcapacity in the primary aluminum sector, a long period of time dominated by greenfield and brownfield projects has come to an end. Nowadays, the focus has changed to retrofits and small improvements on existing anode paste plants. In the late seventies of the last century, the combination of a screw pre-heater with a continuous kneader plus a downstream intensive remixer-cooler became the state of the art for anode paste preparation. The energy input for remixing and cooling did not have precise specifications, however, the delta T during cooling could be high if hydraulic presses were still in use. In the course of time, numerous single kneader lines have been expanded by adding an intensive remixer-cooler. Nowadays, other issues, especially the green and baked density decrease because of lower raw material quality, are of high importance. Equipment improvements in terms of higher specific mixing energy input and longer retention time combined with better wear protection will be necessary. In addition, the early models of Eirich Intensive Coolers are reaching the end of their life span and need an adequate replacement.

The paper describes the most interesting improvement steps from the beginnings until today.

Keywords: Carbon; mixing; paste; anode; retrofit.

1. Introduction

There are various reasons for revamping a green anode plant:
- Key equipment being worn out, seriously damaged or inefficient
- Introduction of a second mixing level for optimized process conditions [1]
- Increase of specific mixing energy with regard to green and baked density
- Higher quality and throughput requirements in connection with an amperage creep in the electrolysis
- Higher standards for health, environment and safety (HES)

Apart from a few D-type machines installed in the seventies and eighties of the last century, the breakthrough of the EIRICH Intensive Remixer-Cooler came with the RV23Conti model in 1989. After more than 20 years of permanent operation, the equipment is worn out nowadays and technically no longer up-to-date.

The main advantages of an equivalent new machine are:
- Heavier machine structure
- Better access for maintenance purposes
- Stronger power train (rotor motor and gear unit)
- Thus higher specific mixing energy available
- Mixer scale with 4 load cells
- Higher max. operational temperature

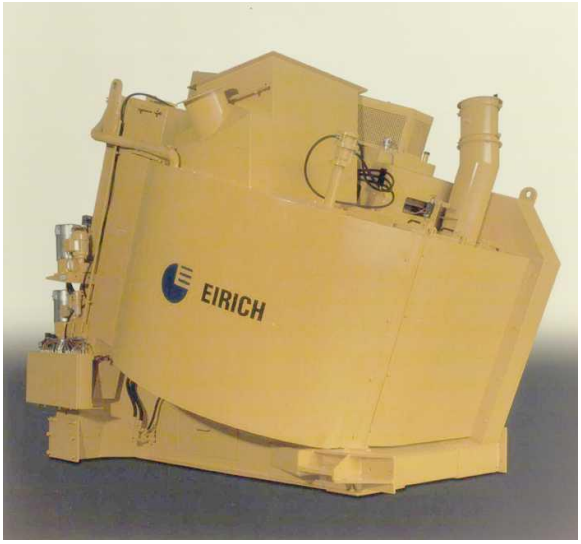

Figure 1. EIRICH remixer-cooler RV23Conti.

Figure 2. EIRICH remixer-cooler RV24Conti.

Table 1. Comparison of the main features of the cooler

	RV23Conti	**RV24Conti**
Manufacturing period	1989 - 2001	2001 - ….
Installed rotor drive	160 kW	200 kW
Typical rotor power	130 kW	160 kW
Specific mixing energy at 35 t/h	3.7 kWh/t	4.6 kWh/t
Max. operating temperature	180 °C	200 (250) °C
Mixing container volume	2 700 liter	2 700 liter
Paste load max.	2 300 kg	2 500 kg
Retention time at 35 t/h	3.9 minutes	4.3 minutes
Mixer scale	2 load cells	4 load cells
Inspection doors	2	3
Machine weight	11 800 kg	12 900 kg

2. Anode Plants with Key Equipment Being Worn Out

2.1. Smelter in Australia
Replacement of the RV23Conti intensive remixer-cooler by the RV24Conti

One of the two prototype machines for intensive anode paste cooling was supplied to a greenfield smelter in Australia early in 1990. The machine was to be integrated in a brand-new paste plant with very limited space. As a result, the design of the transfer chutes proved to be difficult and led to operational problems. Once a year, a general overhaul was performed by lifting the whole machine through the roof and forwarding it to the workshop by means of a crane.
Nevertheless, the machine has done its job in a sufficient manner over a long period. In the end, high maintenance costs plus the limited installed power of the machine led to the decision to replace the RV23Conti by a new RV24Conti which became operational at the end of 2008.
Thanks to the today's 3D design software, the integration of the new machine into the existing steel structure could be realized without any difficulties. All problems related to the transfer chutes, e.g. lump formation, disappeared when using the new design. The mixer scale now shows the real paste load in the machine.

2.2. Smelter in North Africa
Replacement of the RV23Conti intensive remixer-cooler by the RV24Conti

A severe fire which developed at the lower level of the paste plant tower in August 2012 destroyed a significant part of the key machinery. Amongst others, the RV23Conti remixer-cooler, being operational since the year 2000, was completely damaged. In a very special effort, EIRICH managed to dispatch a new RV24Conti in less than four months to help the customer to restart the paste plant as fast as possible.

Figure 3. Smelter.

Figure 4. RV23 completely damaged.

2.3. Alucam, Cameroon [2]
Replacement of continuous kneaders by an EIRICH Mixing Cascade (EMC®)

In 1996, Aluminium Pechiney decided to modernize the Alucam anode plant in Edéa, Cameroon to a significant extent. The two existing continuous kneaders were worn out, amongst others, due to poor maintenance. The installation of an RV19 EMC® made it possible to reach an increased throughput rate of 11.5 t/h despite using solid pitch. It was the first industrial scale EMC® in the world! Compared to a 1:1 exchange of the existing mixing equipment, both the investment expenditure (CAPEX) and the operational expenditure (OPEX) could be reduced significantly.

Figure 5. Alucam paste plant.

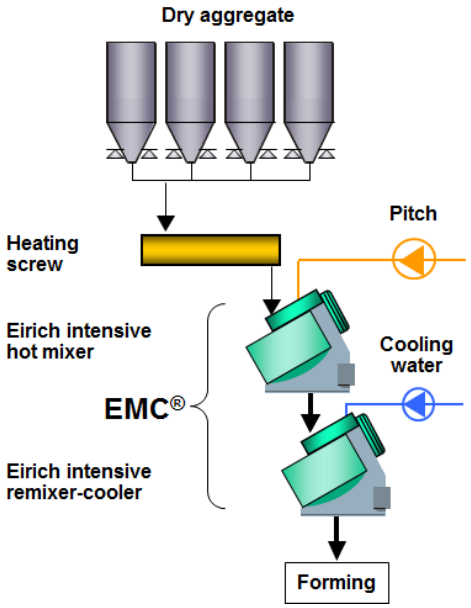

Figure 6. EMC® flow diagram.

2.4. Talum, Slovenia [3]
Second mixing stage converted from continuous kneader to intensive remixer-cooler

At Talum, prebake anode production started in 1987 with the typical configuration of a screw heater followed by two continuous kneaders in series. Two types of green anodes were produced for the 75 kA and 180 kA pots in the electrolysis. Apart from the introduction of liquid pitch, the conversion of the second mixing stage from continuous kneading into intensive remixing and cooling was the biggest milestone during the last 25 years.

Main issues for conversion:
- Limited kneading temperature (no real cooling phase)
- Low homogeneity of the paste
- Variation in temperature during vibro-compacting

Main achievements with the EIRICH remixer-cooler:
- Good control of the final temperature of the paste (variation +/- 2 °C)
- Higher homogeneity of the paste
- Lower porosity, electric resistance and improved density
- Lower content of coal tar pitch
- Less green scrap
- Lower overall maintenance costs
- Higher level of automation

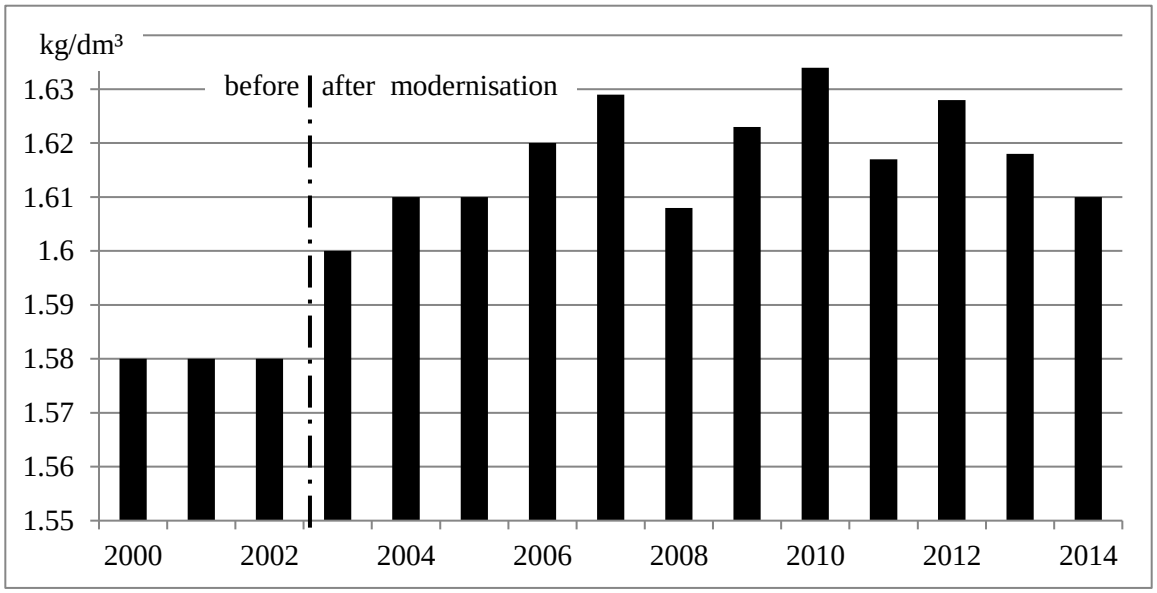

Figure 7. BAD before and after modernization.

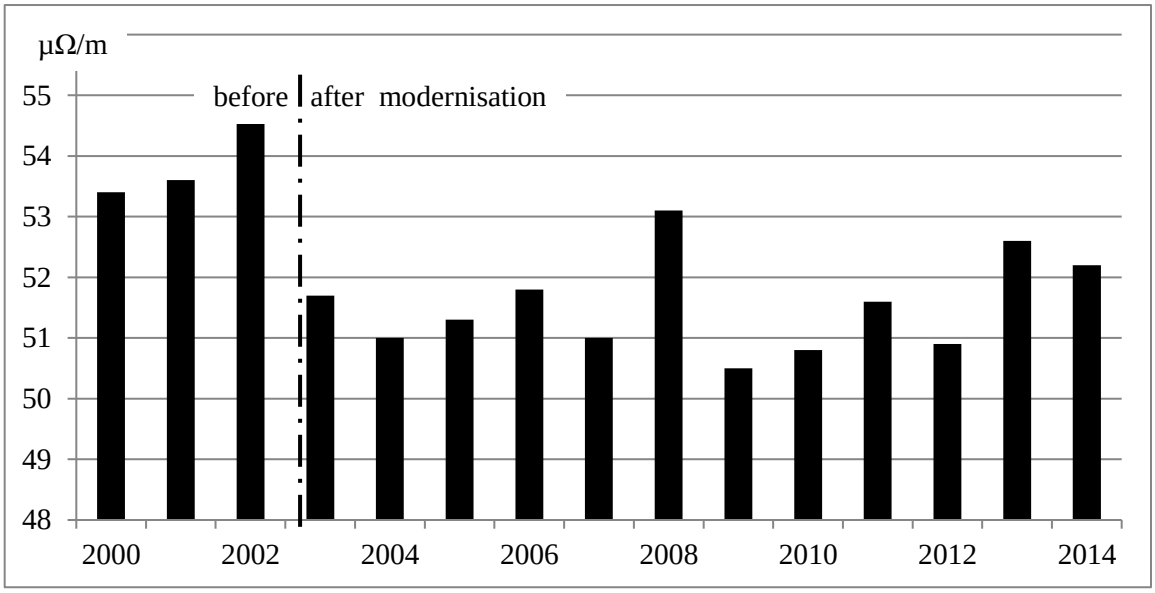

Figure 8. Specific electric resistance before and after modernization.

3. Introduction of a Second Mixing Level

In the past, numerous paste plants were built following the single kneader concept to reduce investment costs. Furthermore, double kneader systems, originally designed for the use of solid pitch, were still in operation. To reach a better overall performance, the following attempts were necessary:

- Provision of independent temperature levels for both hot mixing and cooling
- Increase of homogeneity of the paste
- Decrease of fluctuations in paste quality
- Limitation of operational expenditure (OPEX) at a reasonable level

The proven EIRICH high-performance cooling process using evaporative cooling was introduced into numerous existing paste plants [4]. By means of injecting water into the anode paste and subsequent immediate evaporation, a delta T up to 50 °C can be achieved. In parallel, the system is a very effective homogenizer thanks to the additional retention time of three to five minutes as well as the specific mixing energy of three to four kWh/t.
An efficient pitch fume and steam treatment system is mandatory for this process, not only for environmental reasons but also to guarantee a water free paste at the outlet of the cooler. Depending on the local legislation a classic dry scrubber with or without a downstream RTO is an adequate solution. Hot “dilution air” may be necessary to avoid condensation in the ductwork.

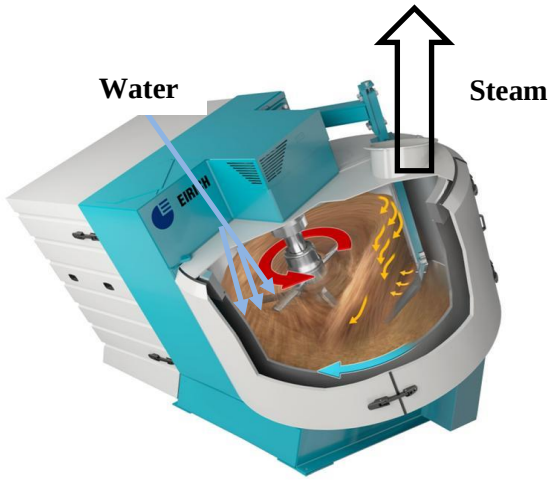

Figure 7. Eirich intensive remixer-cooler principle.

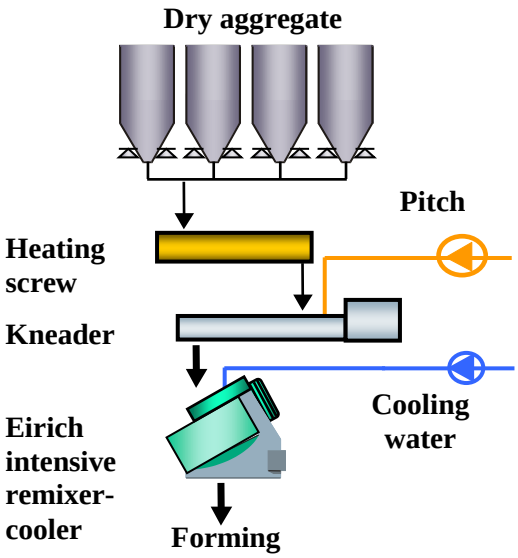

Figure 8. Conventional paste plant with two independent mixing levels.

3.1. Slovalco, Ziar nad Hronom, Slovakia [5] Addition of a second mixing stage

The original flow diagram of the green anode plant consisted of a screw heater with downstream plug screw plus one single continuous kneader, a cooling conveyor and an atmospheric vibro-compactor. Due to the limited cooling capacity of the conveyor, the hot mixing temperature needed to be limited with regards to the atmospheric forming process.

The extended paste mixing line with a remixer-cooler Eirich RV19Conti together with a new pitch fume and steam treatment system became operational in the second half of the year 2000, after a startup period of only 4 weeks. Thanks to the second mixing step the plant now shows a significantly higher performance, especially as far as paste quality is concerned.

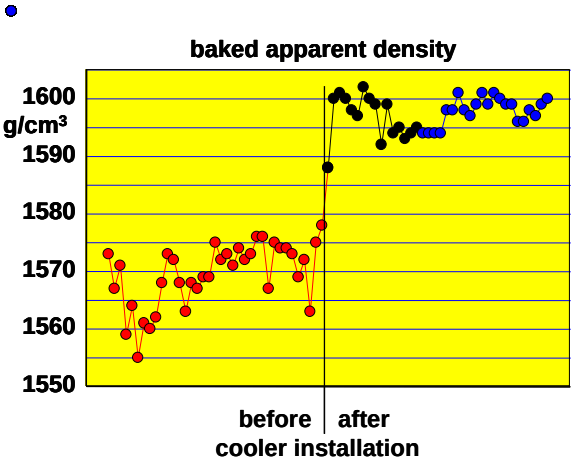

Figure 9. Change in BAD.

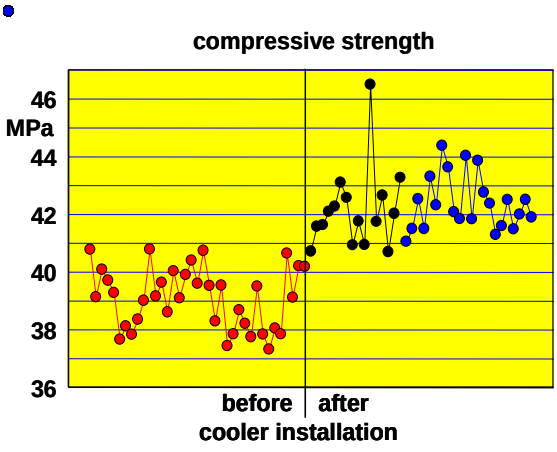

Figure 10. Change in compressive strength.

4. Detail Optimization

The EIRICH intensive mixing system offers numerous options for optimizing the machine with regard to a certain product to be prepared. The biggest influence is coming from the rotor tool(s) which rotational speed and sense as well as shape and number of blades can be varied. The standard rotor blade is operated in the so-called updraft sense which means that the product is lifted from the bottom towards the top of the mixing container. Using downdraft blades increases the mixing energy significantly, but makes the mixer more sensitive to operational problems. Furthermore, the higher the specific mixing energy, the higher will be the wear on the blades as well. Special hardfacing systems have been developed.

Figure 11. Plated with hard metal.

Figure 12. Tungsten carbide hardfacing.

Figure 13. Rotor blades updraft.

Figure 14. Rotor blades downdraft.

5. Conclusions

Early models of EIRICH intensive remixer-coolers are reaching the end of their lifespans and will be replaced step-by-step. The two-level mixing system with a hot mixer plus a downstream remixer-cooler is the state of the art for anode paste preparation. Detail improvements targeting on higher specific mixing energy input and/or better wear protection can be easily made on existing machines.

6. References

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