

Eirich intensive mixing, a universal mixing principle for carbon paste

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Carbon pastes are used in many different fields of the heavy industry, for instance, as anode or cathode blocks for primary aluminum smelting, as graphite electrodes for electric arc furnaces, as carbon bricks for refractory linings, as Soederberg electrodes for reduction furnaces, etc.

In the eighties of the last century, the intensive mixer started on a triumphal march through this industry. Originally used as a high-performance replacement of slowly running batch mixers and as a remixer-cooler downstream a continuously operated kneader, the intensive mixer constantly opened up new fields of application in the carbon sector such as the “all-intensive” anode paste preparation by means of an Eirich Mixing Cascade system (EMC[®]) as well as batch preparation systems for graphite electrode manufacturing and for graphite specialties.

Due to its special benefits such as high efficiency and an attractive cost/performance ratio, the intensive mixer can be found everywhere in the carbon industry today.

Anodes for primary aluminum smelting

The world's production of primary aluminum was amounting to approximately 45 million tons in 2012. The requirement for anode paste might be approximately 21.9 million tons of prebaked anodes respectively 2.5 million tons of Soederberg anodes.

Due to the high throughput rates and the constant formulas at the same time, continuous preparation systems are almost used exclusively for carbon anode paste preparation. More than every second prebaked anode is produced from partially or completely intensively prepared paste (Eirich remixer-cooler respectively Eirich Mixing Cascade EMC[®]). So, the use of intensive mixers for the preparation of anode paste has become state of the art in the primary aluminum industry. [9]

Remixing and cooling of anode paste

With the continuously operating Eirich intensive mixer, a machine was found not only reliably coping with this task definition but additionally achieving excellent homogenization of the paste. By direct addition of water to the anode paste and subsequent immediate evaporation, cooling capacities were achieved which established systems have not ever reached by far. For example, a water flow of only 440 l/h is already good enough to cool down 35 t/h of paste from 180 to 155 °C.

On top of that is the effect of a more or less “cost-free” homogenizer: By the relatively long retention time of 4-5 minutes, the intensive mixing effect and the additionally introduced mixing energy of approximately 4 kWh/t, a considerably improved paste quality is achieved compared to single-step preparation.[1],[2]

All these factors led to the fact that nearly no single-step paste preparation lines were built in the last 15 years. At the same time, numerous existing plants were retrofitted

with Eirich intensive remixer-coolers. Nowadays, nearly 60 Eirich remixer-coolers are operational in the anode sector.

High-performance remixer-coolers downstream conventional kneaders have been installed recently, for instance, at Alcoa Mosjoen/Norway, Qingtongxia/China, EMAL 1+2/Abu Dhabi, Shaanxi Yulin/China and Zhongwang/China.

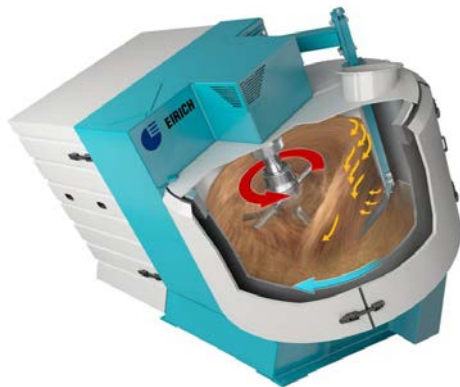


Fig 1: Eirich intensive mixing principle thanks to the second mixing level



Fig 2: RV 24 conti remixer-cooler for a Chinese anode plant

For a long time period, the RV23/RV24 series, rated for 35 t/h throughput, were the most common equipment. Nowadays, the new RV 28 and RV 33 mixers with significantly increased performance are covering the upper range of 35 – 60 t/h.



Fig. 3: Eirich RV28 / RV33 series mixers for anode paste preparation

All-intensive preparation of anode paste

The successful use of the intensive mixing principle for paste cooling was the initiation for the development of the Eirich Mixing Cascade (EMC[®]). Two series-connected intensive mixers perform both hot mixing of coke and binder pitch plus subsequent remixing and cooling. The special advantages of the Eirich intensive mixer such as low CAPEX and OPEX, short standstill periods on the occasion of wear-related repairs, long retention time, compensation of short-time variations in paste composition, especially efficient and thus moderate energy input, etc. come into one's own. On top of that, the machines are available for a wide range of throughput rates so that even most modern smelters with more than 600,000 t/year of aluminum production can be supplied from an anode plant with just one single preparation line.

After launching a comparatively small plant in Cameroon in 1998,[7],[8] nowadays the EMC[®] has gained ground in China [3], India as well as in the Persian Gulf [5] and in Canada. At the Qatalum greenfield smelter the magical limit of 60 t/h was achieved in one single line for the first time.[6] Meanwhile, there are 16 EMC[®] lines under construction or in operation worldwide.

EMC[®] lines are available for throughput rates from approx. 15 til 60 t/h

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Throughput	15	30	45	60 t/h
Mixer type	RV 19	RV24	RV 28	RV 33

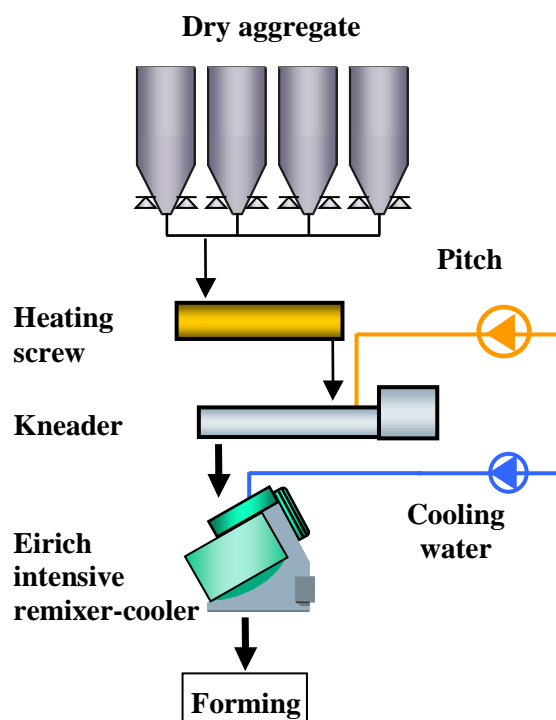


Fig 4: Conventional two-step paste preparation

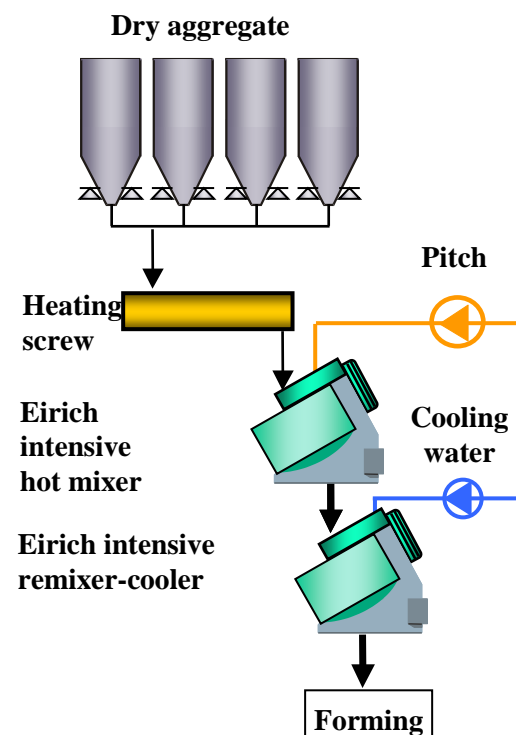


Fig 5: Eirich Mixing Cascade EMC[®]



Fig 6: 36 t/h paste plant at Sohar Aluminium/Oman



Fig 7: 60 t/h paste plant at Qatar Aluminium/Qatar

Shaanxi Meixin anode plant project

Shaanxi Meixin Industry Investment Co., Ltd. is a joint venture company founded by Shaanxi Coal and Chemical Industry Group Co., Ltd. and Shaanxi Non-ferrous Metals Holding Group Co., Ltd. on a fifty-fifty basis. It is situated in Dongjiahe Industrial Park, Tongchuan city, Shaanxi province.

Their greenfield anode plant with a capacity of 300,000 t/y of baked anodes, located close to the existing “Tongchuan Aluminum Smelter” is currently in the start-up phase.

Paste plant design

The green anode plant has been designed that way that two parallel paste lines are placed side by side within one tower building. Each paste line has been dimensioned for a nominal capacity of 35 t/h. The advantage of this design is to use the plant with the most common paste capacity worldwide to reduce the risk. At the same time, this design greatly saves the costs of civil construction works.

Project execution

Eirich was awarded the contract for the supply of two independent EMC[®] paste plants, including the coke preheating screws and the process controls. The vibrocompactors were supplied separately by a local company.

The construction of the anode plant started at the end of 2012. The roof of the plant was closed in August 2013. In July 2014, most of the major equipment was placed in position. Detailed installation works (connection, piping, cabling) are now in process. Cold commissioning has started in Q3/2014. Hot commissioning will follow immediately after that. The anode production will be initiated in 2015.



Fig 8: Coke screw heater 2 x 32 t/h



Fig 9: Remixer-cooler 2 x 35 t/h

Carbon products for other metallurgical purposes

Thanks to the universal mixing principle, Eirich intensive mixers have been successfully used for manufacturing graphite electrodes for electric arc furnaces, cathode blocks for primary aluminum smelting [4] and carbon blocks for linings of blast furnaces.

Based on the given task definition, the paste preparation for these high-quality final products is entirely performed batchwise. Especially the so-called Ultra High Power (UHP) qualities for graphite electrodes with large diameters require an optimally prepared press body. The very fact that there are up to three months between paste mixing and the quality control of the final product shows the high risk of such a process with the mixer being one of the key elements.

For this purpose, a lot of manufacturers are using Eirich high-performance compact systems, combining separate direct electric dry aggregate preheating with intensive hot mixing and subsequent cooling plus downstream paste storage.[9]

Numerous conventional mixing systems could each be replaced by one single Eirich line. Not only the maintenance effort was reduced by about a third, but also the mixing effect itself was significantly improved compared to the existing sigma blade kneaders.

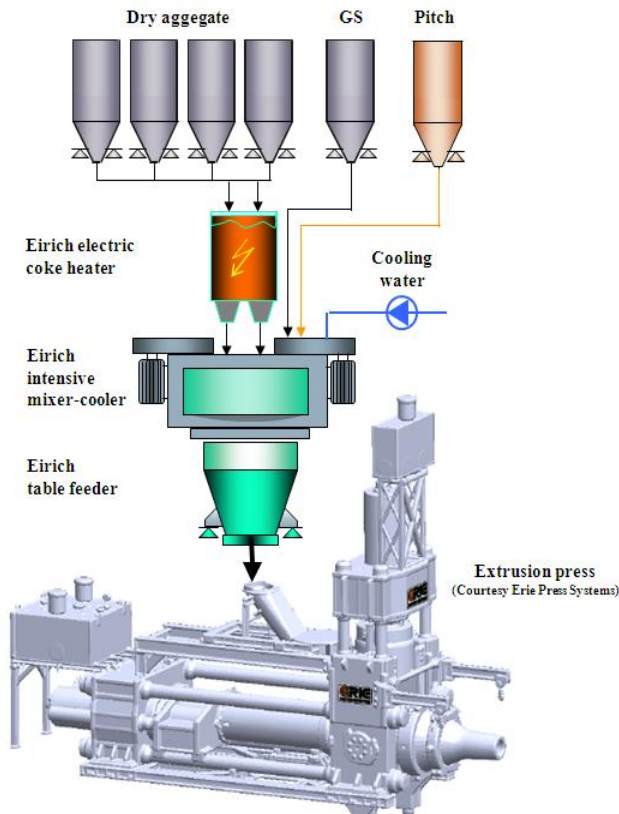


Fig 10: Eirich high-performance compact system for batchwise preparation of carbon paste



Fig 11: Paste plant at Graphite India Durgapur 2012

Graphite specialties

These products cover a wide range of different applications such as molds for semiconductor manufacturing, ingots for continuous casting, carbon brushes, acid-resistant heat exchangers, bearing ring seals, high-temperature heaters, etc. A wide variety of different formulas is used at partly ultra-high mixing temperatures. Parts are shaped by extrusion, pressing or isostatic molding.

Mixing by chemical-thermal reaction (so-called “defuming”) is used to produce precursor materials for different applications. Volatiles are expelled from the pitch during hot mixing. Subsequently, the pitch volume decreases and the mixture becomes more and more dry. As soon as it becomes crumbly, discharge is necessary. Defuming requires a carefully designed mixer to make sure that sufficient surface area on the mixture is created during mixing. The batch cycle time is to be optimized depending on the formula.[10]



Fig 12: Eirich preparation plant for graphite specialties

Conclusion

Thanks to its specific benefits, intensive mixing has become proven technology in the carbon paste preparation sector. Further technical and commercial growth potential is granted. Both continuous and batchwise preparation is possible, depending on the process requirements.

The future lies in carbon paste preparation with Eirich intensive mixers distinguished by high efficiency at low investment and operating costs!

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Others

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References

1. Stokka, P., Norsk Hydro Research, Porsgrunn (NO). Green paste porosity as an indicator of mixing efficiency, Light Metals (1997)
2. Hohl, B., Maschinenfabrik Gustav Eirich, Hardheim (DE) and Gocnik, L., Slovalco, Ziar nad Hronom (SK). Installation of an anode paste cooling system at Slovalco, Light Metals (2002)
3. Hohl, B., Maschinenfabrik Gustav Eirich, Hardheim (DE) and Wang, Y.L., Aostar Aluminium Company Ltd, Meishan, Sichuan Province, (PRC). Experience Report, Aostar. Anode paste preparation by means of a continuously operated intensive mixing cascade, Light Metals (2006)
4. Hohl, B., Maschinenfabrik Gustav Eirich, Hardheim (DE) and Burjak, V., UKRGrafit, Zaporozhye (UA). High-performance preparation plant for cathode paste, Light Metals (2008)
5. Backhouse, N. et al., Rio Tinto Alcan LRF, Gustav Eirich, Sohar Aluminium. From technology development to successful start-up and operations of Sohar: The potential of the Bi-Eirich mixing line, Light Metals (2010)
6. Bouché, C., Somnard, B., Solios Carbone, Givors (FR) and Bhajun, S., Qatar Aluminium Limited, Doha (Qatar). 60 tph single line green anode plant commissioned at Qatalum, Light Metals (2012)
7. Thomas, J.-C., Aluminium Pechiney (FR). New concept for a modern paste plant. 7th Australasian Aluminium Smelting Technology Conference and Workshops, Melbourne, 2001
8. Dreyer, C. et al., Aluminium Pechiney LRF. Reconstruction of the mixing line for anode paste production at Alucam, Light Metals (1998)
9. Hohl, B., Maschinenfabrik Gustav Eirich, Hardheim (DE). History and development of intensive mixing technology for carbon paste preparation, Icsoba, 2012
10. Arnold, A., SGL Carbon GmbH, Meitingen (DE). Applied mixing technologies in the carbon and graphite production Cfi/Ber. DKG 83 (2006) No.4