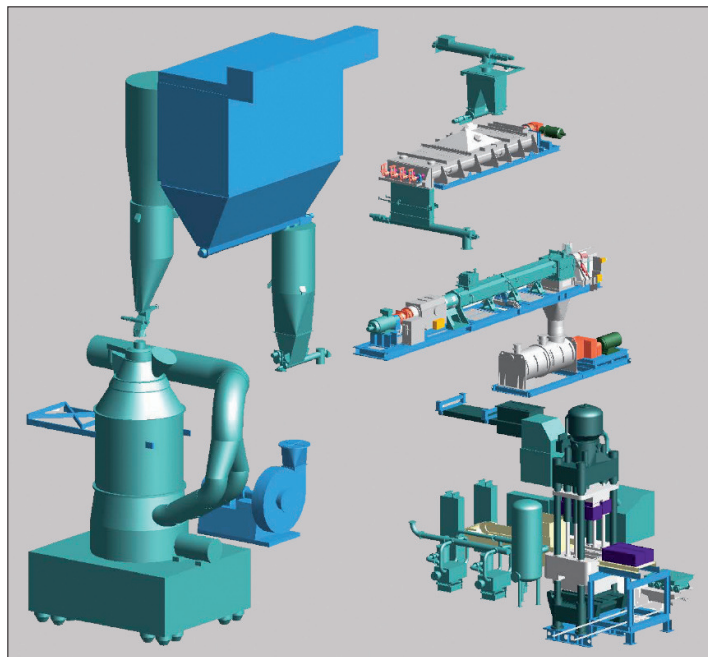


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The future of anode manufacturing

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BUSS *ChemTech*

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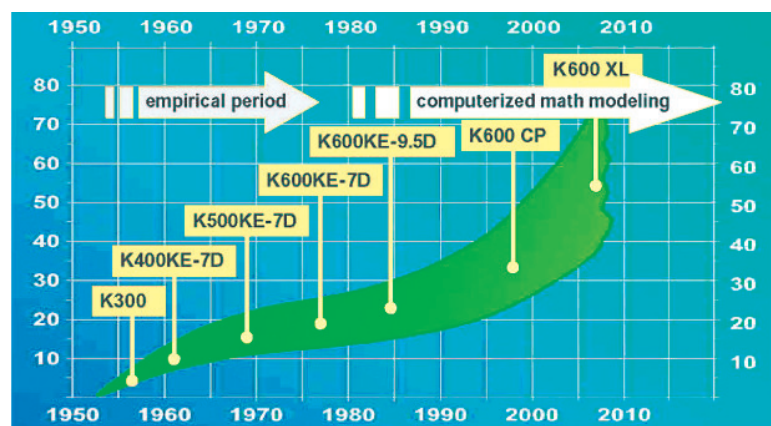


Fig. 1: Production increase since 1950

Demand from industry sets the pace for new technology: since the first continuous anode paste process for 1.5 tonnes per hour of anodes in 1951, the demand has increased, reaching today a throughput requirement of 80 tonnes per hour, in a single line for the next generation of mega smelters above 1 million tonnes per year. Today's high energy and raw materials' costs focus attention on economies. Economical handling and consumption of energy and resources has become the key to success.

In the 1950s, the process know-how for the Buss Kneader was necessarily based on experience in the food

Kneading and mixing process

industry. The production of chocolate and chewing gum required a smooth process to evenly distribute essences, and so the Buss Kneader with its oscillating kneader principle was developed. This concept proved appropriate for use in the aluminium industry. For such a harsh industrial environment a new, modified continuous Buss Kneader was developed. Therefore the K300 KE became the cornerstone of a fruitful collaboration between Buss and the aluminium industry.

Whereas about 60 years ago our engineers had just started to understand

the factors influencing kneading, today our process department has accumulated experience and developed complex programmes to simulate the process in detail and to optimise these factors industrially. The K600 XL is the result of this optimisation, developed from the K600 CP and representing the peak of 60 years of experience: 80 tonnes per hour of high quality anode paste, in one single production line, with an availability of more than 95% and the reliability of the well known Buss concept.

Raw materials, formulation of green paste

To obtain good green paste it is necessary to prepare the "right mix" of coke and pitch. The best pitch content in the formulation depends on coke and pitch properties. The general recipe should be formulated by laboratory trials (plastography tests) with raw materials. An optimised recipe, based on raw materials to be used in the operation, will be

obtained during the first phase of production. How to get the two components together to make the good paste for the perfect anode is not a secret, but needs a good understanding of the physical and chemical properties of coke and pitch. These two components should be proportioned precisely as per optimised recipe, maintained hot, and kneaded one into the other with maximum striation for exactly the time required for wetting the dry component's surface by pitch and for forming the right quantity of binder matrix. It is definitely not as simple as mixing sand with liquid.

To achieve the optimum quality of anode paste several conditions must be met:

- Maximum particle size 12 to 16 mm
- A stable fine fraction during the whole process
- Minimum particle degradation during kneading/mixing and cooling, so as not to create additional surface and additional pitch consumption
- Temperature of both raw materials should be high and stable
- Slow and intensive motion of fragile coke particles
- Intensive mixing / kneading "striation" to wet the whole surface of all the particles
- Controlled process (residence) time (average process and each single particle).

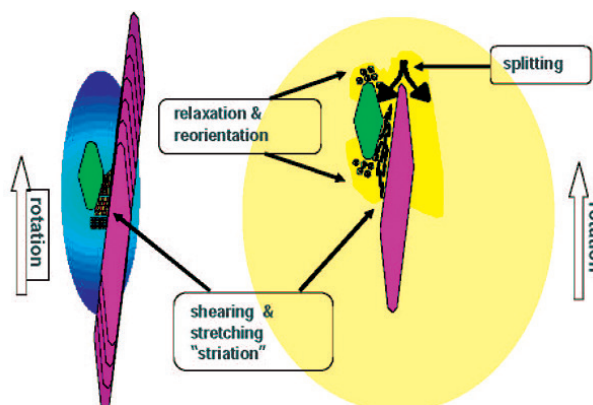


Fig. 2: Inside the process of a Buss Kneader between kneading teeth (green) and flight element (pink)

Residence time

Residence time is important for the probability of wetting all particles. Within a large process volume such probability is small, as the product quantities are high and the occurrence of compounding is uncontrolled – obviously, therefore a long residence time is necessary to increase the probability. Contrary, within a small process area the compounding probability is very high and the material will be mixed in a short time. This is the unrivalled effect inside the Buss Kneader: a small process volume and a high energy input are combined with intensive striation at low rotational speed.

An extended residence time does not substitute for proper mixing/kneading. Too long a residence time will increase the required pitch quantity, as pitch will be gradually absorbed by the coke and not act as binder between coke particles. The surplus of pitch will be exposed to the baking process and calcined, will develop more than the usual volume of volatiles (which need to be additionally treated) and finally will increase baking loss. Therefore, the uncontrolled and long residence time in inadequate mixing equipment will finally result in wasting expensive raw materials, in adding to the environmental impact and in increasing the anode cracking rate in the baking furnace as a consequence of out-gassing of volatiles. The optimal process needs only surface adsorption, where

pitch is working as “glue” and the binder matrix closes small pores to form the optimal anode.

Energy input

A very important factor for describing a good mixing/kneading process is the energy input into the paste. The Buss process produces “high mechanical energy input”, through the high number of smooth movements (Fig. 2). Other systems try to compensate for low mechanical energy input with high speed rotating tools combined with a long residence time. This is not an adequate alternative as explained above.

To resume, the key to reduce raw material consumption is not the absorption of pitch into coke particles, but the adsorption process of wetting particle surfaces.

Buss Green Anode Plant

We have almost 60 years of experience, from dry fraction preparation, dosing of dry and liquid components, preheating, kneading/mixing up to anode forming. The result is the Buss Green Anode Plant.

The key to success for an optimised process, i.e. reduced Capex and lowest Opex, is the supply of proven technology. To choose the optimal plant, only the best and most cost effective solution should be considered, with the best available components, assembled by experienced industrial partners. This has been the task of the Buss ChemTech technology team and its partner companies, leading to a reduced number of separate machines to a new building concept with reduced building cost, and to the lowest consumption costs of raw materials.

The result of these efforts is a significant reduction of Capex and Opex. Buss ChemTech, with its unique Buss

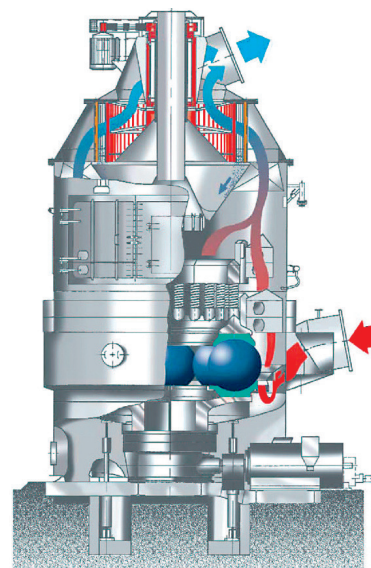


Fig. 4: Claudius Peters EM110-7115 vertical ball mill with dynamic classifier

Kneader as the heart of the plant, is the only company able to implement to above concepts in a complete green anode plant.

Production capacities: the classical 35 t/h as well as the intermediate 50 t/h and the high volume 80 t/h Green Anode Plant are following the “single-line philosophy”, representing the horizontal paste line (HPL) composed of:

- one horizontal coke preheater (up to 65 t/h)
- one Buss Kneader (up to 80 t/h) and
- one horizontal paste cooler (up to 80 t/h).

The horizontal paste line is fed with the hot liquid pitch and with a reduced number of dry fractions (3 to 4 coke fractions, green and baked recycling material), and it is equipped with a vertical ball mill and with simplified transportation systems. Downstream of the HPL are several high-speed hydraulic anode presses each for up to 60 anodes per hour of any size.

The Buss Green Anode Plant forgoes using water cooling for the green anodes due to the low forming temperature of the anode press. Thus the green anodes remain stable and do not require any further active cooling.

Considering all factors discussed, Buss ChemTech represents an experience and flexible partner, capable of designing of the solution best adapted to the needs of each anode plant.



Fig. 3: Buss Green Anode Plant

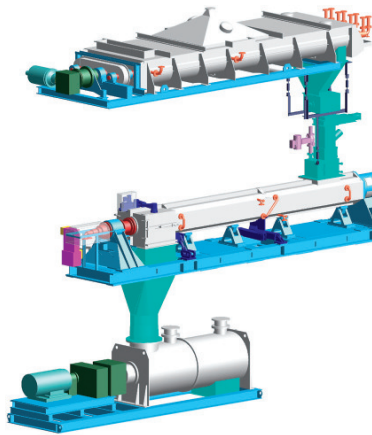


Fig. 5: Buss horizontal paste line HPL

Dry fractions, green scrap and butts

- Less silos
- Less transport
- Less space requirements = reduced building structure.

Vertical ball mill

- Continuous production of fines
- No cone mill required
- Smaller units (continuous production)

- More stable product quality (continuous process).

Buss horizontal paste line HPL

- Totally controlled process
- Less fluctuation
- Less raw materials
- Less maintenance
- Reduced number of machines.

Hydraulic anode press

- Highest production capacity of up to 60 anodes per hour
- At least three times the lifetime of a vibrocompactor
- Higher density of anodes
- Better homogeneity of anode
- Minimal height and weight variation of anodes
- No anode cooling tunnel required.

Environmental impact

- Reduced due to less volatiles, less contaminated water and lower raw material consumption.



Fig. 6: Laeis hydraulic anode press up to 60 anodes per hour

Author

Michael Kempkes, mechanical engineer, is Sales Manager of Buss ChemTech since 2005. He has held several sales positions during his career and is now in charge of general sales activities and product development with focus on the Middle East region and on key accounts worldwide.

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