Aluminium Times

- The new Buss AG KX Kneader range
- Buss AG meets the requirements of the larger smelters to increase capacity of carbon anode paste plant
- Reliability and strength of the KX series machine construction is continued
- KX series performance is increased by 50% compared to older models
- China and Middle East smelters orders received
- KX series requires less space
- Reduced maintenance and wear
- Technical support, servicing and inspection is provided globally
- Front cover picture shows easy service accessibility of the KX series

- Buss AG
CH-4133 Pratteln
Switzerland
Tel: +41 61 825 66 00
info@busscorp.com

www.busscorp.com

Sales Contact Jörg Kellermann

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# KX Kneader series launch demonstrates Buss AG return to technology leadership

The demonstration of the new Buss AG KX Kneader range, which took place on 22nd May 2012, clearly showed how the KX design is both an adaptation and a development of existing technology. As well as the gathering of international visitors on the day, several delegations were also received in May. Aluminium Times Editor Chris Holding attended the KX launch.

As smelter outputs become ever larger, with higher pot amperages sought and additional potlines installed, greater carbon anode paste plant throughput is required and the spotlight has turned back to an area in which the original pioneers at Buss AG needed once more to step up to the plate and deliver.

The latest smelters being constructed are 700,000 tpy output with two potlines. In the first ten years of operation, the capacity can be expected to increase by as much as 20 per cent from additional pots and increasing of amperage, whilst Phase II expansions will also come on stream. This pushes the target of metal output up to 1.6 million tpy, requiring up to 1 million tpy of baked anodes, a need which can now be comfortably met by including just two KX Kneaders in the paste plant. This article explores both this enhanced solution and the company behind it.

*Fig 1. Christian Hauser explaining the KX feed section design*

## The company

Buss AG of Pratteln, Switzerland is a machine engineering company with process knowhow. Their equipment is well known in temperature and shear-sensitive product applications. Carbon paste is shear-sensitive, because the coke it contains should not be damaged. Buss AG is a true pioneer in this application - their first kneader for carbon paste production was supplied 1951 to Aluminium Rheinfelden Germany

The original reciprocating kneader patent was actually shared between B&P Process Equipment (USA/Canada) and Buss AG (Rest of World), but for the last 50 years it is Buss-developed technology that has been used around the world, with around 200 machines being manufactured. With their process knowhow in the art of mixing and kneading, Buss AG have taken bold steps in developing and patenting the next generation of kneaders.

The KX Kneader investment is just one third of the traditional cost per tonne of production, although with an overall $2 billion new project spend, the kneader itself becomes only a small part of the investment. The first 4-flight machine to be supplied is a KX 650 DT (DT = dynamic throttling) type to a Chinese customer. The second kneader will be supplied to a Gulf region customer. The first commissioning is expected during H1 2013.

## The right time

Potline amperage and throughput are on the increase. In China levels of 500 - 700 kA are sought. There are already two 800 ktpy lines and several 700 ktpy lines, equating to a 57 tph throughput, and several potline expansion projects also underway elsewhere, for which the KX Kneader can be retrofitted. The space premium with existing paste kneader plant design means that the KX series, with 30 per cent more throughput per machine size, is highly recommended for retrofit debottlenecking projects.

*Fig 2. Close-up picture of armoured 4-flight screw design*

## A machine apart

Safety is now a top priority in the West, the Gulf and increasingly in China also. The KX Series adoption of electrical heating means no HTM oil circuit is required. There is also a sealed bearing at the feed end. Oil heating of the shaft is banned in some countries after accidents as a result of insufficient maintenance. Oil heating is expected to disappear within five years. Heat retention is a benefit if there is any plant shutdown elsewhere – even up to 24 hours there is minimal temperature loss inside the KX.

## Productivity

To produce 1,000 kg aluminium, 560 kg anodes are required. Those anodes arise from 360 kg calcinated coke, 140 kg buts, and 90 kg pitch (30 kg is the loss in the backing process)

The pitch, coke and anode butts are mixed in the kneader to make new anodes.

Kneaders are now more likely to become the production bottleneck due to higher amperages and additional potlines. The existing machines are becoming stretched to their limit. The performance of 40 tph on the old models has been enhanced to 60 tph by the KX Series, with the KX750DT in particular capable of much higher throughputs still. Smelting is a continuous process, so high reliability is needed. The reliability and strength of the new KX machine construction is clearly visible. Even one or two of the older Buss AG designs have survived up to 50 years in operation. The new range comprises the KX540DT, KX650DT and KX750DT models.

### KX650DT Specifications

| | |
|---|---|
| Design Throughput: | 60 tph |
| Length: | 6,200 mm |
| Screw Shaft Diameter: | 650 mm |

The KX Kneader processing chamber is divided into four different zones, each with optimised screw and housing geometries according to purpose. Petroleum coke preheated to 180ºC is fed to the intake zone and transported to the process zone. The screw flight pitch is greater than the screw shaft stroke to ensure constantly uniform forward flow. Back venting enables drawn-in air to escape without interfering with the incoming petroleum coke feed.

### Front section

Hans-Ulrich Siegenthaler, Head of Process Technology, has 22 years' of experience at Buss AG including 5 years in process technology design. He explained that coke wets more easily with pitch at a certain temperature range. There is an optimum forming temperature for the paste. The traditional sticking problem with liquid pitch is solved by using a separate heated pitch injector in the mixing zone for fluidisation of solid feed, and carefully controlling heating along the kneader. In the wetting and transformation zone immediately after the intake, the pitch, previously liquefied in a separate unit, is injected into the petroleum coke at 180ºC through borings in the special-version kneading pins. This direct injection prevents deposits and clumping as well as the release of volatile components.

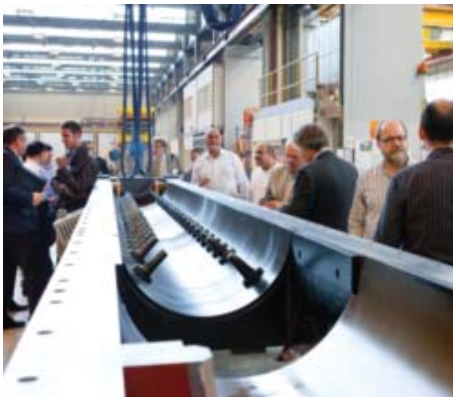

*Fig 3. The removable kneader upper housing is easily accessible on the service station right*

### Process control

The optimum kneader barrel temperature is 180ºC. This is maintained in the KX by an electrical heating system comprising PID temperature control: there are 8 axial heat zones and the current is monitored in each one. Temperature monitoring is via 16 thermocouples. The front section has 8 x 3.2 kW heaters while the rear section has 8 x 6.8 kW heaters, giving a maximum 80 kW start-up cycle. The heating element design from Backer ELC AG features super high purity magnesium oxide insulation with resin seals, and is a replaceable assembly based upon proven technology. With normal loading and no mechanical damage it will last up to 30 years in this application according to Managing Director Christoph Frey. There are also 2 thermocouples on the barrel and 1 on the product outlet.

The startup time from 5 to 180ºC is around 4 hours. At production speed, the paste residence time is above 100 seconds, but the temperature varies by less than 1 degree due to the adiabatic nature of the process. The paste exits the kneader at 130 -170 ºC, after which it undergoes independent cooling.

*Fig 4. KX unit in the test bay at Buss AG in Pratteln, Switzerland (upper housing removed)*

The particle size for the homogenised paste is important. The gate position and specific power can be used to control the apparent paste density. The machine is 1.7 density paste capable, a specification being looked at by the latest smelter ventures.

### 4-flight mixing

In the mixing and kneading zone the Buss Kneader screw segments and kneading pins interact to ensure intensive mixing of the petroleum coke and pitch. At the same time the liquid pitch diffuses into the pores of the petroleum coke, which requires an adequate and optimally uniform dwell time of the mix in this zone. This distributive mixing is decisive for the excellent homogeneity of the anode paste.

Buss AG have built 150 4-flight kneaders so far in all applications. Prior to Buss AG developing 4-flight mixing for anode paste in 2008, market needs were developing and the Buss AG market share had fallen away. The 4-flight technology was first developed for plastics compounding. The resulting calculation data was the basis for the development of 4-flight machines for the aluminium industry. A 4-flight has over 30 per cent more surface area than a 3-flight. Customers with older Buss Kneaders may also benefit from some of the KX improvements such as pitch injection, improved inlet, dynamic throttling, and a reinforced kneader screw. Due to the reduced space requirement of the KX, customers can use the KX to modify (debottleneck) existing production lines.

The screw flight pitch is greater than the screw shaft stroke, leading to a pulsing of the feed, always in a positive direction. The screw stroke required on the KX is shorter, leading to lower kW consumption. The 256 (2 to the power 8) folding cycles counter the cycle of the screw. The machine length is related to this. Design-wise, the shaft torsion limit is length = 9.5 x diameter, otherwise the elongation at operating temperature is too great. Thus there is a design optimum diameter for each throughput range.

The KX motor is rated to deliver the 50 per cent more throughput. Buss AG have designed their own gearbox for the screw stroke. The gearbox is reinforced and delivers more than twice the torque of that of the older 600 series.

### Dynamic throttling

Buss AG have adapted the equipment design to meet the demands of the market. They are certain that the KX dynamic throttling in the extrusion zone will prove that the traditional flap die control method is not required. Having dynamic throttle ability gives smoother flow patterns. Dynamic throttling counteracts the transport effect of the kneader screw - thereby increasing the mixing and kneading zone filling degree to further improve mixing - and generates the pressure required for anode paste extrusion without breaking up the coke fraction. Changing the screw speed will adjust the torque and respectively the specific energy. Typically only +-2-3 rpm is needed. This is already proven with 4-flight technology in plastics. Nevertheless a flap die can still be incorporated in the kneader for additional control and with the new KX this will last longer than in a conventional kneader. The flap die is on the upper housing when fitted.

### Maintenance

The KX Series utilises standard crane access to remove the upper housing and kneading screw. The associated service station does give some extra footprint, but the advantages are considered to easily outweigh this. The service station cover can be rotated on its axis to suit the operator, so maintenance access immediately easier, with no need to clamber into the machine, much better for safety. Also, there is flexibility in the siting of the ancillary lubrication units. Overall the KX Series has only one half of the number of parts compared to the old Buss Kneader design. The kneader screw shaft no longer has an external bearing.

Availability is >95 per cent, with maintenance carried out every 12-14 weeks typically. After any

*Fig 5. Buss AG has a large production area*

downtime, there is a rapid reconnection of the cover and the electrical supply at one point. Around 30 per cent less maintenance is expected, as there is no hydraulic unit maintenance and a lot less dirt due to having a sealed shaft unit. Temperature and flow optimisation by dynamic throttling is also expected to result in around 25 per cent less wear.

### Training

Staff rotation policies in smelters mean that regular training and service visits are prescribed.

Training takes place either at Pratteln or on site. In some cases customer operators can be trained to carry out certain repetitive maintenance work to optimise the overall service provision from Buss AG.

### Dedicated to the future

The market for new smelters is Russia, India and China, of which China is forecast to produce 50 per cent of all aluminium by 2020. Although seen as a conservative industry, the primary aluminium sector in the Gulf Region and China has recently taken forward strides with increased efficiencies and higher throughputs throughout the smelter, and India and Russia are not far behind. Already at feasibility level there is a demand for up to 90 tph throughput machines coming from China. Current machines are specified to be capable of 60 tph production. On average there are 4-5 big projects per year in the aluminium industry.

Buss AG has a long and successful history in and is dedicated to the carbon paste business going forward, maintaining strong links with qualified partners like carbon electrode formulation expert Werner Fischer of R&D Carbon Ltd. Manager Aluminium Christian Hauser and Product Manager Aluminium Jörg Kellermann have been visiting producers directly again since 2009. Smelters expect their suppliers to have longevity, and a guarantee of service for 25 years or more is important to them. Buss AG were the number one supplier in 2002 and they desire to regain that technology leadership.

### The company behind KX

Buss AG have always been specialists in process technology for continuous mixing and kneading systems. The company makes compounding systems for temperature and shear sensitive applications. Around 80 per cent of its kneaders are sold to the plastics industry. The Buss AG factory has a production area of 16,000 m2 and the present employee complement is 180, of which 40 per cent are design and process/application engineers. This sets Buss AG apart from its competitors.

### Recent history

In 2006 Fabrel Lotos and the management bought Buss AG from the previous owners. In 2008 the firm recommenced direct marketing of anode paste kneaders. In late 2010 they gained direct sales again on the 600 series.

Buss AG has six direct subsidiaries for servicing, inspection and spares: in China, Germany, Japan, Singapore (for India), UK and USA. With 200 machines operating in the aluminium industry worldwide, Buss AG has remained the leaders in kneader servicing. The continuous nature of the smelter operations means that both servicing and spare parts have a high priority. Buss AG stock over 12 million euros worth of parts at Pratteln across all models, including all key and critical items. There are also agents for Buss Kneader sales all around the world.

### Qualified partner

The most notable Buss AG capabilities can be summarised as follows:

- Process capability with 4-flight mixing
- In-house manufacturing skills
- Machine reliability record
- Global service network
- High priority on spares availability and delivery

The good working relations, mild climate and availability of skilled workers in Northern Switzerland all play their part in guaranteeing lead times all year round. High salary costs mean high quality production is the only way to go, as is the case in Germany.