**Balanced GTCs at the heart of aluminium production**

Gas Treatment Centres (GTCs) in aluminium smelters have a dual purpose. Not only do they treat fluorinated outlet gases to avoid harmful emissions, they also participate actively to aluminium production. Indeed, GTCs provide electrolysis pots with alumina enriched with fluorides. This fluorinated input optimises aluminium production. A. Courau*, N. Darsy* and C. Lim* explain.

Fives’ GTC technologies capture more than 99.5% of the alumina and fluorides emitted at the pots and recycling to the electrolysis process, thus optimising plant operation. Fluorides – a major constituent of the cryolitic bath – are essential to the electrolysis of aluminium as they allow lowering the melting point of alumina from over 2000°C down to 960°C, while maintaining the bath acidity for a better alumina dissolution rate.

The hot cryolitic bath contained in electrolytic pots emits fluorine vapours, which react with air moisture to form hydrogen fluoride (HF). Some fluoride dusts are also draught during pot operation through the pot suction ductwork. The quantity of fluorides that is captured and recycled through a GTC is in the range of 30 to 45kg per ton of aluminium produced. For a 500,000 T/year smelter, the quantity of fluorides recycled by the GTCs can therefore exceed 20,000 T per year, thus making GTCs not only a pollution control system but a key process equipment for aluminium production.

**Alumina enrichment**

Fives GTCs are designed for homogeneous fluorination of alumina at their outlet. Such solutions rely on a distribution of gas flow to filters, distribution of alumina to reactors and a large alumina storage volume inside filter hoppers, thus providing favourable conditions when alumina is injected to adsorb HF. The alumina fluorination level is usually followed up by regular measurements of the fluoride content in enriched alumina samples from each hopper bottom, expressed in %F of the alumina.

**Optimised distribution of gas flow**

There are three important steps related to gas flow distribution. First of all, suction on all pots must be balanced in order to obtain an equal gas collection efficiency on each pot. Similarly, the overall gas flow must be equally distributed among all GTC filtering modules to maximise scrubbing efficiency. Finally, inside one filtering module, the gas flow must be distributed homogeneously among all filter bags.

Fives has developed and patented different ways to balance suction on all pots. Depending on project requirements, such balance can be reached with fixed orifice plates or with dynamic devices. Furthermore, Fives can offer a controlled boosted suction on the pots in process of anode replacements works, using either a dual ductwork with booster fans or a single duct system with patented device[1]. Both options allow maintaining the nominal flow on all other pots in normal operation[2]. The flow from all pots is collected into branch ducts supported alongside the potrooms that further merge into large courtyard ducts that are connected to the GTC inlet plenum.

The gas flow distribution to each filter module is achieved by the inlet plenum. The design of the inlet plenum provides an equivalent flow to each filter of the GTC. As all projects are different, CFD calculations and airflow studies are performed for an optimal design of the inlet plenum, which usually looks like a fishbone.

**Fig 1** shows a reduced-scale model that was implemented for a GTC simulation with five filters while **Fig 2** shows an example of velocity distribution calculation through an inlet plenum.

All filter module outlets – whatever the type of filter module selected – are equipped with motorised balancing dampers coupled with flowmeters. These balancing dampers are combined with flowmeters and stabilise the flow repartition set up by the inlet plenum, thus...
allowing a perfect gas flow distribution among filter modules. Indeed, when necessary, dampers create for each module an adjusted artificial pressure drop, which makes GTCs able to properly run under special configurations such as shutdown or start-up of one or several filter modules. These dampers also allow for the necessary adjustments in system pressure drop due to the unequal distance between filter modules and the inlet plenum flange or to the GTC outlet duct-to-fan configuration.

In these circumstances, the system ensures that all filter modules treat the same flow at +/- 5%.

These balancing dampers can be adjusted during the life of the GTC, as initial adjustment at commissioning may require an update to take into account the condition of filters or maintenance works performed. This feature is useful when filter bags are changed for one module. The lower filter drag with new bags can then be compensated by partial closure of the filter outlet damper to maintain same flow rate between all modules. This helps replacing bags one module at a time.

Filter modules themselves have benefitted from air flow studies to reach an optimal distribution of gases among filter bags leading to Fives’ latest developments in terms of filtering technologies such as TGT-R1 and Ozeos.

The TGT-R1 filter module is characterised by its reactor, which is integrated within the filter module. It allows a low-velocity gas flow and a homogeneous repartition among all bags. One of the main advantages of this filter is its ability to run autonomously without fresh alumina supply for up to two hours, thanks to its large-capacity hopper. Indeed, in case fresh alumina feeding is stopped for operational or maintenance reasons, alumina internal recirculation into the filter allows TGT-R1 filters to continue operating at their highest fluoride collection efficiency until all the alumina contained in its hopper is completely saturated.

The large capacity hopper of these filters is also beneficial to deliver to the pots an alumina with steady fluoride content. This storage capacity allows a typical residence time of four hours for the alumina inside the GTC. When periods of peak fluoride emissions occur at the pots, the large volume of alumina being recirculated from the filter hoppers to the reactors acts as a buffer and maintains a low fluoride gas emission. This storage capability absorbs and smoothes any sudden variation in enriched alumina fluoride content that would be caused by changes in fluoride inlet concentration due to pot operation, and allows feeding back to the pots a fluorinated alumina with a more consistent fluoride content.

Ozeos is Fives’ most recent dry-scrubbing technology with integrated reactor. Ozeos filter modules have been eco-designed to reduce their pressure drop, ground footprint, weight, and electrical and compressed air consumption[1]. The compact design suits at best the large gas volume treated by centralised GTCs for modern high amperage pots. This technology includes a lower velocity reactor that reduces risks of scaling, abrasion and alumina attrition, as well as a series of features to facilitate control and maintenance. This module has been tested since 2005 in Saint-Jean-de-Maurienne (France), prior to the first industrial reference, which was commissioned in 2014 at Rio Tinto Alcan’s new AP 60 potline at their Jonquière site in Canada[2].

**Distribution of alumina to reactors**

Alumina is introduced into the gas stream at the reactor stage. Alumina distribution and injection must be carefully studied to maximise its mixing and its scrubbing efficiency with the gases.

Indeed, the optimised alumina distribution key is for a homogeneous fluorination rate and a global high scrubbing efficiency. Like with filtering modules, key requirements for alumina distribution take place at two levels: First at the distribution box, where alumina is divided towards each module in equal quantity, then in filters’ reactors where alumina shall be spread out to enhance contact with incoming gases.

To reach an equal distribution of alumina among each module, Fives has developed a proprietary distribution box. It is located upstream from the reactors and receives alumina conveyed from the fresh alumina silo. The principle of the distribution box is very simple: Alumina is discharged towards as many outlets as the number of filters in operation. Thanks to alumina fluidisation, alumina behaves as a liquid and the flow is identical for each outlet, in a verified range of +/- 5%.

In order to maintain a sufficient and uniform concentration of alumina in the reactor, alumina is recycled several times from the module fluidised hopper into the reactor. Recirculation influences the performance to capture HF and the recirculation rate can be adjusted at times in order to stay below the maximum authorised emission level.

**Conclusion**

The alumina enrichment process is enhanced in Fives’ GTCs due to a design that ensures a balanced repartition of gases over filtering modules, a proper distribution of alumina as well as a maximal contact between alumina and gases.

Such a homogeneous and consistent alumina fluorination also allows for a more stable scrubbing performance of GTCs with no peak of HF emissions at the stack. Fives’ solutions aim at combining industrial performance with sustainable development. As for GTCs, process optimisation is closely linked to lowering environmental impact, thus demonstrating that these two objectives are among Fives’ main priorities.

**References**

[1] Quentin de Gromard Antoine, Lim Chin Boosted suction systems reviewed- Aluminium International Today (September/October 2013)


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