Extended surface filter bags – applications and benefits

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Abstract

The HF gas emitted by the reduction pot is captured in Gas Treatment Centre (GTC) by reacting the gas with alumina. In a well designed system, 95 % of the reaction occurs at the alumina injection point where the gas comes in high turbulent contact with alumina prior to the fabric filters. The filters then act as a last point of contact of gas and alumina where final reaction occurs. The fabric filters in the GTC capture the particulate alumina and the final amounts of fluoride gas. With amperage increase, the pot gas temperature increases and the alumina/HF reaction rate decreases. This problem can be mitigated by using extended surface filters which offer 50 – 130 % increase in available filtration area. With the increase in surface area, the air-to-cloth ratio is dramatically reduced, in most cases cut in half. This enables the GTC to work on a much-reduced differential pressure. The emissions (roof as well as HF and particulate stack emissions) can be reduced with the existing GTC and without major capital expenditure. The presentation uses several case studies to show the need for the installation of increased surface bags – from limited airflow to reduction in emissions and finally energy savings.

Keywords: Gas treatment centre; HF - alumina reaction; extended surface filters.

1. Introduction – working principle of a well designed GTC

The main function of a Gas Treatment Center (GTC) is typically seen to scrub the HF out of the gas-stream coming from the pots. While doing that, the GTC is performing various other tasks that are equally important to the production process.

On the process side, an efficient reaction of the HF gas with the injected alumina enables recycling the pot gas fluoride by continuously feeding fluoridated alumina to the reduction pot and thus minimising the requirement of AlF_3 addition.

On the environmental side, the GTC:

- Captures both HF gas and particulate fluorides to protect the environment and allow smelters to maintain emissions within their licence to operate conditions,
- Cools the reduction gases by diluting them with large quantities of ambient pot room air which is drawn into the pots by the GTC, and
- Provides sufficient ventilation of the pot room by drawing pot gas away from manned operation areas.

In performing these functions the GTC should maintain emissions below licenced operating limits without allowing the GTC to be a major bottleneck to aluminium production.

Even though the GTCs in smelters are extremely efficient at capturing emissions, there are always still some minor emissions from both the GTC and fugitive emissions from the pot room itself.

In a well designed system the gas flow rate induced by the suction of the GTC (Φ_{DRAFT}), is higher than the pot gas flow rate emanating from the buoyancy of the hot gas produced in the reduction reaction ($\Phi_{Pot\ Gas\ Bouyancy}$). Thereby negative pressure should exist throughout all areas and heights (H) above the anode cover under the hood so that ambient pot room gas is drawn into the pot at any open area of the hooding. With the air inflow, the hot reduction gas is diluted, cooled, and drawn into the pot duct, away from the pot room (Figure 1) [1].

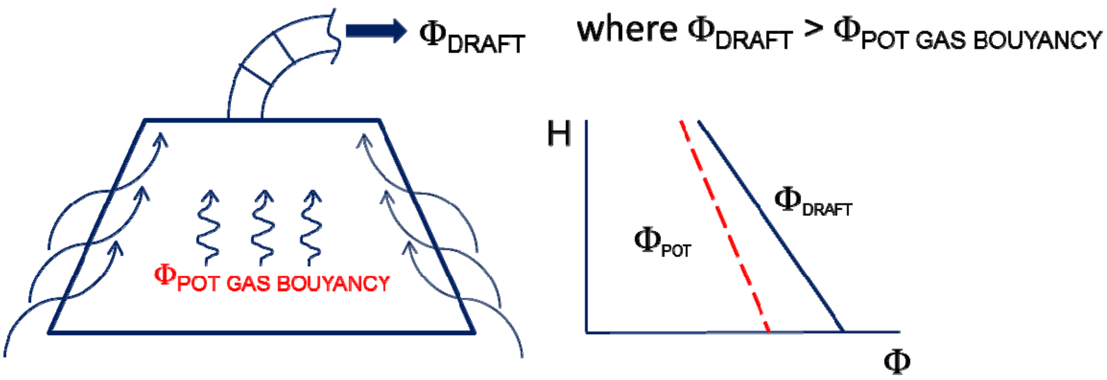

Figure 1. Gas flow equation under normal operating conditions.

In the GTC, the HF gas emitted by the reduction pot is captured by reacting the gas with alumina. In a well designed system, 95 % of the reaction occurs at the alumina injection point where the gas comes in high turbulent contact with alumina prior to the fabric filters. The filters then act as a last point of contact of gas and alumina where final reaction occurs. The fabric filters in the GTC therefore capture the particulate alumina as well as the final amounts of fluoride gas.

2. Effects of amperage creep

Higher smelter production rates cause:

- An increase of he quantity of hydrogen fluoride in the gas,
- Higher gas temperatures which in turn reduce the HF/alumina reaction rate and
- Increased volume of gas.

The effect of the above-mentioned reactions is that inside the pot, more heat flows from the crust which increases air buoyancy and vertical buoyancy gas flow ($\Phi_{\text{Pot Gas Bouyancy}}$) which cannot be compensated by the draft induced by the GTC (Φ_{DRAFT}) in the whole under-hood space. Above a certain height (H) inside the hood, overpressure is created and the under-hood gasses are pushed into the potroom as fugitive emissions. This is illustrated in Figure 2 [1]. To return to normal operation, pot draft has to be increased, so that $\Phi_{\text{DRAFT}} > \Phi_{\text{Pot Gas Bouyancy}}$.

The other consequence of higher heat flow from the anode top is an increase in gas temperature, which will reduce the alumina/HF reaction rate. This means the reaction at the alumina injection point may no longer be able to remove 95 % of the HF and an increased amount of alumina to react with the excess HF is required. The GTC is therefore subject to increases in both gas volume and particulate dust load, resulting in higher operational pressure drop and more frequent pulse cleaning. Consequently, on the one side both particulate and HF emissions from the GTC will increase, but also the GTC can come to a point where the frequent cleaning cannot keep up with the requirements from the potroom side and the GTC is in a way limiting the production.

Table 1. Case studies.

Case Study:	1	2	3	4
Goal:	Emission reduction & airflow increase	Emission reduction after amperage creep	Energy savings	Increased production with stable absolute emission
Reduction dp %	25	35	30	
Reduction pulse frequency %	50	50 – 70 (depending on season)		33
Reduction Stack Emission				
HF (%)	50	45		20
Particulate (%)		45	Stable	
Reduction Roof Emission (HF %)				24
Increase airflow (%)	8			12
Reduction in gas temperatures (°C)				6.4
Reduction fan electricity (%)		20		
Reduction energy consumption (%)			33 (including other conversions)	

5. Conclusion

Extended surface filters have proven over the past 6 years that they are a powerful tool to debottleneck existing GTCs and FTCs where the process demands have overtaken their capacities ($\Phi_{\text{POT GAS BOUYANCY}}$ larger than Φ_{DRAFT}). Yet, each project has to be carefully evaluated that the process and operational parameters support the installation of extended surface filters and the best and most efficient set up needs to be determined.

The conversion of your existing GTC to extended surface filter bags does not require structural changes to the GTC, therefore the only invest required is for the extended surface filter bags and corresponding cages.

6. References

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