Low Resistance, High Flow PrimaFlow® Filters

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Abstract

Extended surface filter bags (ESB), also known as StarBags™, have been used for over fifteen years in primary aluminium smelter gas treatment centers (GTC). They were initially validated as a cost-effective way to increase the capacity of an existing GTC when potlines increase production with line amperage increase, thereby debottlenecking production increases without the need for capital upgrade in the GTC. Since inception and lapse of the initial product patent, there have been several design modifications to the commercially available ESB filters. Most of these modifications have been focused single facedly on increasing the available filtration area in order to further leverage the initial application benefits.

With the trend towards the continued incremental increase in amperage, ESB filter product application and design modifications have now been shown to have benefit limitations. Failing to recognize these limitations, some more recent ESB projects have now failed to achieve all of the project target outcomes in several aluminium smelters.

Recognising this application limitation, a new systematic approach to the StarBag™ design and implementation has been developed. This paper will discuss the limitations of current ESB filter designs, present a new systematic approach to this problem and outlines some successful application case studies. In one particular application case study presented, it will be shown that the latest ESB design development has achieved all of the project target outcomes while at the same time has achieved a much higher gas flow through the GTC than has been achieved with any other technology previously used.

Keywords: Gas treatment centre, Alumina dry scrubber, Extended surface filter bags, StarBag™, PrimaFlow®.

1. Introduction

In the 1970s, pleated cartridge filters were introduced [1] as an alternative to fabric filter bags in an effort to reduce the footprint of new capital equipment. This was achieved by a reduction in air-to-cloth (ATC) ratio by drastically increasing the cloth area. However, limitations were encountered where high dust loading bridged the tight pleats in the cartridge filters [2], and it was soon discovered that cartridge filters were not appropriate in high dust load environments [3].

In the mid-1990s the ongoing need to lower ATC ratios in existing equipment seeking better baghouse performance without pleat bridging, inspired the invention of the StarBag™ [4]. The process of commercializing this invention was initially slow, until after assignment of the original patent, Albany International (currently known as Solaft Filtration Solutions) undertook the first pilot trial of StarBags™ and subsequent full GTC retrofit at Boyne Smelters in 2005-2006 [5].

As is common with many new developments, there were many design changes between the original patented concept and the fully commercialized product. These design modifications focused mainly on maximising the available filter cloth area within the geometry outlined in the patent, enabling a product capable of mass production in a cost-effective manner and providing sufficient structural integrity to the filter support cage.

Subsequent aluminium smelter GTC StarBag™ retrofit projects [6] proved StarBags™ to be a genuine and repeatable viable alternative to GTC capital equipment upgrade when the smelter increased metal production though amperage increase. In such amperage increase installations where the conversion to StarBags™ were conducted with either no additional gas flow to the GTC or with a small percentage of increase in gas flow, the efficiency and productivity gains when compared to the results from the standard cylindrical filter bags are typically expressed as:

- 30-35 % reduction in filter differential pressure (DP)
- 50-70 % reduction in pulse frequency
- 40-45 % reduction in particulate and gaseous HF emissions from the GTCs
- Reduced electrical load on the ID fans.

However, in other later installations where total gas flow through the GTC was increased more significantly, application limitations of the current design ESB filters meant that some of the abovementioned process improvements were no longer achievable.

2. Design and Limitations of Current ESB filters

The original filter cages of the ESB concept [4, 7, and 8] incorporated pleated filter bag on a twin wire cage to support an eight pleat ESB filter. The wire cage was supported by wire horizontal support members, which were manually constructed using jigs and spot welders. These support members were variable in quality and created difficulties in welding to the longitudinal components, Figure 1 left. Such manufacturing difficulties could not prevent large protruding knuckles of wire on the horizontal support members that exposed the ESB filters to significant abrasion on the back of the filter media during pulse cleaning. Some manufacturers continue to use the wire design originally developed regardless of quality issues in manufacture.

Figure 1. ESB filter cage support, Left: original wire design, Right: subsequent pressed metal component.

Subsequent filter cages of the concept [9] incorporated a pleated filter bag on a single wire cage to support 10 or 12 pleat ESB filters. The increase in number of pleats was to enable a further increase in available filtration surface area over prior art. Pressed metal horizontal support members were cut and pressed automatically with consistent quality, with a more robust cross-sectional shape to support the wire cage and this significantly reduced the difficulties in welding

7.3 Case Study 3 – Rio Tinto Aluminium Alma Smelter, Canada

Rio Tinto Aluminium's Alma Smelter in Canada have been using 8-ray ESB filters and cages since 2010 in both GTC and FTC applications. While the conversion to ESB filters brought many operational benefits [6], the filter installation crew have always reported difficulties and excess time required with filter cage insertion and removal in their FTC.

In order to test the PrimaFlow® concept and assess the merits concerning ease of installation, two filter cells within the carbon-bake fume treatment baghouse have been fitted with PrimaFlow® filters. The performance has been compared over the first 12 months of operation to the performance of the 8-ray ESB filters also used in the FTC baghouse.

The customer reported satisfaction with the ease of installation and they observed three measurable performance benefits of the PrimaFlow® filter over the 8-ray ESB filters. The customer observed a significant and sustainable reduction in differential pressure, a significant reduction in pulse cleaning frequency, and a higher process gas flow over time, Figure 11. They also see the measured reduction in pulse cleaning as a means to lower emissions and extend filter bag life.

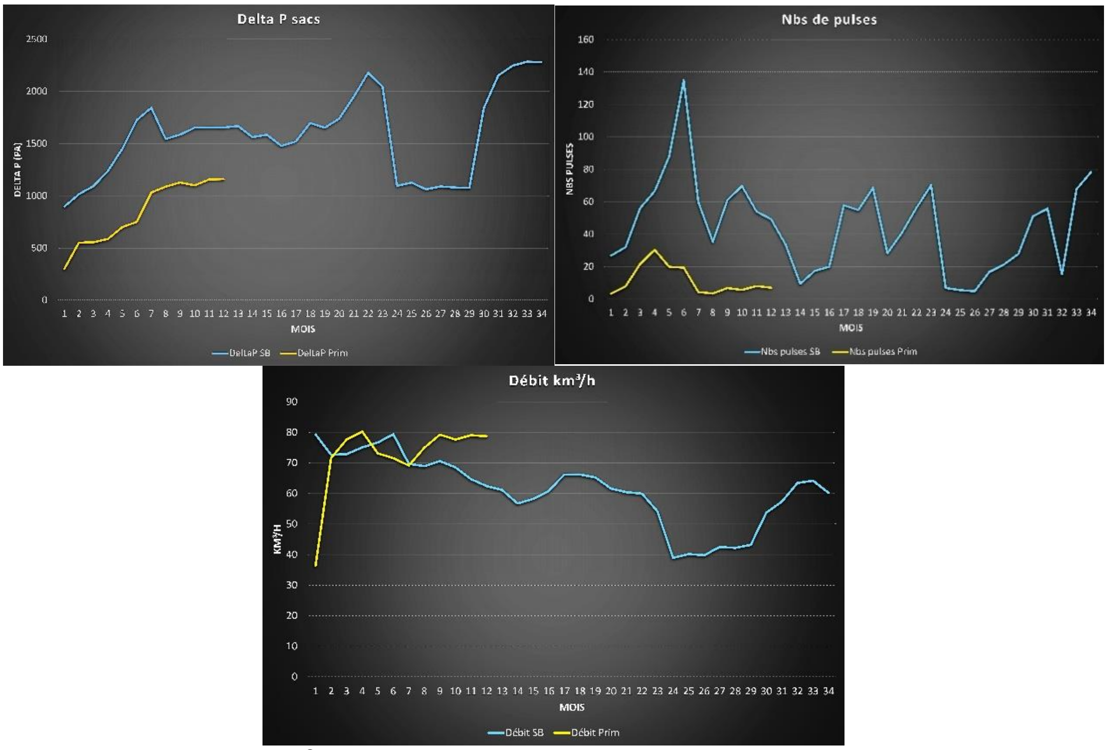

Figure 11. PrimaFlow® conversion, Left: comparison of differential pressure, Right: comparison of cumulative cleaning pulses per month, Bottom: comparison of total gas flow on a monthly basis.

8. Further Work

There are many different applications and reasons for upgrading a filter baghouse to ESB filters. The scope and design of such upgrades is governed by the customer's application problem and desired upgrade outcome. Therefore, it is essential to consider as many of the process application aspects as possible when undertaking such an upgrade and designing the solution accordingly, rather than just simply maximizing filtration area for all application upgrades.

SOLAFT Filtration Solutions are in the process of creating a CFD modelling system in order to both optimize and expedite the PrimaFlow® design system for each application that is being considered for a process technology upgrade.

9. Conclusions

Application limitations in the implementation of older design ESB filters have been identified with respect to long filters and high gas flow. When older design ESB filters are applied in a process that is approaching these limits, it is not possible to achieve the performance gains previously experienced in applications with lower gas flow rates. This limitation and lower than expected performance has been observed at several major industrial sites.

A new system of ESB filter design has been undertaken. Rather than single mindedly focusing on maximizing filter area, a new and more balanced design methodology has been adopted. The new PrimaFlow® system considers and optimizes the filtration area of the ESB filter, the filter internal gas flow resistance and a new generation of high capture low resistance filter media.
The PrimaFlow® system has demonstrated, in both single cell and full baghouse conversions, to provide significantly higher gas flow and lower differential pressure than any previous embodiment of the ESB filter concept.

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