High-Tech Filters

Georg Rathwallner, Inspec Fibres, Austria, discusses the use of sophisticated high-tech materials to increase bag life-cycles and efficiency.

Introduction

The current economic situation of the cement industry creates sensitivity regarding off-times and process stability. More stringent air-pollution laws, especially when using waste-derived fuels, are drawing more attention to the off-gas cleaning facilities, usually bag filters. This article does not deal with electrostatic precipitators - as even they have well known disadvantages. By using more sophisticated felts at a comparably low differential pressure, even in tougher operating conditions, bag life can be doubled. This usually justifies the higher price. Fine fibres and trilobal shaped cross-sections are, meanwhile, a common approach to produce felts with finer pores and a higher fibre surface. Furthermore, the blending of different materials appears to influence the filtration behaviour by changing the distribution of static charges.

The energy used by the fan accounts for 60 - 80% of the baghouse operation costs and therefore, a stable and low differential pressure makes it worth considering investing in highly developed filter bag materials. This will have be done anyway, when production is restricted due to limited airflow through the filter. Maintenance costs must also be considered

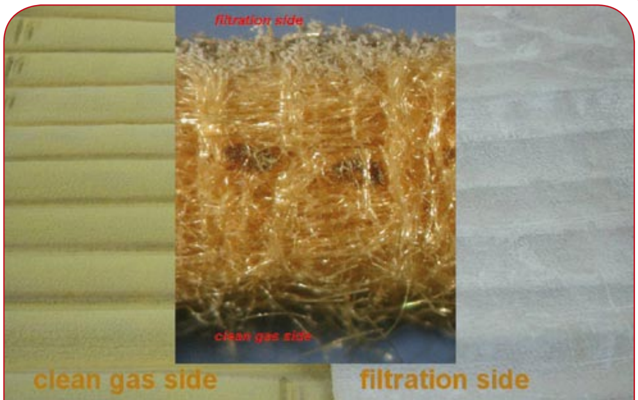

Figure 1. P84 needle felt on a P84/PTFE hybrid scrim after eight years in a kiln filter in Brevik/Norway.

Table 1. Filter bag operating conditions in Brevik	
OEM: FLS Airtech	
Pulse jet system, online cleaning	
Filter material	P84 on P84/PTFE hybrid scrim
Temperature	160 - 185 °C, peaks up to 250 °C
Air to cloth ratio	1.29 m/min
SOx	115 - 1000 mg/Nm^3
NOx	500 - 900 mg/Nm^3

– a cut back by 50% is achievable, not taking into account the possibility of reduced kiln downtime.

The differences that cement plants exhibit in terms of construction and operation, demand a detailed analysis of each individual baghouse to find the best suitable material. The given overview can be used as a guide for a certain preselection, based on the origin of the gas stream. Besides the material itself (fibre material, fibre titre, fibre cross-section), processing (needling, heat treatment, singeing) and surface treatment (water or oil repellent finishes) also have a detrimental effect on the performance of filter bags. Nevertheless, they can only work properly when based on a suitable fibre material.

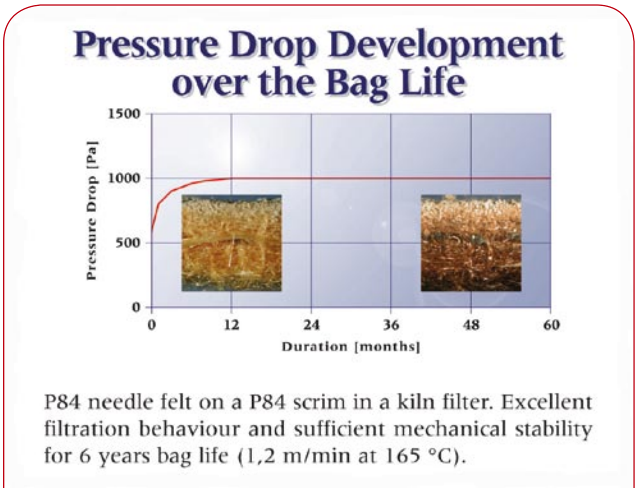

Figure 2. Schematic development of pressure drop in a kiln filter.

Figure 3. P84 needle felt on PTFE scrim after two years at 185 °C (peaks up to 230 °C) in an alkali bypass filter.

Kiln dedusting

Depending on the availability of cooling systems, the baghouse inlet temperature in most cement plants is between 100 °C and 200 °C. Therefore, a wide range of filter fabric materials is used. PAN (polyacrylic homopolymer, e.g. Dolanit) is suitable when peaks above 140 °C can be prevented; PPS (polyphenylene sulfide), m-aramide and poly-amide-imide cover peak temperatures up to 200 °C. Continuous operation at temperatures at or above 180 °C, or peak temperatures above 250 °C, lead to an insufficient lifetime for these materials. P84, PTFE and glass are the materials most capable of withstanding such operating conditions.

Besides acidic flue gas components such as SOx, HCl and HF, the high content of NOx at 1000 mg/m^3, due to the high combustion temperatures, is typical for kiln off-gases. Within the nitrogen oxides, NO_2 rarely has a share of above 1% in cement kilns.

To optimise costs and performance, various blends of the above-mentioned materials are used. In particular, P84 has been developed to become a standard blending partner to improve the filtration efficiency of PTFE felts, and has become increasingly popular in blends with low cost fibres. Baghouses are typically designed with a/c ratios of 0.6 - 1 m/min, in comparison to values slightly above 1 m/min with more advanced felts.

The co-combustion of waste derived fuels is leading to stricter limitations regarding particulate emissions. This is due to incineration products like dioxins that are known to adsorb on solid substances and leave the plant in that form. The use of additional gas treatment systems in order to stay below emission limits, can be avoided by reducing particulate emissions with high-tech filter fabrics; for example, blends or cover layers with fine fibre, trilobal or multilobal fibres (see Figure 1, Table 1 and Figure 2).

Kiln/mill-filter

When kiln and raw mill dedusting is combined, the temperature within the operating mill is typically between 90 and 160 °C, 90% of the time. The choice of suitable fabric materials is restricted because when the mill has stopped, the filter fabric must withstand temperatures up to and above 200 °C. Materials like glass, PTFE and P84 can withstand peak temperatures of up to 260 °C. However, glass and PTFE show relatively poor filtration behaviour, which often results in the need to laminate a membrane on these materials. The high dust content when the mill is in operation often leads to abrasion and membrane failure. The gas composition in compound operation differs mainly by the higher water content from kiln off-gases. P84 needle felts

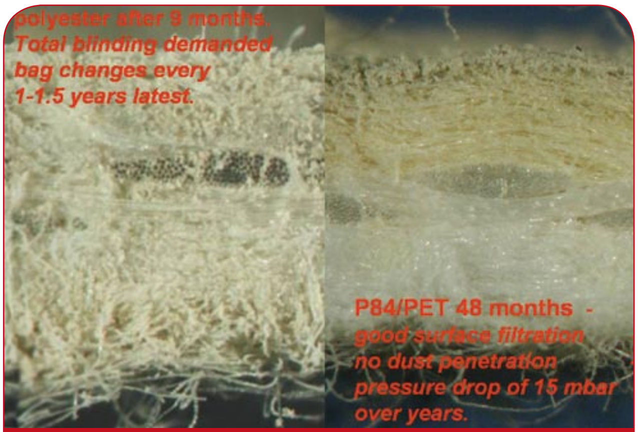

Figure 4. Comparison of a polyester felt with a P84/PET blend in a finish mill.

are widely unaffected by abrasion and are capable of staying below the strictest emission limits. In such applications, life times of three to six years are commonly achieved with P84 felts, granting process stability, low emissions and low differential pressure during the entire bag life. Another advantage of P84 is that spare bags stored over an extended period of time for immediate replacement in case of failure are not affected in quality.

Alkali and chloride bypass

The typical material for bypass dedusting is PTFE, with or without membrane. The temperature and chemical environment restrict the choice of materials for this. Depending on the configuration and the demands the bypass has to fulfil, the conditions vary (e.g. if chloride rather than alkali separation is to be maintained). Sticky dust is not favourable for membranes but the filtration behaviour of pure PTFE needle felt is sometimes behind expectations. P84, supported by a PTFE scrim, has proven its suitability in an alkali-bypass in Austria, showing excelle0nt surface filtration behaviour and just minor decay of the polymer material after 12 months at 185 °C with peaks of up to 230 °C (Figure 3). The estimated bag life is comparable with PTFE, where the blinding of the fabric typically limits the operational time.

Clinker cooler (without cooling)

From a chemical point of view, this is one of the less challenging high-temperature applications within a cement plant. It is, more or less, hot air that has to be dedusted, typically at temperatures close to 200 °C. Membranes suffer from the abrasive character of clinker dust and frequent short-time peaks of high temperatures, significantly above those of continuous operation, limit the choice of suitable materials. The low humidity of the gas stream and the lack of harmful incineration products allows m-aramides and amide-imides to be used besides P84, and sometimes PTFE or glass. In the case of increased dust penetration and emissions, blends with fine fibres, such as multilobal shaped P84 fibres, in the dust side batt are capable of solving the problem.

Clinker cooler (with cooling)

The process of cooling the air from 200 °C down towards 100 °C invites an increasing number of suitable filter materials. In the case of air dilution cooling, the volume of airflow is increased and will demand a bigger filter. The other option is an air/air cooler. Using this, the volume of airflow to be handled by the fan and the baghouse is reduced and the effort of cooling is, at least partly, compensated. The filter materials besides those mentioned for 'hot' clinker cooler are PPS, PAN and polyester (PET), as well as blends with tri- or multilobal-shaped fibres.

Cement grinding

Where temperatures fall below 100 °C and there is a lack of harmful gas constituents, low cost materials are favoured, and therefore polyester is most commonly used. The trend in the cement industry is moving more and more towards higher short time hardness, which can be achieved by finer particulate size distribution. The finer dust is leading to premature blinding of the standard polyester felts, resulting in additional shutdowns to replace the filter bags. Blending of PET with PAN and P84 fine fibres in the filtration side batt result in marginally higher prices of the filter bags but represent the economically favourable solution (Figure 4).

Coal mill

Filters behind coal mills operate under the most challenging conditions in terms of filtration efficiency. The very fine and non-agglomerating dust is likely to penetrate into the felt, resulting in increased differential pressure and premature failure due to mechanical burden. A relatively low a/c ratio, in combination with sophisticated filter and felt construction, are adequate measures to counteract those troubles during operation.

Conclusion

Dedusting in cement plants can be divided into several typical applications with different characteristics concerning temperature, dust and gas conditions. The decision regarding the most suitable material, which is much more than just finding a chemically and mechanically sufficient solution, needs a more detailed view on the particular application.

The actual situation, with high demand for building material, is asking for an optimisation of auxiliary systems such as baghouses in order to guarantee maximum productivity. Once installed, the filter material remains the only part that can easily be replaced within the system. Operators are becoming more sensitive for off-times, due to the necessary bag replacement, maintenance costs and process stability in general. Therefore, more sophisticated high-tech materials are being used as they prove their advantage in life-cycle analysis and efficiency.