

Dedusting Options

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Introduction

Fabric collectors are being extensively used in the cement industry, with their application widening to include processes (where the electrostatic precipitator (ESP) has for a long time been the accepted dedusting system) such as preheater cement kilns, raw meal, Lepol kilns and dedusting for clinker coolers.

In recent years, several developments have been made as well as significant progress in filtration medias, creating a fabric collector, which is a viable alternative to ESPs. More and more kiln, raw meal dedusting systems and Lepol kilns are being upgraded, replacing ESPs mainly with pulse jet cleaned fabric collectors.

The majority of present day coal grinding and drying plants use a variety of fabric collectors. If inert operation can not be guaranteed at all times, these filtering separators reduce explosion pressures using explosion-resistant construction with explosion relief. On the other hand, if inert operation can be achieved during all operating phases it is possible to dispense with the structural explosion protection.

Explosion-relief equipment can consist of rupture discs or tested explosion flaps. Mixed needle felts made of polyacrylonitrile and polyester have proved to be very successful filter media for filtering

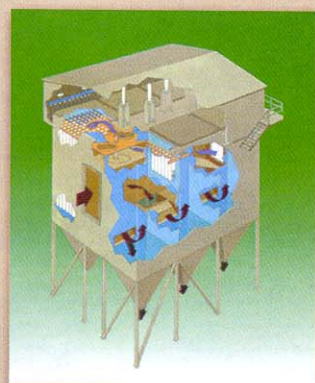
separators in coal drying and grinding plants. All metal parts that come into contact with the filter bag must be correctly earthed to prevent electrostatic discharge between metal parts.

Why bag filters?

- Pulse jet cleaned filters operating at high a/c ratios, compared to reverse air cleaned filters = reduced investment costs.
- Advances in filter medias, increase a bag life = lower operating costs.
- Stricter emission regulations through all operating conditions = lower emissions.
- Efficiency not affected by changes of fuel.
- CO can be present in the exhaust gases.
- Online maintenance.
- Space requirements basically the same as existing systems.



Combined clinker cooler and Lepol kiln dedusting at Ciments d'Origny, Rochefort.



The AAF FabriPulse XLVC filter.

Case study one

In 1997, an existing ESP was to be replaced at Ciments Lafarge. The gases from the raw mill and kiln in combined operation, or kiln only (10% of the operating time), are cleaned in an AAF pulse jet filter, cleaning online. The bag material selected was the Goretex membrane/superflex fabric laminate. Membrane surface filtration uses a PTFE membrane to collect the particulate matter that impinges on it, and special cages are installed. The guaranteed life was 3 yrs full plus 2 yrs pro ratio. There has been not a single bag failure after 5 yrs of operation, and the pressure drop has remained constant at 1200 Pa.

As the kiln uses a variety of fuels, special precautions have been taken to protect the bags both from an over temperature as well as operation at low temperatures where condensibles in the

Table 1. Case study one: Lafarge Martres. Dedusting kiln and raw mill

Kiln operation	V = 105 000 Nm ³ /h T = 160 °C
Kiln and raw mill operation	V = 130 000 Nm ³ /h T = 160 °C
Fuel used	High viscosity oil Coal Petcoke Other waste fuel
Gas composition	CO ₂ = 27% O ₂ = 7.5% H ₂ O = 15% N ₂ = 50.5%
Type of filter	FabriPulse 8-14-238
Type of bags	Goretex membrane/superflex fabric laminate
Cleaning mode	Online
Maintenance	Online
Cleaning system	Compressed air with 4.5 bar max on demand
dp filter	1300 Pa
Outlet particulate concentration	<10 mg/Nm ³
Startup	February 1997

Table 2. Case study two: Ciments d'Origny (Holderbank). Dedusting of Lepol kiln and clinker cooler

Kiln and clinker cooler operation	V = 378 000 Nm ³ /h T = 120 °C
Kiln startup	V = 86 415 Nm ³ /h T = 650 °C
Forced air cooler	V = 85 000 Nm ³ /h T = 350 °C (upset condition) T = 230 °C (normal operation)
Type of filter	FabriPulse XLC 12-14-324
Type of bags	Dolanit needle felt with PTFE coating
Cleaning system	Compressed air at 5 bar minimum
Cleaning mode	Online
Maintenance	Online
dp filter	1200 - 1300 Pa+
Outlet particulate	<10 mg/Nm ³
Startup	March 1998

gas stream can cause blinding of the bags.

One of the features of this installation has been the planning of the erection of the filter and substitution of the existing ESPs without any loss of production, as the changeover was made during the scheduled maintenance shutdown of the plant.

Case study two

In 1998, an existing ESP was replaced at Ciments d'Origny.

The system is designed to handle the emissions from three kilns in a single fabric filter plant,

namely the start up stack, the Lepol kiln and the clinker cooler. The advantages of combining kiln and clinker cooler dedusting are the following:

- Reduced investment cost of up to 30% of the conventional system.
- The combination of coarse dust from the clinker cooler with finer dust from the kiln improves dust cake on bags = less dp, lower operating costs.

During the startup or stoppage of the kiln, the gases are exhausted without traversing the grate

through a lateral chimney. The hot gases are diluted in a cyclovortex mixer by means of ambient dilution air down to a temperature of 650 °C, which is the maximum inlet temperature that the forced air-to-air heat exchanger can accept.

The forced air cooler then cools the gases to 350 °C, and following dilution with ambient air at a mixer the gases enter the AAF pulse jet collector. The forced air cooler is sized to cool the clinker cooler gases even in the case of an upset condition. During normal operation, the gases from the clinker cooler are cooled to 120 °C in the heat exchanger, and mixed upstream of the collector with the gases from the Lepol kiln, whose temperature cannot exceed 180 °C.

Provisions are made to introduce dilution air to the system if the mixing temperature exceeds 120 °C. Should the temperature reach 125 °C for 10 min or more, the filter is isolated and the gases are led to the startup chimney.

The collector is insulated and heat tracing is provided. The bag material selected was an acrylonitrilic homopolymer, which is resistant to hydrolysis.

The filter is designed to allow, if necessary, offline cleaning and online maintenance, by closing the inlet butterfly and outlet poppet dampers.

The installation has been in operation for 3 yrs and is working in conformity with its design parameters, without any bag changes.

Case study three

In order to reduce the emissions at the existing stacks to less than 15 mg/Nm³ and comply with future legislative emission limits, Cimpor Souselas decided to install fabric collectors downstream of the existing ESPs. The ESPs will be kept in place acting as precollector with the fabric collector operating as the final filter. This will allow Cimpor to operate the kiln with whichever fuel they wish and still meet the stack emission requirements.

The AAF pulse jet cleaned filter is capable of operating at 260 °C

should the evaporative cooling be out of operation, but will operate at 140 °C under normal conditions. The FabriPulse operates online, and has features that allow online maintenance. The fabric selected after very careful assessment of investment vs operating/replacement costs was a 730 gr/m² woven glass with a PTFE membrane. The bag cages and tube sheets are constructed from 316L stainless steel. The unit is insulated and heat tracing of the pyramid hoppers is provided.

Case study four

At the Juracime Cornaux plant, a Lepol kiln was dedusted by an ESP. In order to meet the new emission regulations, Juracime decided to upgrade the existing ESP operating in pressure mode with a pulse jet cleaned Beth Pulse fabric collector. A survey of the existing precipitators showed that the casing and hopper were in good condition and could be recovered.

At the same time a decision was made to operate the filter in suction using the existing fan. This was made possible due to the fact that the motor is frequency modulated, so that by increasing the speed of rotation of the fan, the static pressure increase is sufficient to overcome the additional pressure loss of the fabric filter.

The filter will be operated at a minimum temperature of 95 °C to avoid operation below the dew point. As the maximum temperature cannot exceed 120 °C, the filter media selected is an acrylic homopolymer, which is resistant to hydrolysis and has proven itself in the Origny plant.

In all these installations, the AAF/Beth pulse jet filter constitutes the heart of the installation. It is an online cleaned filter (which incorporates an optional offline cleaning feature) with online maintenance capability. Integral combined inlet and outlet manifolds, ensure a uniform distribution of the gas and dust to the fully compartmented filter. Flow through individual compartments can be automatically interrupted

during bag cleaning by closing pneumatically operated outlet poppet valves (this feature is optional). In order to isolate a filter compartment to carry out online inspection and maintenance, dampers are also provided at the inlet of each compartment. Dust laden gas is distributed to the filter bags from the hoppers, which act as disengagement chambers for the coarser particles, ensuring simple and positive sealing. The dust deposited on the outside of the bags is dislodged at intervals by brief sharp pulses of compressed air injected into the top of the bags.

The dislodged dust falls by gravity into hoppers beneath the individual compartments and, hence, into the dust transport system. The collector is insulated and heat tracing provided.

The bag material selected will depend on the operating characteristics of the process. Woven glass with PTFE membranes, acrylonilic homopolymer and polyimide bag materials have been successfully applied.

Application of bag filters on coal/petcoke grinding/drying

The risks of fire and explosion are of decisive importance for the

design and operation of fabric filters in the dedusting of coal/pet coke grinding/drying processes.

The special features of bag filters for this application therefore result mainly from safety considerations. Collection of combustible dusts from oxygen containing exhaust gas requires special precautions.

In order for a dust explosion to occur the following 3 conditions must be simultaneously fulfilled:

- Sufficient concentration of combustible dust.
- Sufficiently high oxygen concentration.
- Sufficiently powerful source of ignition.

If one of these three basic conditions is not fulfilled, the combustion process will be unable to develop. Precautions are therefore subdivided into those directed to prevent the occurrence of dust explosions and those for coping with the effects of such explosions.

Following ignition inside a vessel without venting, the rate of pressure rise is rather slow during the first stage. During the second stage, the explosion reaches the maximum rate of pressure rise and leads to the maximum explosion pressure. During the third stage, pressure is dropping slowly.



Left. Compound raw mill and preheater kiln dedusting system and right, coal mill dedusting plant, Cimpor, Portugal.

The following precautions may be taken to cope with the effects of dust explosions:

- Designing the whole plant, or part of it, to withstand the maximum possible explosion pressure.
- Designing for reduced explosion pressure with arrangement for pressure relief.
- Designing for reduced explosion pressure in connection with explosion suppression.

The remaining possibilities to cope with the effects of dust explosions are as follows. Prevention of a combustion process can be achieved by:

- Inertisation with nitrogen or CO₂.
- Exclusion of all sources of ignition.
- Limitation of O₂ concentration in dust/gas mixture <13 vol% plus safety margin during all conditions of operation, including startup and shutdown.

The first possibility is the explosion proof or explosion resistant design. The maximum explosion pressure is in the order of 10 bar, as far as dust explosions are concerned. Vessels designed to withstand an explosion pressure of 10 bar will be of cylindrical design.

An explosion proof casing will resist the maximum explosion pressure without undergoing any permanent deformation, whereas a casing, which is merely explosion resistant, is allowed to undergo deformation but must not rupture. The design calculation of both types follows well established rules.

The second possibility is the design for reduced explosion pressure with venting, including:

- Design casing for a reduced explosion overpressure of 0.4 bar.
- Dimensioning of the necessary relief surface according to VDI 3673.
- Both burst discs and explosion doors can be applied for explosion relief.
- Explosion flaps close after explosion and may be used further.

Table 3. Case study three: Cimpor Souselas. Dedusting kiln and raw mill

Kiln operation	V = 260 000 Nm ³ /h T = 140 °C
Kiln and raw mill operation	V = 260 000 Nm ³ /h T = 160 °C
Emergency cooling tower off	V = 375 000 m ³ /h T = 260 °C
Gas composition	CO ₂ = 27% O ₂ = 7.5% H ₂ O = 15% N ₂ = 50.5%
Type of filter	FabriPulse 10-16-252
Type of bags	Woven glass with PTFE membrane finish
Cleaning mode	Online
Maintenance	Online
Cleaning system	Compressed air with 4.5 bar maximum on demand
dp filter	1300 Pa
Outlet particulate concentration	<10 mg/Nm ³
Startup	June 2000

Table 4. Case Study four: Juracime Ciments. Dedusting of Lepol kiln

Kiln	V = 100 000 m ³ /h T = 110 °C
Type of filter	Bethpuls - BP.6.96.7.7.12
Type of bags	Dolanit needle felt
Cleaning system	Compressed air at 5 bar minimum
Cleaning mode	Online
dp filter	1500 Pa
Outlet particulate	<10 mg/Nm ₃
Startup	April 2001

Provided the casing is of the same mainly cylindrical shape described earlier, the design calculation follows the same well established rules. These rules cannot be applied to vessels of mainly rectangular shape, which have to be submitted to type tests by means of controlled explosions at an official institute. Beth pulse and explosion flaps are DMT Dortmund tested and certified.

Additional safety requirements will include:

- No internal stiffenings of housing walls to prevent dust deposit in filter.
- Oversized dust removal devices to avoid dust storage in hoppers.
- All metallic parts especially cages to be grounded to prevent sparks.
- Explosive relief vents upstream of the filter to prevent transmission of the explosions.

Finally it must be said that up-to-date fabric collectors for the above applications where dust loads reach 400 - 600 gr/m³ do not need preseparators.

Conclusion

The pulse jet fabric filter has proven itself as a reliable collector in the cement industry, not only in dedusting material handling operations but also process gases from kilns, raw mills, clinker coolers and coal/petcoke milling/drying plants.

Stricter regulations and significant progress in fabric medias have made the pulse jet fabric collector a reliable alternative to the ESP. There is a growing tendency to replace existing precipitators on kiln processes by pulse jet fabric collectors.

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