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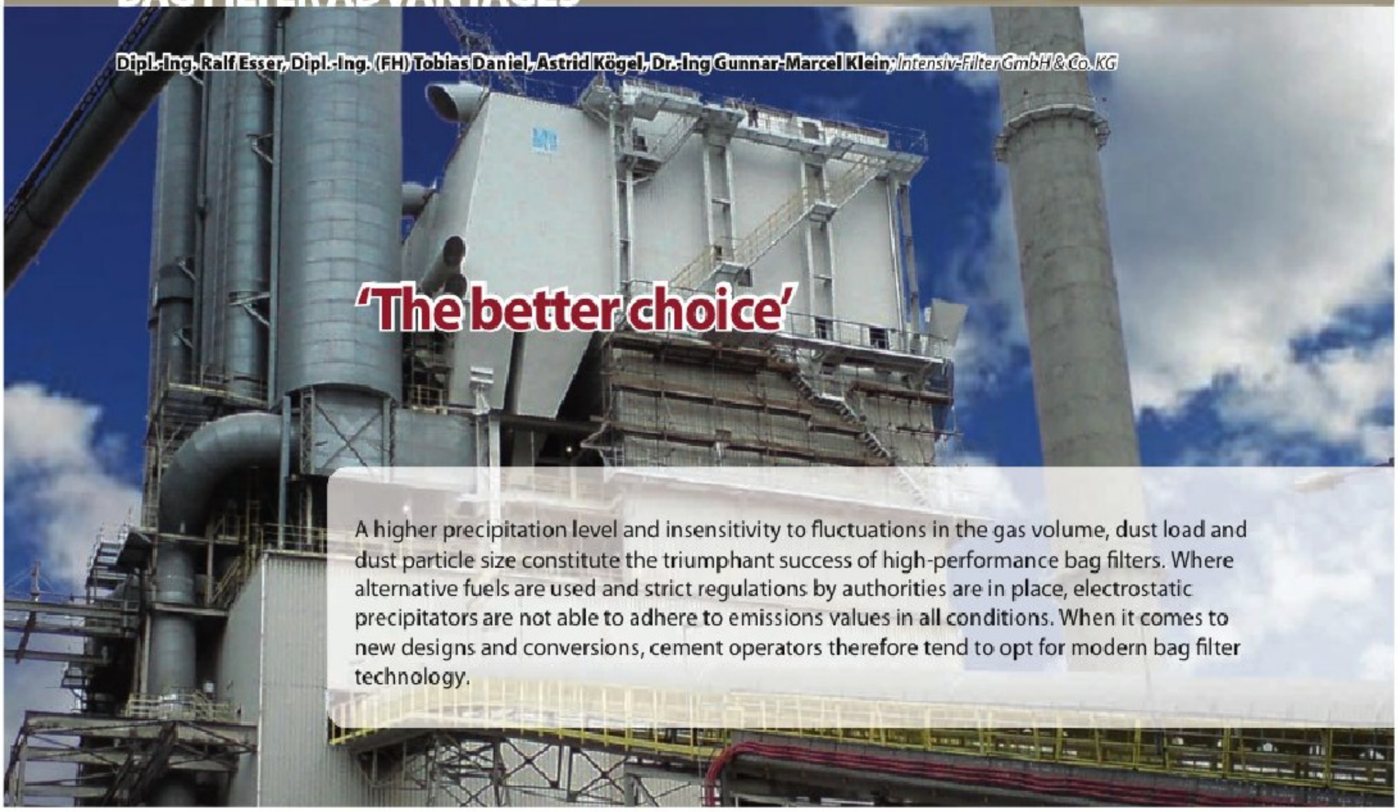


Dipl.-Ing. Ralf Esser, Dipl.-Ing. (FH) Tobias Daniel, Astrid Kögel, Dr.-Ing Gunnar-Marcel Klein, Intensiv-Filter GmbH & Co. KG

'The better choice'

A higher precipitation level and insensitivity to fluctuations in the gas volume, dust load and dust particle size constitute the triumphant success of high-performance bag filters. Where alternative fuels are used and strict regulations by authorities are in place, electrostatic precipitators are not able to adhere to emissions values in all conditions. When it comes to new designs and conversions, cement operators therefore tend to opt for modern bag filter technology.

Bag filters are used when highly concentrated dust-laden gases are to be purified. Their operational characteristics are influenced by numerous system, operating and material parameters. These determining factors are closely interrelated in terms of their effects. Relevant system parameters include the structural design of the filtering installation (number of filter chambers, design of raw gas supply) as well as the structure and operating method of the cleaning system (online, offline or semi-offline cleaning). Operating conditions such as gas volume and temperature also have a decisive influence on filtration and cleaning characteristics. The composition of the gas to be cleaned, its agglomeration properties and reactivity of the dust types to be separated as well as their particle size and the distribution of particle sizes are further factors which need to be taken into account when designing the filtering installation.

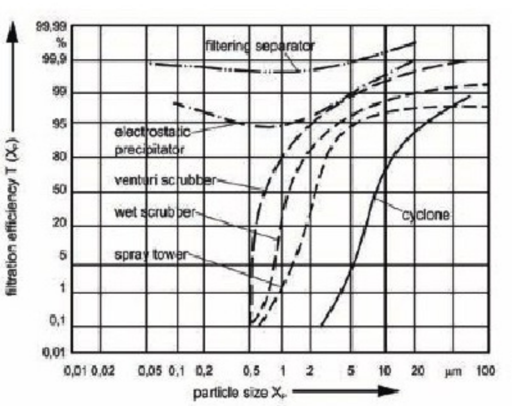
The cleaning effect of bag filters is based on what is known as surface filtration. Due to a variety of effects this leads to the filtering of particles, which are initially contained in the gas, at the filter media. A distinguishing feature of the design of Intensiv-Filter bag filters is characterised by a supply of the raw gas in a cross-flow. The dust-loaded gas enters the filter housing through the raw gas duct, where it hits the distribution plate. Here, pre-precipitation takes place, and the speed of flow is reduced. The raw gas flow is homogenised and channelled in cross flow to the filter bags. After a short time, a filter cake forms on the surface of the filter bags. This acts as the actual separator. With the rising cake thickness, the pressure drop and separation efficiency increase. This makes a periodic cleaning of the filter media necessary. After a specified time or when a certain pressure drop is reached, cleaning (regeneration) is triggered. The deposition of a dust layer improves the filtration effect but leads to an increasing pressure drop at the same time.

Electrostatic precipitators are likewise systems designed for the precipitation of particles from gases, though these are based on the electrostatic principles. Cleaning takes place in four main steps:

- Charging of the dust particles in an electrical

Below and below right: Comparative examination of separation. Graph source: M. Bank, Basiswissen Umwelttechnik.

	Bag Filter	Electrostatic Precipitator
Clean gas dust load	< 20 mg/m3	> 30 mg/m3
Pressure drop	500 – 1.500 Pa	300 Pa
Air to Cloth ratio	50 - 80 m^3/m^2h	n. a.
Dedusting efficiency	>99 %	95 – 99 %



field;
- Transport of the charged dust particles to the collecting electrode;
- Caking and layer-forming on the collecting electrode;
- Removal of the dust layer from the collecting electrode.

In comparison to electrostatic precipitators, the benefits of bag filters are numerous:
- Greater consistency and less residual dust content, especially when using secondary fuels to comply with the requirements of authorities;
- Efficiency of bag filters is not dependent on changing operating parameters;
- Dust precipitation is not determined by water content or gas properties;
- No CO deactivation for kiln dedusting filters;
- Online maintenance capabilities;
- Simple access from the clean-gas-side.

Besides the above benefits, converting ESPs into bag filters bring further advantages for cement manufacturers:
- Outlay for a conversion is considerably less than for the cost of a new installation;
- Upgrade time is reduced considerably by filter heads with variable filter head sizes and can be carried out during scheduled downtime;
- Filter bags of 8m (and longer) enable existing electrostatic filter housings to be used without increase of the floor space.

Upgrade concepts

The superior technology of bag filters has long since cancelled out the benefits of electrostatic precipitators. In particular, electrostatic precipitators cannot adhere to current dust emissions guidelines, which will become even stricter in the future. There is therefore huge interest on the part of plant operators in upgrading electrostatic precipitation systems to bag filter systems. Intensiv-Filter has proven, in a series of successful installations, that upgrades to bag filters conform to the expectations of operators while significantly undercutting emissions guidance values. The Intensiv-Filter concept is presented below and can be used to convert almost all electrostatic precipitators to bag filter installations. A typical upgrade comprises several steps:
- The internal ESP components are removed until just the exterior walls remain;
- Head plates are removed and baffles, filter head modules, compartments are installed;
- Modification work takes place on duct work and on the dust discharge system, if necessary;
- Maintenance doors, gangways and ladders are installed;
- Filter elements are installed;
- Cleaning system is installed.

With conversion concepts, the question often arises as to whether the new clean gas area is to be placed in the existing electrostatic filter housing or on it. This decision is linked with the quantity of gas to be filtered, the size of the existing electrostatic precipitator system and the maximum length of the filter bags. The amount of time needed, like the whole upgrade project, varies according to each individual situation. On several occasions, Intensiv-Filter has performed conversions during regular winter shutdown time and, generally speaking, the new bag filter has been commissioned after six weeks assembly work in total.

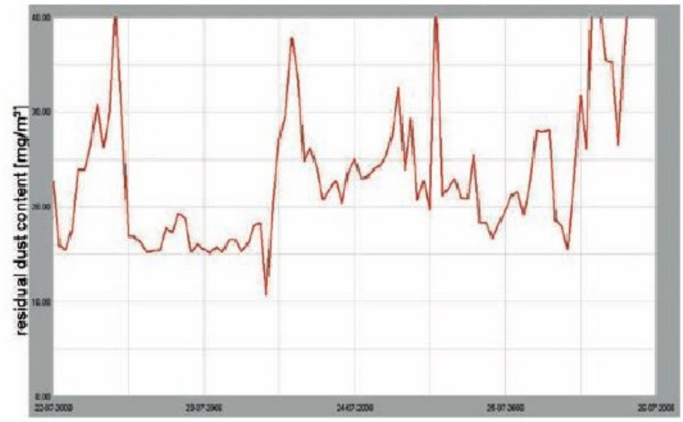
Practical experience at a cement plant in Poland

A typical project was the conversion of an electrostatic precipitator at a plant belonging to the Dyckerhoff Group in Nowiny, Poland. The Dyckerhoff Group, part of the Italian Buzzi Unicem Group, has been operating in Poland since 1996. Among other plants, the group operates a cement plant for the manufacture of Portland cement in Nowiny. In 2008, the local production capacity was 1.6Mt of cement. In order to modernise the cement plant at the Nowiny site, Dyckerhoff has invested in progressive technologies and global production standards.

As had already happened at several of the Dyckerhoff Group's production sites in Germany also, the electrostatic precipitators for kiln- / raw mill lines I and II were replaced with efficient Intensiv-Filter bag filters at the plant in Nowiny. Firstly the electrostatic precipitator technology previously in place was no longer able to comply with current emission limit values. Secondly, the goal was to exploit the benefits of bag filter systems, which is the dominant technology these days.

The dedusting of the kiln exhaust gases of two raw mills was previously carried out by two electrostatic precipitators. With emissions values of more than 50 mg/m^3 n.c. at peak, the performance threshold of the electrostatic precipitators had been reached. Current emission limit values could not be adhered to and no

Below: After successful commissioning of the Nowiny plant's newly converted bag house, April 2009.



Above: Residual dust content from the old ESP.

further increases in volumetric flow were possible. Increases in capacity were also impossible with the existing technology, making an upgrade imperative.

The project

Due to its many years of expertise in the area of dust removal, Intensiv-Filter was presented with the task of devising a suitable solution. In 2003 Dyckerhoff Polska – at that point still known as Cementownia Nowiny – commissioned Intensiv-Filter with the upgrade. The first step was conversion of the electrostatic precipitator for raw meal mill line II. This was finished and commissioned by 2005. When the contract was awarded for converting line II, the operator also made an agreement with Intensiv-Filter to upgrade kiln line I. Changeover to the new filter for line I took place in mid-2009.

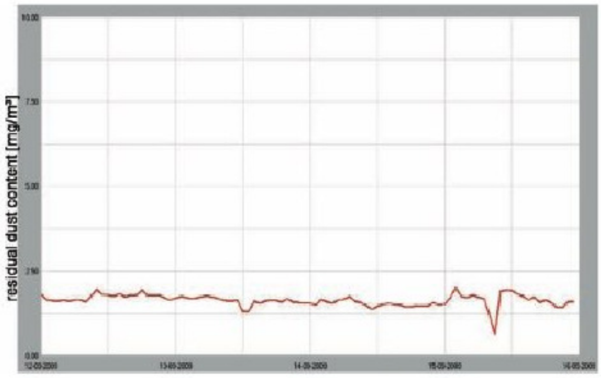
Line II: Since the existing gas conditioning tower could maintain an operating temperature of 120°C, high-temperature-resistant filter materials were not necessary and a tried and tested polyester/polyacrylnitrile material was chosen. To protect the filter material from possible damage due to temperatures resulting from operating malfunctions prior to the bag filter, a decision was made to use additional air dilution dampers. This ensured a safe temperature within the filtering installation.

Line I: The down-time for this project was 10 weeks – two weeks for the removal of the inner components and eight weeks for the actual conversion. The scheduled implementation was from January to March 2009. The technical requirements of the rotary kiln/raw mill line II formed the basis for the second dust removal installation. However, due to the success of the 7m and 8m bags in operation in cement plants at Geseke and Deuna respectively, also part of the Dyckerhoff Group, the bag length was modified to this size here too. This enabled cleaning for line I to be even further enhanced. As with line II, the design was laid out for an operating temperature of 120°C, which was likewise achieved by the existing gas conditioning towers. In this case too, there was no need for high-temperature resistant filter media. In addition to this change compared to the first implemented retrofit, the ducting was enlarged, fresh air cooling expanded and the capacity of the ventilator increased. The housing of the electrostatic precipitator, the dust transport system and bunker were integrated into the bag filter. Therefore considerable savings on conversion costs could be achieved.

The diagram of the residual dust content of the old electrostatic precipitator (from 2008) and the new bag filter (2009), seen right, shows the different values once again very clearly. At its peak, the residual dust content of the ESP was well above $50mg/m^3$. A graph of emissions from the new bag filter (below) shows that it has

Right: Design data for Line II.

Dust removal kiln- / raw mill line II Retrofit 2005	
Original ESP	Elwo (licensed construction of Lurgi, BS 672)
Intensiv-Filter bag filter	IFJEN 85/18-6000 DKS
Needed time for conversion	7 weeks
Gas volume	≤ 270,000 m3/h
Temperature	≤ 120 °C
Raw gas dust content	40 g/m3
Guaranteed residual dust content	≤ 10 mg/m3 n.c.
cleaning mode	offline
Cleaning pressure	~ 0.3 Ma
Compressed air consumption	54 m3/h n.c.
Filter surface area	~4,800 m2
Length filter bags	6,000 mm
Filter material	PAN
Pressure loss	13 hPa



Right: Residual dust content from the new Intensiv-Filter bag filter.

Right: Design data for Line I.

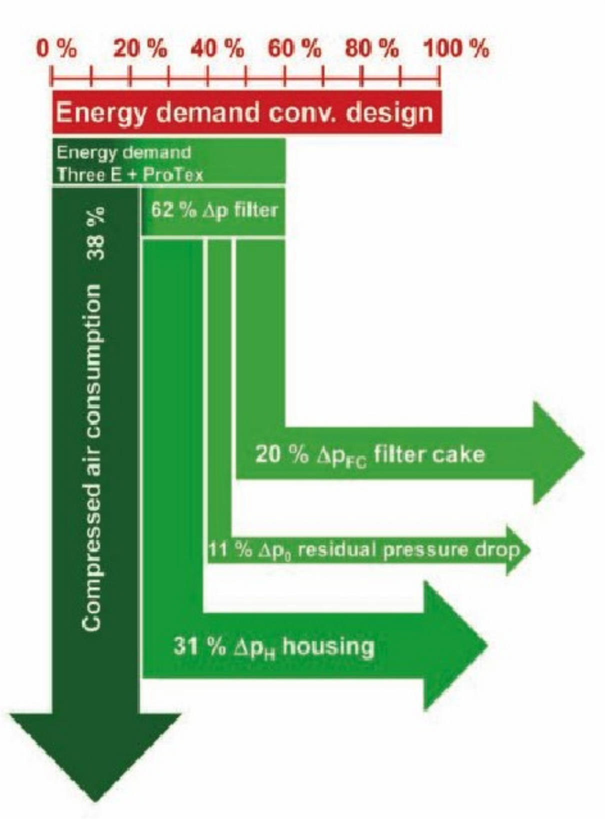
Dust removal kiln- / raw mill line I Retrofit 2009	
Original ESP	Elwo (licensed construction of Lurgi, BS 672)
Intensiv-Filter bag filter	IFJCN 85/18-8000 DKS
Needed time for conversion	10 weeks
Gas volume	≤ 430,000 m^3/h
Temperature	≤ 120 °C
Raw gas dust content	40 g/m^3
Guaranteed residual dust content	≤ 10 mg/m^3 n.c.
cleaning mode	offline
Cleaning pressure	~ 0.3 Ma
Compressed air consumption	72 m^3/h n.c.
Filter surface area	~ 6,400 m^2
Length filter bags	8,000 mm
Filter material	PAN
Pressure loss	6,2 hPa

a residual dust content of 1.5mg/m^3 on average - well below the contractually guaranteed value of 10mg/m.

Future prospects

Essentially, the aim of filter systems is always to combine high filtration effectiveness and reliability with low maintenance demands and operating costs. In doing so, a key role is played by the filter media as these have a decisive influence on the operation of the system - both with regard to compliance with legal limit values and energy costs. The pressure drop of the filter medium and the deposited filter cake makes by far the greatest contribution to the energy costs caused by running the filtering installation. For this reason, Intensiv-Filter places great emphasis on the new development of its own, cost-reducing filter media to reduce these portions of the flow resistance. The new ProTex filter media are the result of its development work. Concentrating on filter media - having perfected injector system, cleaning control system and offline operation in preceding years - has therefore been a logical, future-oriented step.

The aim in developing ProTex was not only to improve the filtration characteristics, but particularly realise the possible savings of energy costs. The functioning of ProTex has been validated in tests and can rightly be described as a development that will contribute to increased energy efficiency in the long term. The graphic on the right shows the energy flow of a ProJet mega® filter with ProTex filter media using Three E technology (optimum cleaning control) in online mode. A comparison of the operating costs of conventional filtering installations with the new developments described in this article, ProJet mega® in offline mode and ProJet mega® with ProTex filter media using Three E in online mode (below), highlights the economic relevance of the new technology. The new filter technology is currently being rolled out in series applications. At the same time, we are working on expanding the portfolio of Intensiv-Filter ProTex filter media to include high-temperature applications.



Conclusion

Upgrade of electrostatic precipitators to bag filters will continue to be a topic for plant operators and filter solution providers. Intensiv-Filter conversion concepts in combination with the latest developments in the field of improved filter media (ProTex) and energy conservation technology (Three E) emphasise the benefits of bag filters – without huge investments or overly long downtime but with improved energy efficiency. It is therefore correct to say that today, the often-cited benefits about lower operating costs for electrostatic precipitators are a thing of the past.

Above: Energy flow diagram for ProJet mega® with ProTex filter media using Three E technology in online mode

Below left: Comparison of the operating costs and savings potential of different systems.