

**EXPERIENCES IN BAG HOUSE APPLICATIONS AFTER
COAL FIRED BOILERS**

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ABSTRACT

BWF Envirotec is the world-wide technology leader in industrial dedusting with textile filter materials based on synthetic fibers and scrims. The delivery program comprises a wide range of ready-made filter media, accessories for dust collectors as well as on-site installing and replacements. BWF Envirotec also offers services, such as filter media recommendations, laboratory analysis of filter media and dusts and the simulation of complex dust removal processes.

BWF Envirotec filter bags have successfully been applied in numerous power plants. In recent years, there has been an increasing demand because more and more electrostatic precipitators at power plants are replaced by bag houses. Reasons for this are stricter emission laws and the high effectiveness of these systems but also - especially in Europe - because of the necessity to install desulphurization systems in order to control the output on SO₂.

This means that bag filters in power plants are used to separate dust and where applicable to neutralize harmful acid gases. Here, combustion residue and any harmful substances contained in the additives are separated on the surface of the filter bag, so the filter material is exposed to heavy mechanical, chemical and thermal stress. Consequently, the choice of the appropriate filter medium is of major importance in these applications.

In the last decade, BWF Envirotec installed more than 1 Mio m² of filter media for the dedusting of power plants. Our comprehensive experiences in filtration with textile filter bags, as well as some case histories will be presented to the auditors of this conference.

TEXTILE BAG FILTERS

Textile bag filters are usually made from synthetic fibers and scrims. The supporting scrim gives high mechanical strength to the filter media and also plays an important role in the control of emissions.



Figure 1: Cross-section of a textile filter medium

Each fiber and each scrim type possesses unique thermal, physical and chemical characteristics which have an important influence on the efficiency and life-time of the filter medium. At the same time, the possibilities to combine these different fiber and scrim types to a filter medium are almost unlimited. The selection of the most suitable combination primarily depends on the application, but also on economical aspects. Over the past years, the following textile bag filters have proved their suitability in power plants.

Type of Fibre	Temperature Cont / Peak [°C]	BWF designation	Hydrolysis-resistance	Acid-resistance	Alkali-resistance	Oxidation resistance
PAN homopolymer	125 / 140	DT	good	good	moderate	good
Polyimide-PAN	125 / 140	PI-DT	good	good	moderate	good
Polyphenylene Sulfide	190 / 200	PPS	excellent	excellent	excellent	moderate
Polyimide	240 / 260	PI	good	moderate	moderate	good

Figure 2: Thermal and chemical resistance of fibers

Technical data sheets usually mention continuous operating temperatures and peak temperatures according to the above table. However, these specifications represent the max. possible limits under ideal laboratory conditions and have to be seen as characteristic values for the fibers. In real operation, chemical reactions with harmful flue gas components or the dust force to use all non-inerted textile filter media at much lower temperatures.

BRIEF INTRODUCTION OF THE FIBER POLYMERS AND FINISHES

Polyacrylonitrile Homopolymer (PAN)

Profile

In its temperature field, the PAN fiber shows a good chemical resistance against acids and alkalis, as well as hydrolysis. However, chemical impacts by hydrolysis and oxidation (by NO₂) have to be taken into consideration for temperature levels above 100°C and relatively high contents of H₂O.

Mechanical Impacts

PAN is a mechanically weak fiber. Therefore, it is sensitive against strong mechanical and physical impacts which result from high dust loading, a/c ratio and abrasive dust characteristics.

Polyphenylene Sulfide (PPS)

Profile

Since PPS suffers oxidation, it is important to define not only the continuous temperature, but also temperature peaks. Excess temperature can also start a thermal oxidation process. Based on a given flue gas composition first the max. allowable continuous temperature has to be defined. Secondly possible peak and emergency temperatures have to be taken into consideration. It is essential not only to quantify the peak value but also the duration and the number of peaks to evaluate the total thermal impact on the filter medium.

O₂ Content

Ambient air contains 21 % Vol. of oxygen. However the chemical reaction is slow at room temperature and can not really harm PPS. As soon as the temperature exceeds 100°C, PPS can only stand a reduced oxygen level.

NO₂ Content

Whenever air is used for incineration, the formation of NO and NO₂ takes place. NO₂ is known as an aggressive oxidizing gas and has to be considered.

Polyimide (P84)

Profile

Under moderate chemical conditions, P84 shows a good separation efficiency due to its multilobal fiber structure. As P84 is sensitive against strong acidic and alkaline environment as well as against ZnCl₂, the operation above the dew point is strongly recommended. The operation below the dew point expedites the chemical degradation of the filter medium .

Hydrolysis

For P84, hydrolysis has to be considered when a temperature of 140 °C is exceeded. As a general rule, it increases with the vapour content, but much more with rising temperature. In order to slow down this effect, the filter medium can be treated with a chemical impregnation.

NO₂ Content

The oxidation of the fiber polymers takes place in the presence of oxidizing gases, especially NO₂, which is known to be very reactive. NO₂ is generated from fuel, raw material and combustion air, when high temperatures of 1300 - 1400°C split nitrogen molecules.

Surface and Protective Finishes for Filter Media Used at Power Plant Bag Houses

Very often, textile filter media are additionally treated with a surface and/or protective finish in order to optimize the cleaning performance and to prolong the life-time.

CHEMICAL INFLUENCES ON THE EFFECTIVENESS OF BAG FILTERS

Before the fiber polymers, scrims and finishes are individually matched to the requirements of the application., it is important to consider the design of the bag house, the dust character and the gas compound. In this case, we only focus on the gas compound as this is the decisive criteria for the effectiveness of the textile filter medium.

Treatment	Dust		Fine	Humid	Sticky	Acid Alkaline
	Low Agglomeration	High Agglomeration				
Code 1 Singed Surface	Blue shaded					
Code 4 Glazed Surface		Blue shaded				
CS17 [®] Oil & Water Repellency				Blue shaded		
CS18 [®] PTFE Surface Coating					Blue shaded	
CS29 [®] Chemical Protection				Blue shaded		Blue shaded
MPS [®] Micro Pore Size			Blue shaded			

Figure 3: Surface and protective finishes for different kinds of dust

Sulfur Content of Combustibles

The most combustibles contain sulfur in a certain amount. Whereas the sulfur content in natural gas is almost negligible, heavy fuel oil (Bunker C) can cause severe corrosion of the dust collector and chemical deterioration of the filter bags, when no flue gas desulphurization exists. As a general rule, a sulfur content of 1% by weight in the coal, forms approx.600 pap. of SO₂ in the flue gas.

Acid Dew Point Temperature

To make things even more complicated, a part of the SO₂ in the flue gas reacts with excessive oxygen to SO₃. SO₃ readily absorbs water, forming sulfuric acid. The consequence is an acidic attack to the filter bags and heavy corrosion of all metal parts. Therefore it is very important to keep the dust collector inlet temperature always 25 K above the acid dew point temperature, to avoid the formation of euphoric acid.

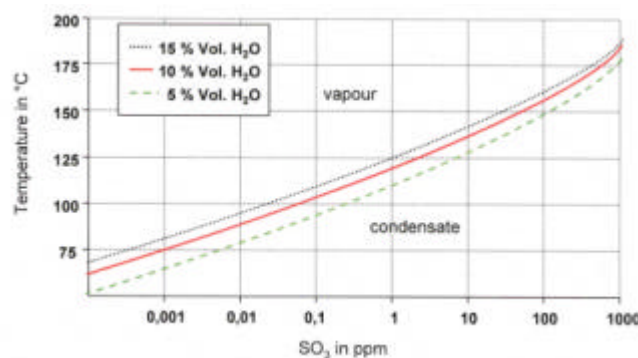


Figure 4: Development of the acid dew point

NOx Content

During combustion nitrogen included in the combustible is transformed to NOx (fuel NOx).In the most cases ambient air is used for combustion. Ambient air consists of 21 % of oxygen and 79 % of nitrogen by volume. At low temperatures nitrogen is stable and does not react. At high temperatures, however, the nitrogen molecules split. It then starts to combine with

oxygen to NO and NO₂. While NO does not have to be considered, NO₂ acts oxidizing and can cause oxidation of the most textile fibers used in filtration.

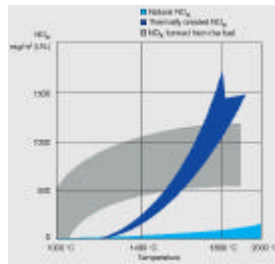


Figure 5: Development of the NOx content

TEXTILE MEDIA AND ITS SUCCESSFUL APPLICATION IN POWER PLANTS

Grate Firing

Grate firing is mainly installed in industrial steam generators or in small power plants. The type used most frequently is the traveling grate with hopper feed. One characteristic of grate firing is that the combustion air is fed in from below through a layer of coarse coal. In order to complete combustion, excess air is required, which in turn causes an increased formation of soot and concentration of SO₃. The very fine particles of soot can therefore bond together considerable quantities of SO₃, which causes a reaction in form of sulphuric acid, should the gas stream drop below the acid dew point. Without flue gas desulphurization, only filter bags made from PTFE are suitable, particularly as some small power plants operate with weekly shut-downs. In case of lower SO₂ contents (e.g. by FGD) also PI filter media can be used. In order to make the procedure for cleaning the filter bags more effective, a coating of the surface of the bags with PTFE is recommended, e.g. BWF Envirotec's protective finish CS30[®] (a PTFE based anti-adhesive finish). With such a high quality filter medium, a service life of more than 6 years can be normally achieved, which is often only brought to an end as a result of mechanical damage such as corroded or broken cages.

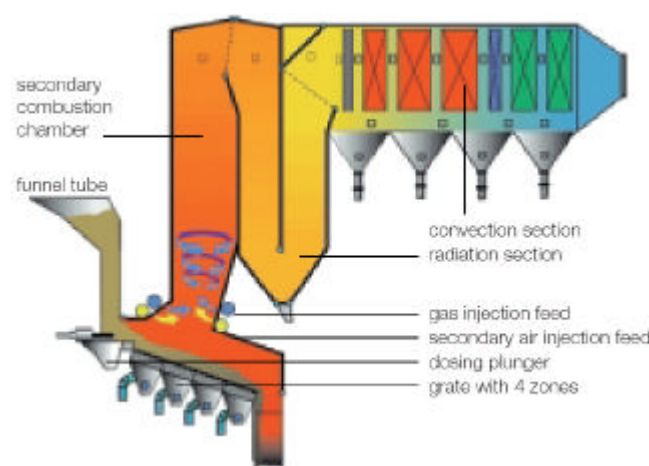


Figure 6: Schematic process diagram of grate firing

Grate Firing ^(Ref. No. 1714) – Ref. 1

Location:	Czech Republic
Combustible:	Lignite Coal
Dust Source:	Grate stoker firing
Air to cloth ratio:	0.98 (m ³ /(m ² *min))
Type:	Pulse-Jet
On/Off-line:	on-line
Filter medium (needlona [®]):	PI/GL 751 CS30
Description:	P84 on glass scrim with PTFE surface coating
Quantity:	800 pcs.
Filter area:	1,352 m ²
Gas volume:	49,989 Nm ³ /h
Temperature:	160°C cont., 180°C peak
Service life:	approx. 50 months

Fluidized Bed Combustion

Fluidized bed firing systems are subdivided into stationary fluidized bed, where the combustion air flowing into the reactor from below, dilutes the sand bed and coal into a suspended fluid state circulating fluidized bed, which discharges a large volume of particles out of the reactor along with the flue gas. The particles are then separated in a cyclone and returned to the reactor. The intense exchange of heat and material increases the efficiency. All fluidized bed firing systems allow the lime to be injected directly into the combustion chamber, resulting in a SO₂ reduction of up to 90%. The comparatively low combustion temperature produces less thermal NO_x as compared to other types of firing. As a result of the acceptable concentrations of O₂ and NO₂ in the flue gas, there is only slight oxidation of the filter medium. Because of its positive price/performance ratio, filter media made from PPS are the best solution available for the dust removal in fluidized bed systems. With an adequate lime feed directly into the combustion chamber, a service life of more than 4 years can be achieved.

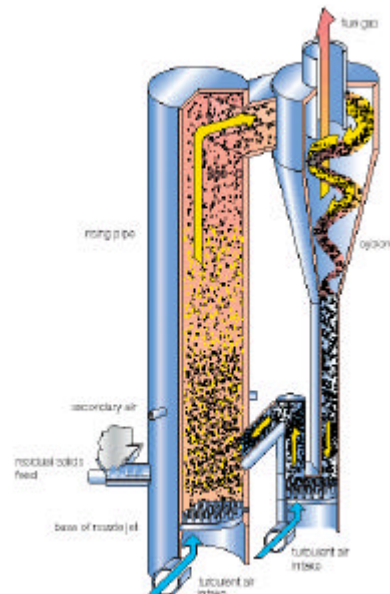


Figure 7: Schematic process diagram of a fluidized bed combustion

Fluidized Bed Combustion ^(Ref. No. 835) – Ref. 1

Location:	Germany
Combustible:	Hard Coal
Dust Source:	Semi dry injection
Air to Cloth Ratio:	1.11 (m ³ /(m ² *min))
Type:	Pulse jet
On/Off-line:	on-line
Filter medium (needlona [®]):	PPS/PPS 554 CS18
Description:	100% PPS filter medium treated with a microporous PTFE foam coating
Quantity:	3,808 pcs.
Filter area:	10,470 m ²
Gas volume:	573,248 Nm ³ /h
Temperature:	60°C cont., 156°C peak
Service life:	First set installed beginning of 1994 Service life at least six years, gradual replacement beginning mid of 2000
Emission specified:	35 mg/Nm ³

Pulverized Coal Firing

Pulverized coal firing systems are mainly designed today as **dry firing**. With this system, fine coal dust is fed directly into the combustion chamber. The particles of coal burn out in suspended state, but without reaching the ash fusing point. As a result, considerable amounts of the fuel ash components get into the flue gas. Because of the irregular shape of the particles, they tend mostly to agglomerate.

Melt firing systems reach temperatures of 1600°C when burning and cause the fuel ash to melt completely. In cooler zones, the melted particles of ash solidify into spherical, glassy small pieces, which are practically free of carbon. The extremely fine distribution of particle size and the slight tendency to agglomeration create a real challenge for the filter medium. Filter media in the MPS range (made from micro fibers) are therefore used for these applications. They achieve surface separation of the finest particles due to their defined distribution of pore sizes. One would expect a critical concentration of NO₂ in the flue gas with the high combustion temperature. However, as the flue gas contains a proportionately low amount of SO₃, a filter medium made from Polyacrylonitrile (PAN), Polyphenylene Sulfide (PPS) or Polyimide (PI) fibers can be installed after a careful consideration of the operating temperature and the oxidation potential. In many application, an additional top layer of P84 fibers can achieve a higher filter surface in order to further optimize filtration performance combined with an improved pressure drop behavior.

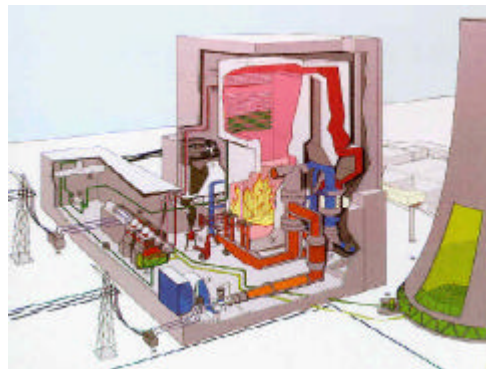


Figure 8: Schematic process diagram of pulverized coal firing

Pulverized Coal Firing – Ref. 1

Location: South Africa
Combustible: Hard Coal
Dust Source: Pulverized Coal Firing
Type: Pulse Jet
On/Off-line: on-line
Temperature: 100°C cont., 130°C peak.
Warranty specified: 48 months full
Emission: 50 mg/Nm³ related to 21,0% Vol. oxygen

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6
Filter Medium	PI-RI/RI 581	PI-RI/RI 581	PI-RI/RI 581	PI-RI/RI 581	PI-RI/RI 581	PI-RI/RI 581
Quantity (pcs.)	15.500	15.500	32.540	15.500	15.500	15.500
Filter Area (m ²)	50.000	50.000	100.000	50.000	50.000	50.000
Gas Volume (Nm ³)	4.723.200	4.723.200	4.723.200	4.723.200	4.723.200	4.723.200
Air to Cloth Ratio m ³ /(m ² *min)	1,08 - 1,26	1,08 - 1,26	1,08 - 1,26	1,08 - 1,26	1,08 - 1,26	1,08 - 1,26