



An effective flue gas treatment system is vital to the operation of a clean and efficient waste-to-energy plant, as the correct function of this system guarantees that all relevant emissions are below the legal limits. Here, Günter Gasparin guides us through the elements of such a system ...



Filtering flue gas

P84

The flue gas treatment system is an integral and crucial component of a modern municipal waste incineration plant. A malfunction would lead to increased emissions and the public have proved, on many occasions, to be very sensitive to such issues. Today's state-of-the-art technology in flue gas treatment covers the absorption of acidic components such as HCl, HF and SO_x and the removal of dioxins, furans and heavy metals by adsorption.

The filtration of dust particles is also part of this process, and no other apparatus is able to deal more efficiently with this issue than a bag filter. The bag filter elements are mechanical barriers for the dust and so they ensure the lowest possible emissions. This is highly efficient when compared to the performance of other technologies, such as an electrostatic precipitator which relies on the physical properties of the dust. Here, we explain the background for the processes on the filter media as this is the key component for a reliable de-dusting system.

Process schemes of flue gas treatment systems

The classic design for a flue gas treatment system for a waste incineration plant would use a two-stage 'wet scrubbing' system as a core component. Two filter units are necessary to make up the wet scrubbing system. The first filter unit is used to reduce the amount of fly ash at the front of the scrubbing system to an acceptable amount. The next step is the scrubbing system itself.

The following process step is dealing with dioxins, furans and heavy metals. This is done by injecting activated carbon or similar products into the flue gas. As these are usually fine dust particles they have to be collected by using a bag filter unit again. Although this system is known to be the most efficient one with respect to

achievable emissions it is also the most complicated and requires a high input of energy.

So as an alternative, semi-dry and sometimes conditioned dry sorption systems (see Figures 1 & 2, on page 24) have proven they are able to fulfil the demand of flue gas treatment systems in the same way as the wet scrubbing system described above, it is a two-stage absorption process. The removal of acidic components in the flue gas is done, by injection of hydrated lime or a similar product in the flue gas, in reactors of various shapes. There are simply-designed ones, such as an injection point in the flue gas pipe, and much more sophisticated ones – such as atomizers or fluidized bed reactors.

The second stage in these processes is the collection of the solid products in a filter unit. Investigations have shown a certain amount of the chemical reactions that take place happen in the dust layer that builds up on the filter fabric called the filter cake, so the filter media is, of course, a key component. The performance of the filter media influences the function of the entire plant, as it is the only barrier for solid particles in the gas stream. A malfunction of the filter unit will result in high emissions or an increased pressure drop.

Filtration and absorption in a one process step

To explain the function of the filter material one has to focus on some specific locations in the flue gas treatment system. At the injection point (e.g. for hydrated lime) the particles are accelerated by the flue gas. During this acceleration the absorption rate is high. This increases the speed of neutralization reactions. Depending on turbulence the rate of reaction can go back until the particle ends up in the filter cake of the filter media. There it forms a kind of fixed bed reactor, and again the rate of reaction is increased as the entire gas flow is forced to pass this fixed bed of reactive particles.



Figure 1. Flow sheet of a semi dry sorption system

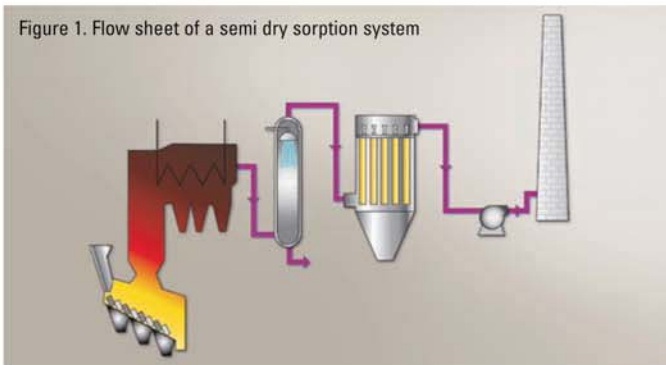
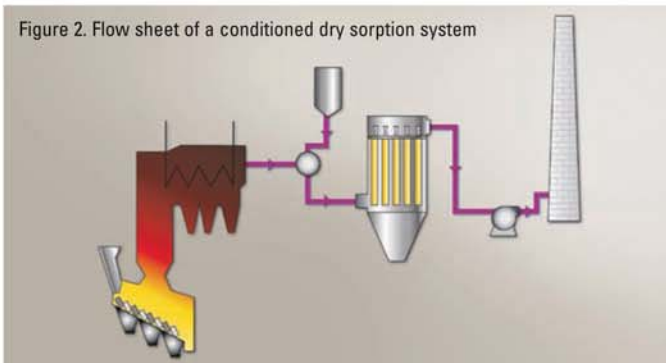


Figure 2. Flow sheet of a conditioned dry sorption system



By using a mixture of hydrated lime and activated carbon, not just absorption but also removal of dioxins, furans and heavy metals by adsorption takes place on the filter media. The bag material is the crucial component for efficiency.

The forming of a homogenous and porous dust layer – the

filter cake – is essential for an effective chemical reaction at the filter media which is offering an even and high gas flow in this area. This is eased by using a needle felt, as a part of the dust cake settles on the felt permanently. This initial dust layer increases the specific surface area enormously and ensures the collection of particles by forming a porous cake during the filtration cycle.

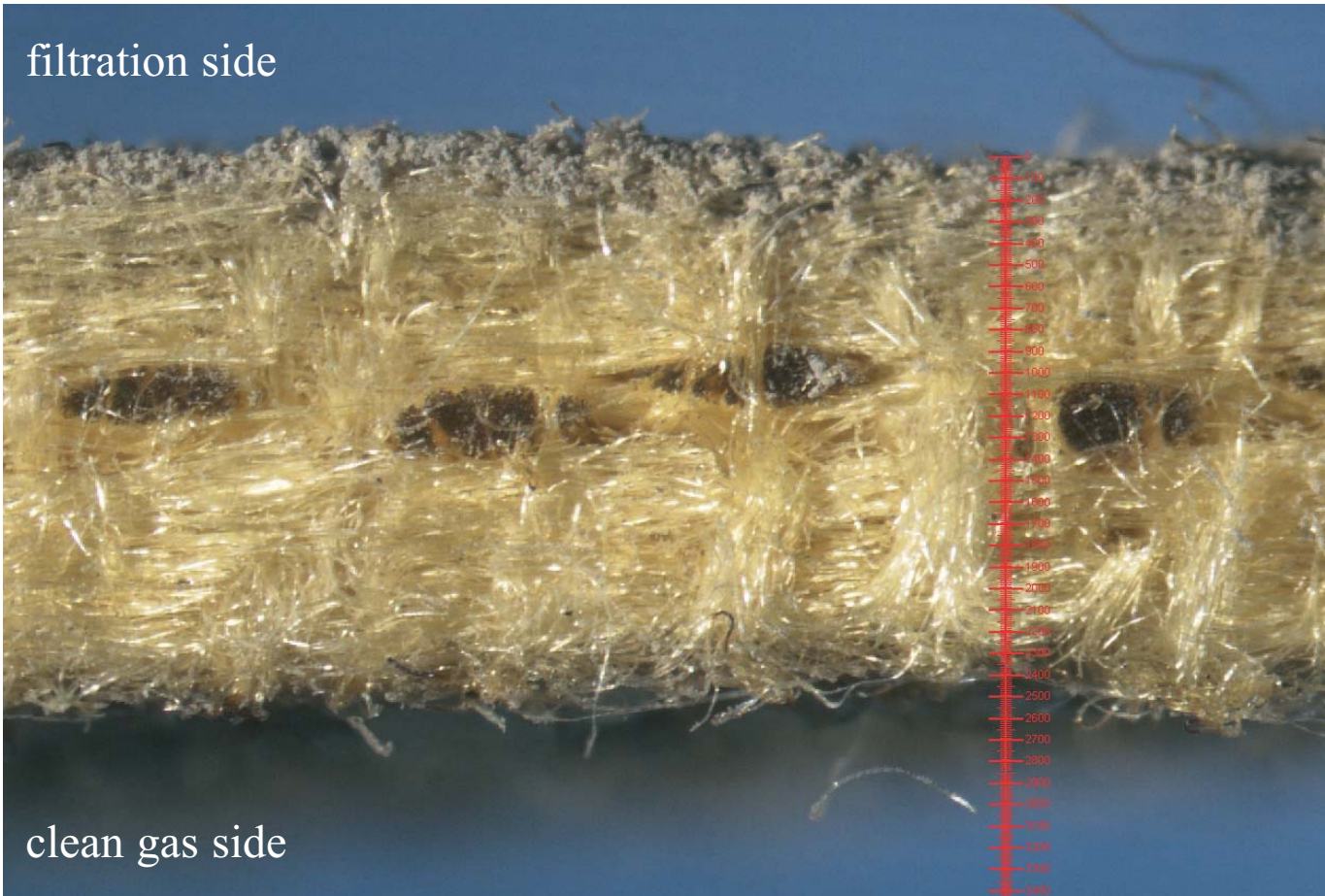
Needle felt-based filter media

Modern filter media are based on a three-layer construction. The basic components – the single fibres – are densified by a needling process. The filtration side is the one in contact with the dust. A woven fabric – the scrim in the middle of the felt ensures the dimensional stability of it. The clean gas side, again a densified fleece layer of single fibres, protects the unit from abrasion due to its contact with the cages during the pulse jet cleaning of the filter unit.

In the past, filter fabrics were designed as depth filter media allowing the dust to penetrate deeply into the construction. Modern constructions are designed to keep the dust layer on, or close to, the surface. This keeps pressure drop and emissions on low levels and ensures a steady operation over the years.

New developments in recent times also include the processing of micro fibres. This offers the additional benefit of even higher specific surface area, and therefore better filtration performance.

The traditional base material for filter media in waste incineration plants is PTFE. It is chosen because of its chemical and thermal stability. The drawback of a PTFE material is the low adhesion coefficient which is of great importance in the collection of particles. Furthermore, this leads to an increased penetration of dust into the structure of the felt material.



Superior surface oriented dust separation



This can be avoided best by using P84 polyimide fibres as base material for the filter media.

The unique cross section which has several lobes offers a high specific surface area. Particles can adhere to this surface easily and form the initial dust layer which helps to collect the particles during the filtration cycle. As dust penetration into the depth of the felt is avoided the overall resistance of the filter media and the cake is minimized which is necessary for long filtration cycles and a moderate and stable pressure drop.

Traditionally, P84 was used in filter units of conditioned dry and semi-dry sorption systems. A further increase of efficiency in the filtration performance is achieved by the use of P84 fine fibres. The specific surface area can be increased from 128 m²/m² for a standard felt to 164 m²/m² for a fine fibre felt construction (see Figure 3).

But even if PTFE was required from the chemical environment the blending of P84 to the PTFE-based felt material helps to increase the filtration performance of the fabric.

Whereas in Germany a two-stage wet scrubbing system was state-of-the-art for a long time, the tendency to use simpler systems on semi-dry scrubbing or conditioned dry scrubbing was followed in France and the UK. Compared to a wet scrubbing system the filter unit in the other systems is an integral apparatus for scrubbing in combination with particle collection. Especially for these systems, P84 turned out to be the superior base material for the filter media. The chemical environment does not require the use of a PTFE and so the filtration efficiency of felt and fibre are the key factors.

One example of a plant which has a long history of P84 based filter bags, is the WTE plant in Thumaide, Belgium. In 1995 the old electrostatic precipitators were replaced by bag filters and P84 was

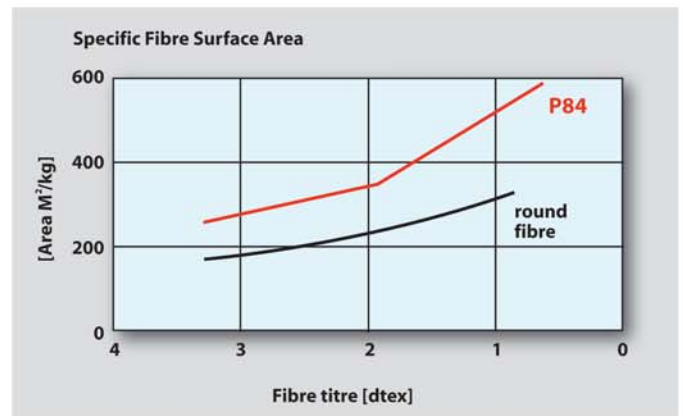


Figure 3: Specific surface area of various fibre cross sections

chosen as base material for the filter bags. During the next plant extension in 2000 two new furnaces were added and the flue gas treatment system had to be upgraded. So, a new filter unit was added to handle the increased flue gas volumes. Again, P84 was selected to be the material for the filter bags.

Due to the long and positive history of this material, P84 based filter bags were also chosen for the now ongoing plant extension with new furnaces and filter units.

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■ This article is on-line. Please visit www.waste-management-world.com



P84 filter bag

Convincing facts - P84 references

Superior performance in waste incinerators.



P84 for filter fabrics:

P84 polyimide fibres allow maximum flexibility whether burning household waste or industrial waste. Filter bags out of P84 will give you long service life and low maintenance cost for many years.

Filtration efficiency:

The unique multilobal profile of P84 fibres provides a larger specific surface area and smaller voids, ensuring that even fine particles will be collected. The extremely high surface area prevents particles from penetrating the felt, resulting in low pressure drop during the entire bag life.

High temperature resistance:

P84 polyimide fibres can withstand peak temperatures up to 260 °C without losing their physical integrity, they don't burn or melt and are capable of withstanding a wide pH range. Installations around the globe are proof of its success.

More successful installations under www.P84.com



P84 fibre cross section



Illustration of a P84 needle felt



View inside a P84 based filter bag



Municipal waste incineration Belgium



Municipal waste incineration Great Britain



Municipal waste incineration Taiwan

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