Filter media savings

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The filter medium takes over the physical job of the gas – solid – separation and must show (apart from the necessary high dust retention) a suitable mechanical, thermal and chemical resistance. This article describes the saving potential for filter media, which are considered to be at the heart of a modern kiln or cooler filter installation.

Filter media are a sensitive component made up of fine synthetic fibres. Depending on the area of operation, they are exposed to different temperatures, neutral, dry, humid or chemically aggressive gases, fine or coarse dust with different material qualities or abrasive dust. Temperature, humidity and chemical composition of the gas to be cleaned, as well as the dust qualities, determine the choice of the kind of fibre. In addition, the fibre titer is an important factor. The finer the fibre, the greater the specific surface and separation efficiency is improved. Therefore, filter media can be considered as being at the heart of a filtering installation. Today a huge number of options in the form of fabric or needle fleece, with and without finishing, are available.

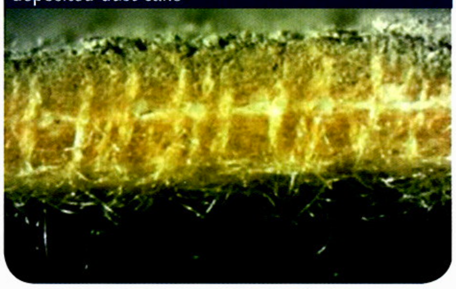
Qualities of filter media

Non-woven fabric

Non-woven fabrics are textile products which are mainly made up of fibres or fibre fleeces that are reinforced after a certain process. Regardless of their kind of manufacturing and solidification process, they have a high separation efficiency on the surface and in the depth.

Non-woven fabrics are mostly characterised by their manufacturing process. Staple fibres are combined mechanically, aerodynamically or hydrodynamically to a fleece. Spun-bonded, non-woven fabrics are produced by spinning fibres in a liquid flux or using a wet spinning procedure. This way, threads spun from spinning nozzles are partly stretched and partly dried – not stretched – and combined to the fleece on a movable conveyer belt. Wet fleeces are short cut fibres deposited under wet conditions. Due to their rigidity and pleating capability fleece materials are suited to the production of filter cartridges[1].

Figure 1: cross-section of filter media with deposited dust cake



Regarding dust separation in filter separators non-woven fabrics are less popular than needlefelts, which dominate the market. The reasons for this are:

- higher costs for binding agents and special equipment
- inserting of other chemical components
- stiffer clutch behaviour
- absence of a supporting fabric which is significant for operating life and separating behaviour of a filter medium.

Needlefelts

Needlefelts have a rather closed surface and, depending on the processing method, a rough bristly or smoothed structure. When manufacturing, fine synthetic fibres or fibre felts are stabilised in a basic fabric using needles provided with barbed hooks. This process is called "needling". The material is hardened on a needle beam by a process of inserting and withdrawing the needles so that the single fibres loop to form a firm textile product. The fibres lie side-by-side, one on top of the other, in parallel, crosswise or tangled, horizontally, vertically or perpendicular in any order. The pores are in between, varying in size and differentiated, depending on compression degree of the felt and density of the used fibres. The porosity is, according to compression degree, at 80 per cent. For reinforcement needlfelts in general contain a supporting fabric inside. The supporting fabric gives a higher tensile strength and a lower stretch to the needlfelts, as is required by the high demands on filter media when cleaning them with air pressure. Primarily, synthetic and mineral fibres are considered as raw material for the high temperature area. The operational time, building up of the filter, cleaning behaviour and the filtration results are decisively influenced by suitable surface refining of the felt materials[1].

Fabric

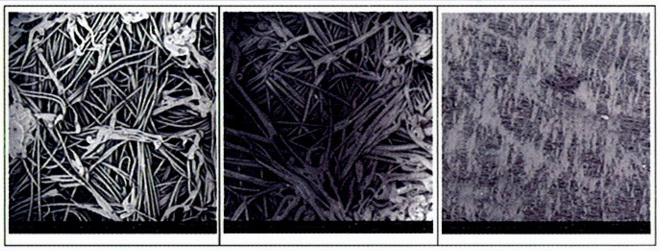
When producing fabric, a crowd of parallel threads – the chain – are connected to a pattern with the weft, ie threads that are running in angles to the chain. Fabrics without a filter auxiliary layer separate in a non-dust state primarily according to the laws of the sieve effect. This means that all particles which are bigger than the pores are held back between chain and the weft. According to the DIN 53887 (German Institute for Standardization) the fabrics used in the dust separation have a weight of 200-450g/m² with air permeability of 100-300 (l/(dm²*min). A filter auxiliary layer in the form of a membrane is attached for the improvement of the separation efficiency. Typical operational areas for such filter media are glass fabrics with a microporous ePTFE membrane (expanded PTFE membrane) which are used at temperatures up to 260˚C.

Needlfelts from microfibres

Originally the use of microfibres in needlfelts was applied to increase the separation efficiency of filter media. The reason for the better filtration efficiency is the higher filtration surface provided by smaller fibres and the lower fibre diameter which hold back finer particles.

Besides high separation efficiency, microfibre needlfelts ensure a lower pressure drop. Microfibres on the inflow side of the filter media prevent the deposit

Figure 2: REM images of filter media surfaces: ProTex PES x200 (l.); ProTex PMIA x200 (m.); ePTFE/membrane x1000 (r.)



of particles deep into the needlfelt and blocking of the filter media can therefore be avoided.

The typical disproportionate pressure rise after periodical cleaning of conventional needlfelt does not occur at microfibre needlfelt. Additionally the cleaning and regeneration of the filter media and the removing of the dust cake from its surface is supported. For a maximum function and effectiveness of microfibres a careful and homogeneous finish of the needlfelt must be ensured.

The requirements on filter media for surface filtration

With surface filtration the dust separation takes place mainly at the inflow side of the filter media. A dust cake remains on the filter media surface and grows with steady dust impinging. The growing dust cake induces a continuous increase of pressure drop in the filter. Hence a periodical cleaning of the filter elements by jet pulse (formerly by shaking) is necessary. However, the initial pressure loss of the new filter media will not be achieved again. The total pressure drop of a filter medium and the dust cake, respectively, depends on several parameters, eg dust cake characteristics (thickness, cake compression, porosity), dust and gas properties (density, particle shape, agglomeration behavior, moisture) and properties of the filter medium (surface texture, fibre titer, homogeneity, pore size and distribution).

The demand of low pressure drop of filter media is partly contrary to its separation efficiency and lifetime. To keep a small dust cake thickness, a pulsing of the medium is more often necessary. But the pulsing can involve a dust penetration and a reduction of the mechanical strength of the medium due to material stress. Therefore, an optimal filter medium has to fulfill the following requirements:

- chemical resistance as well as suitable temperature resistance
- bends and tensile strength, so that no damage occurs by the mechanical movement during cleaning
- optimum air permeability with very high retention for fine dust
- optimum surface filtration
- high separation efficiency
- low residual pressure loss
- build-up of the filter cake with as low as possible increase of differential presssure within a filter cycle (ideally = linear course)
- high long-term firmness and permanence against wear.

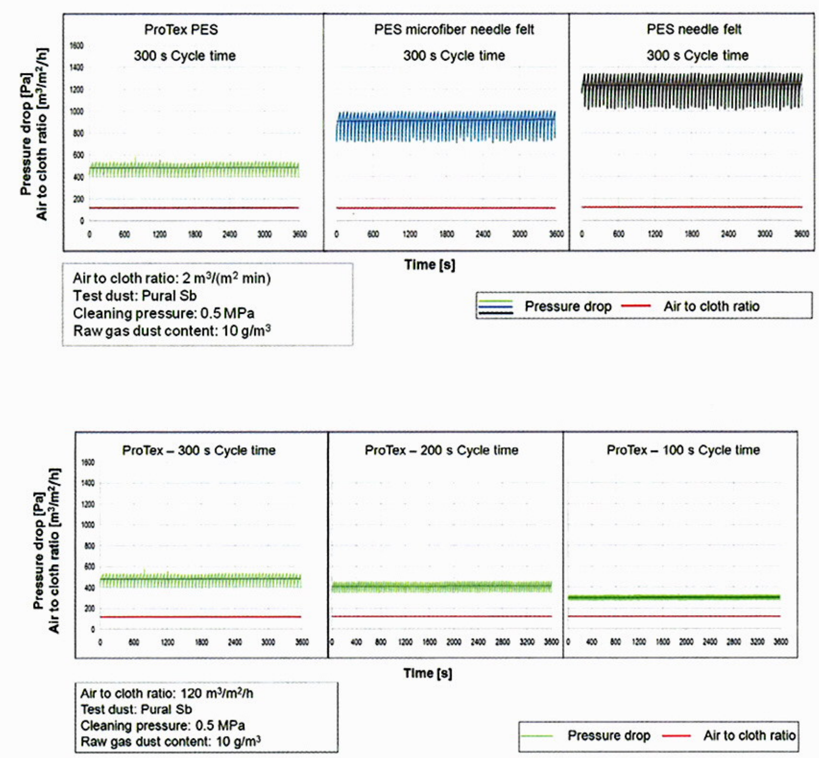
ProTex filter media for best practice filtration

ProTex filter media, a special microfibre filter medium by Intensiv-Filter with microfibre titer <1.5 dtex meet these properies. (Definition of dtex: 1 dtex = 10,000m fibre length weighs 1g.) A study of comparisons between ProTex with different conventional microfibre and non-microfibre needlfelt as well as an ePTFE-membrane filter media (by tests according to VDI 3926) demonstrates its convincing filtration features. Besides very high separation efficiency it is characterised by a significantly lower pressure loss of up to 20 per cent compared to conventional needlfelts.

Besides the described filter media and dust characteristics the real energy consumption of a filter plant depends on the operating mode. The design of the cleaning system, cleaning pressure and cycle time for the periodical cleaning of the filter elements determine the compressed air consumption and fan power. The optimal operating point has to be defined to achieve the maximum energy saving potential of the filter.

A considerable increase in energy efficiency is achieved through a combination of ProTex filter media and operation with shortened cycle times. This technology was introduced by Intensiv-

Figure 3: Pressure lost curves by using different filter media and variation of cycle time – trials a 10-bag technical plant



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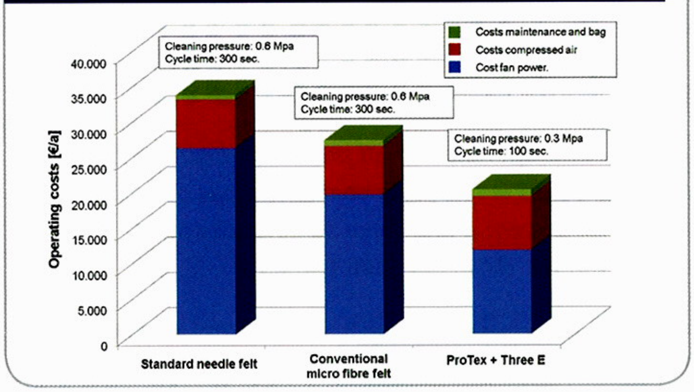

Filter under the 'Three E' (Enhanced Energy Efficiency) procedure. The use of the Three E technology is achieved by the very good separation efficiencies of the ProTex filter media. Trials show that shortening cycle times of 300 sec to 200 sec or 100 sec achieve a decrease of the pressure losses up to a factor of 4 (Figure 3). The saving potential attributed to the reduction of the pressure losses of the filter cake portion, is achieved by the use of ProTex filter media and Three E technology, as well as the application of the coanda-injector in combination with the back-pressure regulated cleaning with the JetBus Controller® [2,3].

To highlight the saving potential of the operating costs, these were evaluated on the basis of a ProJet mega®, type PJM 120/4-4000 (four chambers, 120 bags per chamber, bag length 4m) with a filter surface of 1000m². The result, shown in Figure 4, proves a saving potential of about 11,000 /a (40 per cent) compared with a bag filter under standard condition respectively 7300 /a (27 per cent) by application of conventional micro fibre media under standard conditions. In relation to the CO_2 issues a reduction of 85pta is achieved – the output of a small car of about 608,000 km/a [4].

Besides decreasing operating costs, ProTex and the Three E technology also offer an alternative to increasing the air-to-cloth ratio and enable the reduction in the overall size of the filter, with unchanged operating costs under standard conditions.

References

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