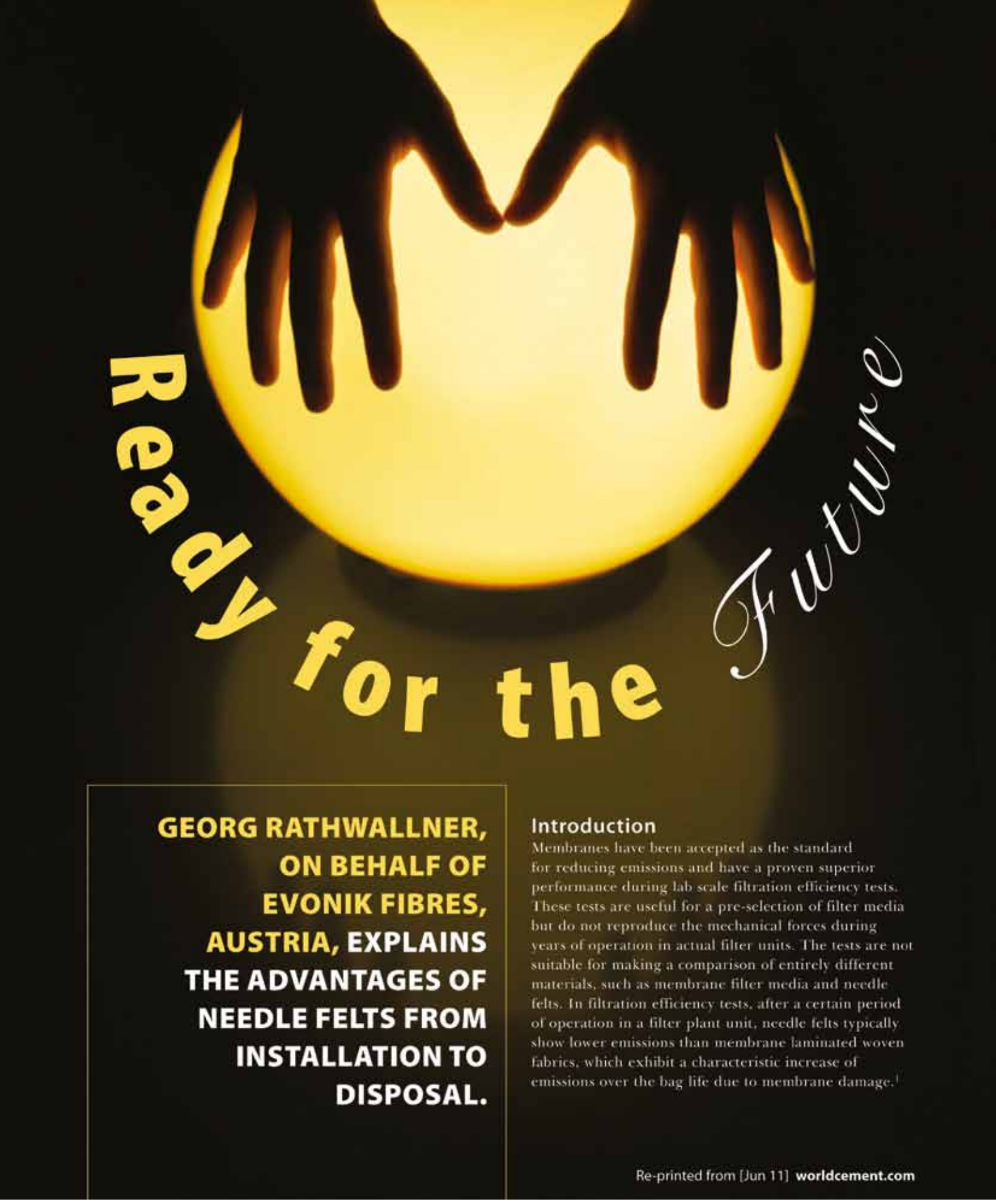

Ready for the Future

GEORG RATHWALLNER, ON BEHALF OF EVONIK FIBRES, AUSTRIA, EXPLAINS THE ADVANTAGES OF NEEDLE FELTS FROM INSTALLATION TO DISPOSAL.

Introduction

Membranes have been accepted as the standard for reducing emissions and have a proven superior performance during lab scale filtration efficiency tests. These tests are useful for a pre-selection of filter media but do not reproduce the mechanical forces during years of operation in actual filter units. The tests are not suitable for making a comparison of entirely different materials, such as membrane filter media and needle felts. In filtration efficiency tests, after a certain period of operation in a filter plant unit, needle felts typically show lower emissions than membrane laminated woven fabrics, which exhibit a characteristic increase of emissions over the bag life due to membrane damage.[1]

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Convincing facts - P84 references

Collection efficiency for cement plants.

Cement plant Japan

Flexibility for changing operating conditions:
When changing from direct operation at temperatures up to 240 °C to compound mode at 140 °C the dust load is increased 10 - 15 times! Even at dust loads above 500 g/Nm³ P84 material ensures maximum efficiency and keeps emission levels far below environmental standards. No CO shut-downs.

Secondary fuels require chemical resistant filter material:
The use of alternative fuels can change the flue gas composition dramatically. P84 material can be used within a wide pH range of 2 - 12 making it the preferred material when flue gas conditions vary due to different fuels.

In summary P84 material offers:

- good chemical and mechanical stability
- high temperature resistance up to 260 °C
- suitability for high a/c ratios up to 1,5 m/min
- superior filtration efficiency

More successful installations under www.P84.com

P84 fibre cross section

Illustration of a P84 needle felt

View inside a P84 based filter bag

Cement plant Austria

Cement plant Poland

Cement plant Canada

P84

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Table 1. Operating conditions for each clinker mill filter	
Size	720 m^2
A/C ratio	1.2 – 1.3 m/min
Dust load	500 g/m^3
Temperature	85 °C

Table 2. Filtration efficiency tests: conditions and sequence		
Filter media	ePTFE membrane/ woven glass 650 g/m^2	100% P84 needle felt 550 g/m^2 from standard 2.2 dtex fibres
Test dust	Cement dust from the hopper	
Dust load	14 g/m^3	
Test sequence	5 x cleaning and Δp-measurement, 2 h with pressure drop controlled cleaning at 1000 Pa	
A/C ratio	2 m/min	

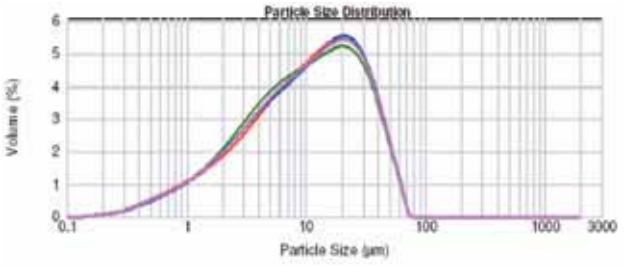


Figure 1. Particle size distribution of the cement dust.

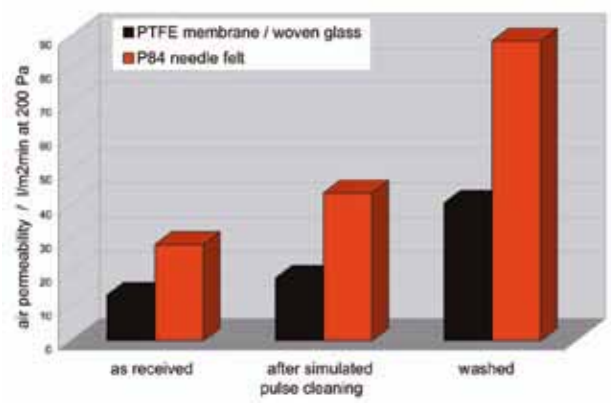


Figure 2. Air permeability after 29 months' operation.

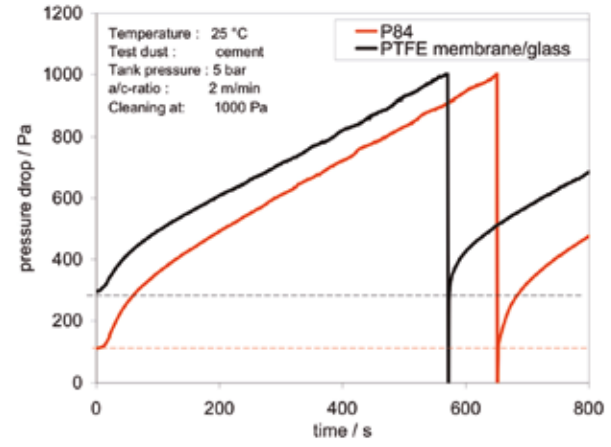


Figure 3. Pressure drop development during a filtration cycle.

Storage of spare parts is another issue where needle felts prove to be an easy-to-handle alternative. As long as conditions are dry and the bags are kept in boxes, needle felts (from polyester to P84) can be stored for years without significant effect on the quality. Membrane laminated materials demand certain care – especially woven glass, which should be prevented from damage from folding. To avoid damage to membrane filter media, special precaution during installation and trained personnel are required. Needle felts are not sensitive in this regards and do not demand special care.

The issue of bag disposal grows in relevance as costs for hazardous waste landfill, which is a common way to dispose of glass bags, increase. Needle felts from fibre materials like polyester (PET), polyacrylic (PAN), polyphenylene sulfide (PPS) and polyimide (P84) can be utilised as an alternative fuel at the end of their lives. No significant amount of harmful pollutants (like NO_x, HCN or HF) is formed during combustion and no minerals and salts are introduced into the kiln.

Surface filtration with needle felts

Depth filtration is a mechanism that results in the accumulation of dust in the depth of the filter media. As a result, the pressure drop increases continuously over the life cycle. This mechanism is used for cleaning gases with a low dust load, such as air conditioning or air intake filter. The opinion that needle felts would be unsuitable as a depth filter media can be shown to be false by investigating the pressure drop (after pulse cleaning) over the bag life. Dust in the depth of the felt would not be released during cleaning and lower the airflow.

Properly chosen needle felts show a constant pressure drop over the bag life after an initial operating period of several hours/days where a permanent dust cake builds up on the surface under normal conditions. Depth filtration occurs just in case of operational problems and can be classified similar to membrane failures and the resulting penetration through cracks in the membrane. If there is demand for increased filtration efficiency (in case of fine dust, high dust loads or low emission limits), microfibres can be a solution.

Bag material selection

To avoid penetration it is essential to prevent damage to the membrane (low cleaning pressure, 20 wire cages, limited dust load and can velocity). Needle felts are quite robust regarding cleaning pressure and abrasion from high dust load and can velocity, and can be used with standard 10 wire cages. It is important to choose a filter media with sufficient filtration efficiency to ensure a stable operation without dust penetration. P84 is the material of choice for kiln/raw mill applications, because of its sufficient chemical and thermal stability and its high filtration efficiency. This latter is a result of the high specific surface of the lobed fibres, and is also utilised in blends with other fibre materials like polyester, polyacrylic and PPS. These blends extend the operating range (A/C ratio and dust load) in comparison to standard materials without P84.

Filter media development

The quality of needle felts is continuously improved. Even though the commonly used fibre polymers are well established, their properties have been optimised, as well as the process of felt production. The tenacity of modern needle felts is higher, pores are smaller and more homogenous than that of earlier material qualities. Fine fibres and microfibres are more commonly used and contribute to the high filtration efficiency. Emissions of single digits of mg/m ^{3} or even less are possible, depending on the operating conditions. For the tests in this article, a standard 2.2 dtex P84 needle felt was chosen.

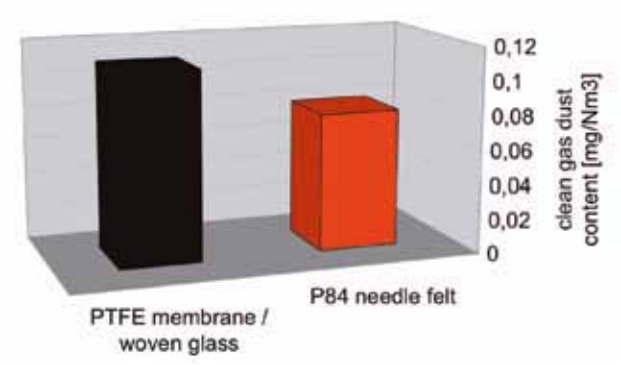


Figure 4. Clean gas dust concentration during test.

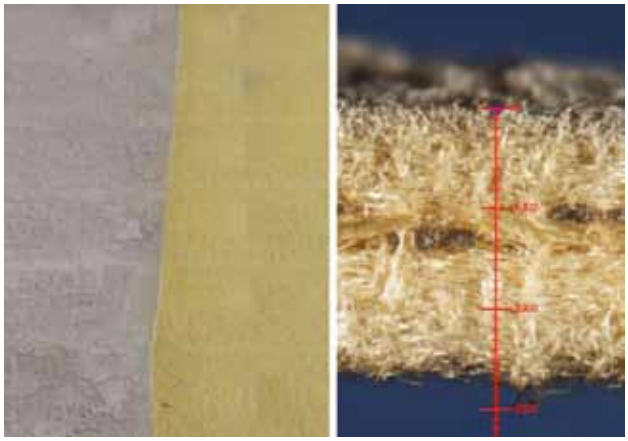


Figure 5. P84 needle felt after 29 months' operation in a clinker mill filter. (Left: dust and clean gas side, right: felt cross-section.) The cross-section is entirely free of dust, showing the typical picture of a surface filter media.

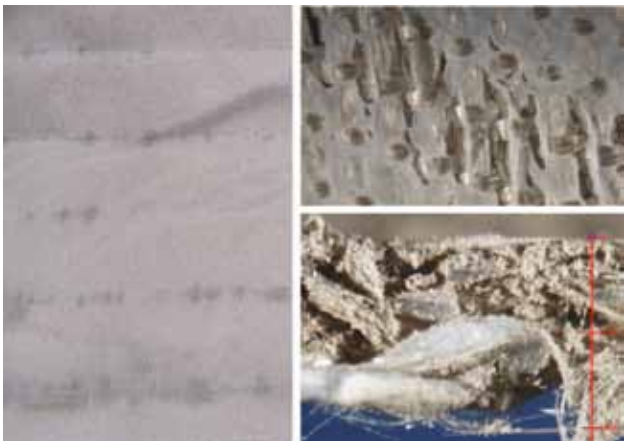


Figure 6. Membrane laminated onto woven glass after 29 months' operation in a clinker mill filter. (Left: clean gas side, right: cracks in the membrane and cross-section.) Surface filtration is achieved as long as the integrity of the surface is maintained.

Filtration efficiency test

The target of this test was to compare the filtration efficiency of two kiln filter media, a P84 needle felt and ePTFE membrane laminated to woven glass. As chemical and thermal ageing was not of interest, a clinker mill filter was chosen because of better accessibility than a kiln filter. The P84 needle felt is a standard material with 2.2 dtex fibres, the membrane on woven glass is from one of the established suppliers.

Both materials, the P84 needle felt and the ePTFE-membrane on woven glass were placed alongside each other in the filter unit (Table 1). The lower air permeability of the membrane media (initially and at the end of the test) results in a lower air flow than through the needle felt. This means that the mechanical burden on the membrane media was even less than that on the P84 felt.

After 29 months' operation in the plant, the filter bags were taken out of the filter and samples undertook a filtration efficiency test on a test rig according to VDI 3926. Dust for the test was taken from the clinker mill filter hopper. Figure 1 shows the particle size distribution of the cement dust sampled from the hopper. The dust load was adjusted to 14 g/m ^{3}, which is the upper level for stable operation with the test equipment. The details of the tested material qualities and the test sequence are listed in Table 2.

Air permeability

The test started with an air permeability measurement and several cleaning pulses to determine to which degree the air permeability recovers. Both media started at a comparable value; gentle dismounting left a certain dust cake on the surface. Whereas the P84 needle felt exhibited good recovery of the air permeability after one cleaning pulse, the membrane material showed the typical higher pressure drop of membrane media, even after five cleaning pulses (Figure 2).

Cleaning frequency/pressure drop

Figure 3 shows the pressure drop development of both filter media during the test. The membrane material needs approximately 10 – 15% more frequent cleaning than the needle felt. In case of similar cleaning frequency, the P84 needle felt exhibits a 1 mbar lower pressure drop, which is an advantage of 10%.

Clean gas dust content

Under test conditions, significantly lower emissions of the P84 needle felt could be observed (Figure 4). The operating time of 29 months can be considered to represent approximately half of the bag life of a kiln filter media.

General condition of the bag materials after 29 months' operation

The P84 felt (Figure 5) shows no damage and no significant penetration of dust into the felt cross-section could be observed. The membrane (Figure 6) already shows cracks and dark shades on the clean gas side, indicating dust penetration. The cross-section is contaminated with dust in areas with membrane delamination.

Economical and ecological comparison over the life cycle

The energy for production of polyimide fibres and also glass/membrane bags is relatively small in comparison to possible energy, and therefore CO_2, savings during operation. A part of the energy for the polymer fibre production can be recovered if used bags are recycled as an alternative fuel. This eliminates costs for bag disposal and landfills.

P84 needle felts typically show a lower operational pressure drop than membrane filter media. The advantage of the 1 mbar difference, which was also the outcome of this test, results in power savings during operation that are a multiple of the energy initially used for the production of the filter media. Furthermore, the energy for the P84 fibre production is made up of more than 80% from renewable sources, and the recycling of the used bags as alternative fuel allows a part of the energy used during production to be recovered.

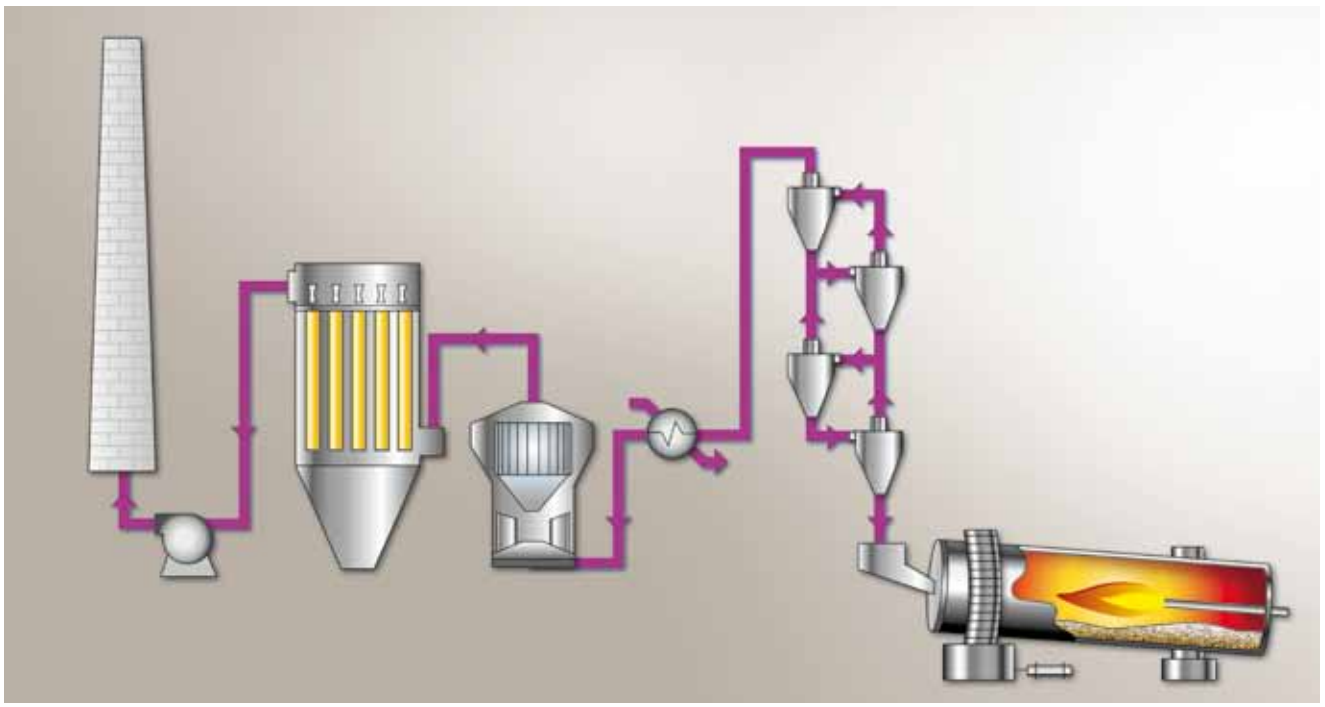
Summary

Needle felts are under continuous development and can offer a solution with results superior to membranes. The major advantage of needle felts is the higher air permeability and the physically more stable construction. This is especially important in case of untrained personnel and at a high mechanical burden during operation (high dust load, abrasive dust etc.). The decision of which material (membrane or needle felt) would be the best choice cannot be based on design operating conditions alone. Critical parameters that influence the performance of the materials (such as gas flow distribution and locally increased mechanical burden) are typically not explicitly stated, but rather an undesired effect of a particular equipment design.

The results of the test show that needle felts can achieve lower emissions than membranes at a lower pressure drop on a long-term basis, a fact that is already realised by a large number of end users who chose the P84 because of its good operating performance, easy handling from storage to installation, and finally its recycling properties, turning used bags into alternative fuel.

Reference

1. Proven in MGF GUTSCHE, 'Filter media today and for future requirements,' *Technical Textiles,* Vol. 2, (2008).



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