

Textile filter system, Method for Regenerating a Textile filter and Regeneration Apparatus

The present invention relates to a textile filter system of a pulse jet filtration device. Furthermore, the invention relates to a method for regenerating a textile
5 filter for removing substances from a flue gas stream and to a regeneration apparatus for textile filters for removing substances from a flue gas stream.

Removal of pollutants from a gas stream, for example a flue gas stream in industrial facilities can be achieved by mechanical filters and chemically active filter systems. One of the most targeted pollutants in fluid gases is NO_x due to its
10 impact on acid rain, deterioration of coastal estuaries and its impact on the greenhouse effect by forming ozone. A further targeted pollutant in flue gas streams is NH₃.

The use of textile filter systems in industrial facilities is known, e.g. from US 6 331 351 B1 or US 8 114 201 B2. The textile filter systems according to
15 US 8 114 201 B2 comprise a bag-over-bag design, wherein one textile outer bag and one textile inner bag are responsible for achieving two different purposes. One bag is provided for removal of particles from the gas stream, the other bag is provided with a chemically active component such as a catalytic component to catalytically decompose NO_x or NH₃. The chemically active filter bags require
20 downtime in order for the filter bag to be periodically regenerated in order to obtain an optimized filter effect again. The particulate filter bag can be cleaned during operation time without removal by a strong air pulse which is blown into the filter system in a direction opposite to the flow direction of the flue gas stream. Thus, the cleaning of the particulate textile filter bag can be achieved within the
25 filtration device.

By the cleaning step particulates are removed from the surface of the particulate textile filter bag.

The textile, chemically active filter bag, however, is to be removed from the device to be regenerated separately during a recovery cycle. By the regenerating step the activity of the chemically active compounds on the chemically active filter bag is recovered.

5 There are two different main filtration concepts for industrial purposes using multifunctional filter systems, namely Reverse-Air and Pulse-Jet cleaning systems. Most of used filter bag types are designed as particulate filter bags. Furthermore, multi-purpose filter systems have been developed in the past. Currently, mainly ceramic filter candles are used within the industry. These rigid
10 filter types exhibit a particulate filtration on the surface and a gas remediation by a chemically active support. Multi-purpose textile filters for particulate filtration and gas remediation are described in literature. Those concepts have been developed for Reverse-Air and Pulse-Jet cleaning systems.

Pulse jet filtration devices can be used with a bag-over-bag design. The pulse
15 jet filtration device comprises an outer particulate textile filter bag which restrains the particles in the gas stream and an inner, textile, chemically active filter sleeve which can be a bag. The flue gas surrounds the outer particulate textile filter bag in a pulse jet filtration device to enter it along its outer surface from which the gas stream gets into contact with the inner, chemically active filter sleeve. The
20 purified gas finally enters the hollow interior circumscribed by the chemically active filter sleeve and emerges via an open axial end of the chemically active filter sleeve. Usually, the particulate filter bag and the chemically active filter sleeve are in a suspended arrangement within the filter device and are supported by a cage which is inserted into the chemically active filter sleeve. The chemically
25 active filter sleeve is pressed against the cage by the flue gas stream, and, on its outer surface, contacts the particulate filter bag. For regeneration or replacement of the chemically active filter sleeve in case of a cleaning cycle the cage is first removed from the device before the chemically active filter sleeve is pulled out of the particulate filter bag. The chemically active filter sleeve is removed for
30 regeneration in long cycling periods whereas the particulate filter bag is cleaned in short cycles.

Beside the pulse jet filtration device, a reverse air filtration device is at least theoretically possible, but not reduced to practice. Here, an inner particulate

textile filter bag and an outer textile, chemically active filter sleeve or filter bag which is slid over the inner bag. The flue gas stream enters the inner particulate textile filter bag. The gas stream passing the particulate textile filter bag in the radial direction contacts the chemically active component of the textile filter sleeve or filter bag where the contaminants such as NO_x or NH₃ react on the surface of the catalytic component.

It is an object of the present invention to provide a textile filter system for a pulse jet filtration device which is faster and easier to handle in regeneration cycles.

10 It is a further object of the present invention to provide a method for regenerating a textile filter, in particular a textile filter sleeve for NO_x and/or NH₃ removal wherein the textile filter has a filter carrier of a textile material and a chemically active component on the filter carrier, in particular a catalytic component, for removing substances from a flue gas stream.

15 It is also an object of the present invention to provide a regeneration apparatus for textile filters, in particular textile filter sleeves for NO_x and/or NH₃ removal, each textile filter having a filter carrier of a textile material and a catalytic component on the filter carrier for removing substances from a flue gas stream.

In one aspect of the present invention, the above first object is achieved by a textile filter system of a pulse jet filtration device, the system comprising a particulate textile filter bag to restrain particles in a gas stream, the filter bag having a radially outer, upstream surface and a radially inner, downstream surface and being provided with a textile carrier bag, the radially inner, downstream surface of the particulate filter bag being provided as a low-friction, preferably a smooth surface. The textile filter system further comprises a textile, chemically active filter sleeve having a filter carrier sleeve of textile material and a chemically active, i.e. catalytic component on the filter carrier sleeve to remove substances from the gas stream. The filter sleeve is insertable into the filter bag to be arranged within the filter bag and is removable from the filter bag. The term "radially inward outer surfaces" is not limited to circular cylindrical or generally cylindrical filter sleeves. Rather, it expresses surfaces which are faced towards the interior and exterior of the filter bag.

By providing a friction reduced, smooth inner surface at the particulate textile carrier bag, removal and insertion of the chemically active filter sleeve from and into the particulate filter bag is significantly facilitated as the outer particulate filter bag and the inner chemically active filter sleeve are contacting each other and, 5 furthermore, may adhere to each other as both textile filter layers are pressed onto the cage during filtration mode. Furthermore, jamming or sticking of the bag and the filter at their contacting surfaces can be avoided.

The term "textile" comprises both woven and non-woven fabrics like felt or fleece.

10 The carrier bag is of a PTFE textile or of any other woven or non-woven textile material.

The low-friction surface is provided by

- a) a PTFE textile (woven or non-woven),
- b) a fiberglass textile (woven or non-woven),
- 15 c) a Polyimide textile (woven or non-woven),
- d) textiles (woven or non-woven) of mixtures of the above materials, or
- e) a coating (at the downstream surface of the carrier bag) having a lower friction than the adjacent carrier bag material, especially a PTFE coating.

The PTFE textile, especially when woven, provides a very low-friction, smooth 20 surface so that the radially inner surface does not have to be coated or treated. The friction of the radially inner surface of the carrier bag shall or can be lower than with a textile comprising a fiberglass fabric or non-woven textile materials.

In order to reduce the friction of a fiberglass textile, a fiberglass textile can be produced as follows. Fiberglass bundles define a single thread. The tread is 25 covered by a PTFE jacket. The covered thread is used for weaving the textile. This textile may be covered on its upstream side by a PTFE layer, e.g. a membrane like an ePTFE membrane.

As an alternative, a coating reducing friction and wear of the bag and of the sleeve can be provided at the inner side of the carrier bag to define the radially

inner, downstream low-friction, smooth surface. In addition or alternatively, the radially inner surface of the carrier bag may be flattened, e.g. by calendaring.

In one embodiment of the present invention, the filter bag has a membrane (e.g. a microporous PTFE membrane) on the outer, upstream surface of the textile carrier bag which membrane defines the upstream surface of the particulate textile filter bag. This membrane can be pre-fabricated and can be laminated onto the carrier bag with or without an adhesive, e.g. a polymer adhesive.

The membrane can fully cover the whole radially outer, upstream surface of the textile carrier bag.

As emphasized before, the textile filter system according to the present invention provides that the chemically active filter sleeve and the particulate filter bag are allowed to contact each other when being inserted.

The textile carrier bag and/or the filter carrier sleeve can be made of a felt or fleece giving the element a certain inherent mechanical stability.

The catalytic compound may comprise catalytic particles for NO_x and/or NH₃ removal, e.g. vanadium oxide supported on titanium oxide.

The catalytic compound such as the catalytic particles can be applied to the textile fiber or fibers before the filter carrier sleeve is manufactured or can be applied onto the prefabricated textile filter carrier sleeve.

The filter bag has an inner diameter or, more generally, an inner dimension (seen in a cross-sectional view) which is at least 2% larger than the outer dimension of the filter sleeve, i.e. the cross-sectional area of the filter bag is larger than the cross-sectional area of the filter sleeve defined by the inner side and the outer side, respectively, to further reduce friction.

The present invention further provides a method for regenerating a textile filter, in particular a textile filter sleeve for NO_x and/or NH₃ removal, a textile filter having a filter carrier of a textile material and a catalytic component on the filter carrier for removing substances from a flue gas stream. The regeneration recovers the activity of the catalytic component of the textile filter after use within a filtration device. The method comprises the steps of:

- a) removing the textile filter from the filtration device,
- b) washing the textile filter with tap water together with a mechanical treatment of the textile filter, and
- c) drying the textile filter.

5 Textile filters comprising catalytic components at the outer surface are difficult to regenerate as in contrast to other catalytic filters such as filters with ceramic monoliths, the textile is of a thermally sensitive, highly flexible material and consequently, standard regeneration of the catalytic material using high temperatures is not possible. The present invention uses regular tap water for
10 washing the textile filter which has been removed from the filtration apparatus to regenerate the textile filter by mechanically treating it during washing of the textile filter. It has been found that mechanically treating the wet textile filter leads to a superb regeneration effect surprisingly without harming the surface of the catalytic component so that the textile filter maintains its original activity almost
15 completely even after numerous cleaning cycles. After drying the textile filter it is reinstalled into the filtration device.

The present invention preferably provides a method for regenerating a textile filter for flue gas which filter is part of a bag-over-bag textile filter system used in reverse air filtration or pulse jet filtration devices.

20 The mechanical treatment, which can be performed by mechanical pressure, can be applied by directing pressurized tap water against the textile filter or, preferably, by exerting pressure on the textile filter by use of a mechanical treatment device having one or more filter treatment parts such as plates or other parts being pressed against the textile filter. Further, funnels could be provided
25 through which the textile filters are pulled, edges of rods along which the textile filter is moved and pressed or nip rollers between which the wet textile filter is pressed can be provided. It is to be emphasized that the textile filter can be moved along the mechanical treatment device or vice versa or both, the mechanical treatment device and the textile filter can be moved relative to each
30 other in order to exert mechanical pressure onto the textile filter. During the washing step, tap water reaches the pores of the textile filter and solves compounds which deactivate the catalytic component in the tap water. The tap

water with the deactivating components solved therein is washed out from the pores by other tap water reaching the pores and by the mechanical treatment.

The washing step can be performed by bringing the textile filter into contact with tap water, and applying mechanical pressure to the textile filter so as to
5 mechanically treat the filter, wherein both steps are performed successively and/or simultaneously.

In accordance with still another aspect of the present invention, mechanical pressure is applied to the textile filter to squeeze water out of the wet textile filter so that substances on the textile filter are washed away.

10 With respect to a NO_x or NH₃ filter, ammonium sulfate, ammonium bisulfate and ammonium chloride, more generally sal ammoniac is washed out by a combined washing and mechanical treating step. The water can be squeezed out from the filter during washing or during subsequent washing steps and/or after the washing as a first drying step.

15 The washing step may comprise the step of rinsing the textile filter with fresh tap water, i.e. tap water which has not been used for the regenerating process.

The rinsing step can be performed by spraying fresh tap water onto the textile filter in the course of the washing step.

The washing step is performed more than once, preferably more than twice,
20 most preferably four times per recovering cycle of the textile filter before the filter is reinstalled again.

When the washing step is performed more than once, each separate step comprises washing and mechanically treating.

Furthermore, it is an option to rinse the textile filter with fresh tap water
25 between each or some of the subsequent washing steps. Preferably, rinsing the textile filter with fresh tap water is at least performed after the last washing step in order to wash out all contaminated previously used tap water and, therefore, all substances in the used tap water.

As already mentioned before, the mechanical pressure can be applied by at least one nip roller, preferably by movement of the textile filter between the gap of adjacent nip rollers so that the mechanical pressure is applied by a mangle.

In order to reduce water consumption, the method is performed for more than
5 one textile filter using the same tap water.

The tap water may be controlled to ensure a predetermined minimum pH value, preferably a pH value above 2.5. Tap water having a pH value below 2.5 is not used anymore.

According to one embodiment, the tap water is free of additives and/or
10 untreated, i.e. normal, untreated water from the domestic tap water reservoir is taken without adding any chemical cleaning additives or without desalting or demineralizing the tap water.

The method may be performed with a textile filter made of non-woven or woven material.

As mentioned before, the catalytic compound comprises catalytic particles for
15 NO_x and/or NH₃ removal, e.g. vanadium oxide supported on titanium oxide and the catalytic compound such as the catalytic particles can be applied to the textile fiber or fibers before the filter carrier sleeve is manufactured or can be applied onto the prefabricated textile filter carrier sleeve using different techniques as
20 disclosed in US 6,331,351.

Finally, the present invention provides a regeneration apparatus for textile filters, in particular textile filter sleeves for NO_x and/or NH₃ removal, each textile filter having a textile filter carrier and a catalytic component on the filter carrier for removing substances from a flue gas stream. The regeneration in the
25 regeneration apparatus recovers the activity of the textile filter after use within a filtration device. The apparatus comprises a tap water bath to wet the textile filters with tap water, a device to mechanically treat the textile filters, and a device to dry the textile filters after washing. The regeneration apparatus uses a tap water bath allowing to guide the textile filter through the tap water bath and to wet
30 it. The tap water bath, furthermore, easily allows to repeatedly use the tap water for numerous textile filters.

The mechanical treatment of the textile filters may be performed outside and/or within the tap water bath.

The regeneration apparatus further comprises a supply of fresh water, in particular a fresh water sprayer, to rinse the textile filters with fresh tap water, i.e. tap water which has not been used before.

As mentioned before, at least one set of nip rollers is provided between which the textile filters are moved. The set of nip rollers can be arranged within the tap water bath, i.e. under water, and/or outside of the tap water bath. At least one or one nip roller per set of nip rollers is motor-driven to accelerate the regeneration process within the apparatus.

When performing a regeneration process, the textile filter may run through the regeneration apparatus several times. With respect to nip rollers the textile filters may be moved forth and back by a driven roller.

The above method and regeneration apparatus can be used in connection with the above textile filter system of a pulse jet filtration device according to the present invention.

The various features, arrangements and embodiments discussed above in relation to each aforementioned aspect may be utilized by any of the aforementioned aspects.

Additional aspects and corresponding advantages will be apparent to those skilled in the art upon considering the further description that follows.

Figure 1 is a schematic view of an industrial facility with a textile filter system according to the present invention in which the regeneration apparatus according to the invention is used.

Figure 2 is a schematic sectional view of a textile filter system according to the present invention used in the filtration device shown in Figure 1.

Figure 3 is a partial cross-sectional view through the filter system of Figure 2.

Figures 4 to 6 are schematic views of a first embodiment of the regeneration apparatus according to the invention in which the regeneration method is performed, the Figures showing three successive steps.

Figures 7 and 8 are schematic views of a further embodiment of the regeneration apparatus according to the present invention in which a method according to a second embodiment of the invention is shown by successive steps.

- 5 Figure 9 is a schematic view of another embodiment of the regeneration apparatus according to the present invention in which a method according to the invention is performed.

Figure 1 shows an industrial facility in which flue gas from a furnace is guided by an exhaust pipe 10 to a pulse jet filtration device 12.

- 10 NH_4OH and compressed air are fed into exhaust pipe 10 via inlet pipes 14 and 16, respectively. A control unit 18 controls the amount of added NH_4OH and compressed air.

- As an alternative, a NH_3 slip from an upstream end SNCR catalytic converter flows from a furnace to the pulse jet filtration device 12 via exhaust pipe 10. In
15 this alternative embodiment, NH_4OH and compressed air are not added to the flue gas stream.

- Filtration device 12 comprises a dust chamber, 20 (preferably equipped with a hopper) into which exhaust pipe 10 opens, and a clean gas or outlet chamber 22 (in literature also named plenum) arranged downstream of dust chamber 20.
20 Outlet chamber 22 is separated from dust chamber 20 by an intermediate wall 24, also referred to as head plate, cell plate or tube sheet, shown in Figure 2.

Numerous parallel textile filter systems 26 also referred to as filter cartridges are arranged in dust chamber 20, one of which being shown in Figure 2.

- The textile filter systems 26 have the shape of bags which are attached to the
25 intermediate wall 24 at their open ends and which hang into dust chamber 20.

- The textile filter system 26 as shown in Figure 2 comprises a particulate textile filter bag 28 for particle retention in the gas stream. The textile filter bag 28 defines the outer bag of a bag-over-bag design further comprising a textile, chemically active filter sleeve 30 which is arranged within textile filter bag 28.
30 Textile filter bag 28 has an inner dimension (with respect to a cross-sectional view) which is at least 2% larger than the outer dimension of chemically active

filter sleeve 30 so that insertion or removal of filter sleeve 30 into and from filter bag 28 is enabled without exerting high forces. The sleeve 30 and the bag 28 usually have the same cross-sectional geometrical shape.

Due to the flexibility of bag 28 and sleeve 30 both are contacting each other at least in major portions. In certain areas, a small gap 32 may be provided between textile filter bag 28 and chemically active filter sleeve 30 in the non-active state of the textile filter system, i.e. when no gas stream is provided. In the activated state of the device, bag 28 is pressed against sleeve 30 so that both are contacting each other completely (i.e. over their whole surface areas lying opposite to each other) or almost completely.

Chemically active filter sleeve 30 can be designed as a bag as shown in Figure 2.

Filter bag 28 and filter sleeve 30 have a cylindrical shape with textile bottom walls 34 and 36, respectively, so that the inner diameter of bag 28 is at least 2% larger than the outer diameter of sleeve 30. As an alternative, bag 28 and sleeve 30 may have the shape of an envelope and may taper to their free lower ends.

Opposite to bottom walls 34 and 36, textile filter bag 28 and chemically active filter sleeve 30 each have an open axial end, wherein the edges are provided as or provided with flanges 38 and 40, respectively, allowing to removably install and hold the hanging filter system 26 to wall 24.

As filter bag 28 and filter sleeve 30 are of textile material and flexible, a support cage 42 is removably inserted into filter system 26 to ensure that filter system 26 retains its shape when flue gas stream 44 (see arrows in Figure 2) exerts an outer pressure onto the filter system.

As shown in Figure 1, numerous filter systems 26 are arranged close to each other and are closely packed. The open ends of the filter systems 26 open into outlet chamber 22 from which filtered flue gas will be guided via outlet pipe 46 to exhaust into the environment. An exhaust section fan may be used to generate low pressure within outlet chamber 22.

As shown in Figure 3, filter bag 28 has a radially outer, upstream surface 50 and a radially inner, downstream surface 52. Filter bag 28 comprises a carrier

bag 54 of textile material made of a woven or non-woven fabric, e.g. of PTFE fabrics. A microporous ePTFE membrane 53 is attached, e.g. laminated to the outer side of carrier bag 54 to define upstream surface 50. The inner, downstream surface of textile carrier bag 54 is a smooth, low-friction surface.

5 This surface is defined by an untreated and uncovered surface of the carrier bag 54 made of PTFE, preferably a woven PTFE textile which per se has a low friction rate.

As an alternative, the inner surface of the carrier bag 54 is calendered and/or covered by a friction reducing coating 56 (see broken lines in Figure 3) to define

10 the inner surface 52.

More generally, the low-friction surface can be provided by a carrier bag 54 of

- a PTFE textile (woven or non-woven),
- a fiberglass textile (woven or non-woven),
- a Polyimide textile (woven or non-woven), or

15 textiles (woven or non-woven) of mixtures of the above materials, or

can be provided by a coating (at the downstream surface of the carrier bag) provided on the carrier bag having a lower friction than the adjacent carrier bag surface, especially a PTFE coating 56.

One example for the coated filter bag 28 is a carrier bag 54 of a fiberglass

20 textile having a PTFE coating 56.

In order to reduce the friction of a fiberglass textile, a fiberglass textile can be produced as follows. Fiberglass bundles define a single thread. The tread is covered by a PTFE jacket. The covered thread is used for weaving the textile. This textile may be covered on its upstream side by a PTFE layer, e.g. a

25 membrane like an ePTFE membrane.

Membrane 53 is provided by a pre-fabricated membrane laminated onto carrier sleeve 54 with or without an adhesive such as polymer adhesive.

Textile, chemically active filter sleeve 30 comprises a filter carrier sleeve 58 of textile material made of a woven or non-woven fabric and a catalytic component

60 on carrier sleeve 58. Component 60 is symbolically shown in Figure 3. In fact, component 60 is defined by catalytic particles to remove NO_x and/or NH₃ from the flue gas stream. Vanadium oxide supported on titanium oxide is one example of an active catalytic compound.

- 5 The catalytic particles are applied onto the fibers of carrier sleeve 58 before or after carrier sleeve 58 is manufactured, i.e. catalytic particles are not only arranged at the outer surface of carrier sleeve 58 but also within the pores or gaps between adjacent fibers of carrier sleeve 58.

10 Carrier sleeve 58 may have a certain mechanical stiffness, e.g. by being made from felt or fleece.

15 Flue gas comprising NO_x and/or NH₃ flowing into dust chamber 20 enters textile filter systems 26 via the outer surface 50 of particulate filter bags 28. Particulates within the flue gas stream having a certain dimension are restrained from entering outlet chamber 22 by particulate filter bag 28. Particles may accumulate onto the outer surface of filter bag 28, i.e. at ePTFE membrane 53. Particles may fall down within dust chamber 20 or may accumulate to form a filter cake. During the filtration process filter bag 28 is pressed inwardly to fully contact filter sleeve 30.

20 The mechanically filtered flue gas is almost dust free and enters filter sleeve 30 where, due to the catalytic surface of the catalytic component, NO_x and/or NH₃ may react to N₂ and water or to NH₄HSO₄ and (NH₄)₂SO₄.

25 Due to the injection of reducing agent upstream the filter device, the incoming flue gas contains NO_x and NH₃ in an appropriate ratio. The catalytic reduction of NO_x takes place within filter sleeve 30, more detailed within the felt defining the carrier sleeve 58. The design of the felt promotes an intensive contact of the gas phase with the active sites of the catalytic particles. This interaction results in a very low NH₃ slip. The implementation into off-gas treatment systems includes the appropriate supply of NH₃, either as directly injected NH₄OH or as NH₃ slip from a SNCR upstream.

30 For cleaning of filter bag 28, pressurized pulse jet air flow is blown via nozzle 62 into filter system 26 from the open outlet end of filter system 26 so that particles 64 accumulated onto filter bag 28 are removed and fall down within dust

chamber 20 to accumulate at funnel outlets 66 at the bottom of dust chamber 20, preferably equipped with at least one hopper.

Of course, filter bag 28 can also be removed from filtration device 12 to be further cleaned.

- 5 The pulse jet of pressurized air blown in the opposite direction of the flue gas stream within the device, however, leads to reduced efforts and reduced downtime of the filtration device for cleaning cycles.

When the catalytic activity of filter sleeve 30 decreases, filter sleeve 30 is removed and regenerated in a regeneration apparatus 68.

- 10 To regenerate textile, chemically active filter sleeve 30, filter sleeve 30 is removed from filtration device 12 after cage 42 is pulled out from filter system 26.

In Figures 4 to 6, regenerator apparatus 68 is schematically shown.

- Regenerator apparatus 68 comprises a basin 70 containing a tap water bath 72 with regular tap water at ambient temperature which is fully untreated, i.e.
15 does not contain any additives like washing additives and is not desalted or demineralized.

- Regenerator apparatus 68 comprises a device 76 for mechanical washing treatment and a device 74 for mechanical drying of filter sleeve 30. It is to be noted that the textile filter is compressed both during the washing and drying so
20 that the thickness of the textile filter is temporarily reduced.

In one embodiment device 76 is arranged within water bath 72, i.e. is arranged under water, whereas device 74 is positioned outside of water bath 72.

Without being treated or sprayed with chemical cleaning liquid, filter sleeve 30 is washed, i.e. contacted with tap water by being moved into tap water bath 72.

- 25 Device 76 comprises two adjacent nip rollers 78 and 80, of which nip roller 80 is driven by a motor.

In this washing step, filter sleeve 30 is pulled through gap 82 between nip rollers 78 and 80 so that sleeve 30 is mechanically treated and washed simultaneously like in a mangle. Tap water is squeezed out of wet sleeve 30 so

that substances on and within sleeve 30 are washed out to regenerate sleeve 30. After having passed through nip rollers 78 and 80, tap water will again enter sleeve 30. These steps of washing the textile sleeve together with a mechanical treatment may be performed several times in one recovery cycle before filter
5 sleeve 30 is reinstalled into filter system 26 again.

In order to automate the washing step, nip roller 80 will be driven in the counter direction after sleeve 30 has been pulled down into gap 82 and end edge 84 of sleeve 30 reaches gap 82 (see Figure 5). Afterwards, sleeve 30 is pulled through gap 82 again in counter direction before roller 80 is changed over again.

10 Preferably, this washing step is performed more than twice, especially four times per recovery cycle.

After the final washing step, sleeve 30 is dried by device 74 which also comprises two adjacent nip rollers 86 and 88, of which one roller is electrically driven.

15 Of course, more than one set of nip rollers can be arranged outside or inside tap water bath 72.

Figure 5 shows the situation in which edge 84 reaches gap 82 so that the rotational direction of nip roller 80 is changed.

Figure 6 depicts the drying step when tap water is squeezed out from sleeve
20 30 when passing through gap 90 between nip rollers 86 and 88.

In an alternative step, textile sleeve 30 may be rinsed with fresh tap water (see nozzle 92 in Figure 6) before entering device 74. Fresh tap water is sprayed onto sleeve 30 at high pressure.

The moisture content of sleeve 30 after passing device 74 is about 30 percent
25 so that sleeve 30 is fully dried outside of regeneration apparatus 68 before being reinstalled into a particulate filtration apparatus. It has been found out that by exerting mechanical pressure onto textile sleeve 30 in the washing step, the catalytic activity of the system is restored to more than 90 percent.

Thus, sleeve 30 can be regenerated several times.

The tap water is used for numerous regeneration processes of numerous filter sleeves 30 in order to reduce the amount of waste water. A device 94 (see Figure 6) comprising a sensor and a control unit controls the pH value of water bath 72. As soon as the pH value has reached 2.5, tap water is replaced by fresh tap water. According to one option, no additives to increase the pH value are used.

Figures 7 and 8 show a further embodiment of the regeneration apparatus.

The apparatus 68 of Figures 7 and 8 has almost the same design as apparatus 68 shown in Figures 4 to 6 so that only the differences and the method carried out by the apparatus of Figure 7 are explained below.

10 In an initial regeneration step, textile sleeve 30 is first pressed under the water surface and into the tap water bath 72. Afterwards, the wet textile sleeve 30 is moved through gap 82 by driving nip roller 80 (see Figure 7). Sleeve 30 is transported to device 74 and passes through gap 90 between nip rollers 86 and 88 (see Figure 8).

15 Sleeve 30 can be sprayed with fresh tap water between devices 74 and 76 (see nozzles 92 in Figure 8) and/or after having passed device 74 (see Figure 8). Thus, there are provided one or more tap water sprayers arranged between the device 76 to mechanically treat the textile filter and the device 74 to dry the textile filter after washing. Preferably two tap water sprayers are arranged on opposite sides of the sleeve 30.

After the first washing and drying step has been performed, sleeve 30 is moved back through gaps 90 and 82 into tap water bath 72 in order to carry out a second washing step. Again, more than one of these washing steps can be performed, e.g. four or five washing steps.

25 In another embodiment of the regenerator apparatus 68, both the device 76 for mechanical washing treatment as well as the device 74 for mechanical drying are arranged above each other and above the tap water bath 72, whereas at least one tap water sprayer 92 is arranged between them. In this embodiment, there are no nip rollers arranged within the tap water bath 72. After passing the device 74 one or more sprayers 92 are spraying tap water onto sleeve 30. Devices 74 and 76 can be arranged vertically aligned above each other as shown in Figure 9.

It will be appreciated that the regeneration apparatus and the method for regenerating the sleeve is not limited to the sleeve shown in Figure 3. The regeneration step and the regeneration apparatus can be used for other textile filters having a catalytic component on the filter carrier and which are used for removing substances from a flue gas stream.

In addition, the regeneration apparatus is not limited to nip rollers to exert mechanical pressure onto the textile filter.

Instead of moving sleeve 30 relative to the stationarily placed nip rollers, the nip rollers can be driven through tap water bath 72 or, more generally, along sleeve 30.

Further, instead of nip rollers forming a gap between them, one or more funnels could be provided between which the filters are pulled. The funnel walls can be diverge after their narrowest portion so that, seen in cross-section, the device looks like a Venturi nozzle allowing to pull the filter through the device in both direction.

Claims

1. A textile filter system of a pulse jet filtration device (12), the system (26) comprising:

5 a particulate textile filter bag (28) to restrain particles in a gas stream (44), the filter bag (28) having a radially outer, upstream surface (50) and a radially inner, downstream surface (52), and being provided with a textile carrier bag (54), the radially inner, downstream surface (52) of the filter bag (28) being provided as a low-friction surface, and

10 a textile, chemically active filter sleeve (30) having a filter carrier sleeve (58) of textile material and a catalytic component (60) on the filter carrier sleeve (58) to remove substances from the gas stream (44),

the filter sleeve (30) being insertable into the filter bag (28) to be arranged within the filter bag (28) and being removable from the filter bag (28).

15 2. The textile filter system of claim 1, wherein the textile carrier bag (54) is of PTFE.

3. The textile filter system of claim 2, wherein the radially inner, downstream surface (52) of the particulate filter bag (28) is defined by the PTFE textile defining the carrier bag (54).

20 4. The textile filter system of claim 1 or 2, wherein the upstream surface (50) of the filter bag (28) is defined by a microporous membrane.

5. The textile filter system of any of the preceding claims, wherein the filter bag (28) has an inner dimension, seen in cross-section, which is at least 2% larger than the outer dimension of the filter sleeve (30).

25 6. A method for regenerating a textile filter, the textile filter having a filter carrier of a textile material and a catalytic component on the filter carrier for removing substances from a flue gas stream (44), the regeneration recovering the activity of the catalytic component of the textile filter after use within a filtration device,

the method comprising the steps of

30 a) removing the textile filter from the filtration device,

- b) washing the textile filter with tap water together with a mechanical treatment of the textile filter, and
- c) drying the textile filter.

7. The method according to claim 6, wherein the washing step b) is
5 performed according to the following steps:

- b1) bringing the textile filter in contact with tap water, and
- b2) applying mechanical pressure to the textile filter,

wherein steps b1) and b2) are performed successively and/or simultaneously.

8. The method according to claim 6 or 7, wherein at least one of the
10 washing step b) and the drying step c) comprises the step of:

applying mechanical pressure to the textile filter to squeeze water out of the wet textile filter.

9. The method according to any of claims 7 to 8, wherein the washing step
b) comprises the step:

- 15 b3) rinsing the textile filter with fresh tap water.

10. The method according to claim 9, wherein rinsing of the textile filter with fresh tap water is performed by spraying the textile filter with fresh tap water.

11. The method according to any of claims 6 to 10, wherein the washing step b) is performed more than once per recovery cycle of the textile filter.

20 12. The method according to any of claims 6 to 11, wherein the mechanical treatment comprises applying mechanical pressure to the textile filter, the mechanical pressure being applied by at least one nip roller (78, 80, 86, 88).

13. The method according to any of claims 6 to 12, wherein the tap water is at least one of free of additives and untreated.

25 14. A textile filter regeneration apparatus, each textile filter having a filter carrier of a textile material and a catalytic component on the filter carrier for removing substances from a flue gas stream (44), the regeneration in the regeneration apparatus recovering the activity of the textile filter after use within a filtration device, the apparatus comprising:

30 a tap water bath (72) to wet the textile filters with tap water,

a device (76) to mechanically treat the textile filters, and

a device (74) to dry the textile filters after washing.

15. The regeneration apparatus according to claim 14, further comprising a supply of fresh water to rinse the textile filters with fresh tap water.

5 16. The regeneration apparatus according to claim 14 or 15, wherein the device to mechanically treat the textile filters and/or the device to dry the textile filters after washing is at least one set of nip rollers (78, 80, 86, 88) between which the textile filters are moved.

10 17. The regeneration apparatus according to claim 16, wherein at least one set of nip rollers (78, 80) is arranged within the tap water bath.

18. The regeneration apparatus according to any of claims 14 to 16, wherein the device to mechanically treat the textile filters is arranged vertically underneath the device to dry the textile filters and wherein both devices are arranged above the tap water bath.

15 19. The regeneration apparatus according to any of claims 14 to 18, wherein a tap water sprayer is arranged between the device (76) to mechanically treat the textile filters, and the device (74) to dry the textile filters after washing.

20 20. The regeneration apparatus according to any of claims 14 to 19, further comprising a device (94) to control the pH value of the water bath.