

however, this impairs cleaning of the filter membrane of filtration-inhibiting deposits.

Another problem related to this upward air flow is that, due to these fluctuations in intermembrane distance, the filter membrane layers are damaged by scratches and tears, resulting in a shortened lifetime of the filter membranes.

It is therefore an object of the present invention to develop a filter element without the disadvantages outlined above.

SUMMARY OF THE INVENTION

Various embodiments seek~~It is an object of the present invention~~ to provide a filter element, which comprises an integrated permeate channel membrane, hereinafter also referred to as "IPC-membrane" or "membrane", ~~as defined in claim 1,~~ and a frame system, hereinafter also referred to as "frame", comprising a first and a second frame profile ~~as defined in claim 1.~~

According to a first aspect, there is provided a filter element comprising (i) an integrated permeate channel membrane which has a flexible structure and comprises an upper and lower membrane layer and a substrate material for supporting said membrane layers, wherein said substrate is a 3D spacer fabric having an upper and a lower fabric surface, tied together and spaced apart by monofilament threads at a predefined distance, wherein each of said upper and lower fabric surface is provided with at least one membrane layer forming said upper and lower membrane layer and wherein a permeate channel is interposed between said upper and lower membrane layers and is connected with an outlet opening for discharge of the permeate of the integrated permeate channel, and (ii) a frame system supporting said membrane and sealing said integrated permeate channel at the edge of the membrane, said frame system comprising a first frame profile and a second frame profile, each of them having form and dimensions capable of surrounding the membrane, wherein each of said first and second frame profile has inner parts and outer parts, wherein said membrane is interposed between said first frame profile and said second frame profile such that the inner parts are in contact with the surface of the upper and lower membrane layers at the periphery of the

membrane, that the outer parts of the two frame profiles are in contact with each other and that the inner parts form a longitudinal channel fitting the membrane, wherein the edge of the inner parts in contact with the surfaces of the membrane layers, nearest to the membrane area, has a curved form, and wherein an adhesive is used to attach the inner parts to the membrane layers and the outer parts to each other.

The filter element ~~of the present invention~~ has the advantage that the IPC membrane supported by the frame system is less sensitive to clogging and damaging during filtration and during upward air flow, resulting in an improved lifetime of the filter element.

The filter element ~~of the present invention~~ has also the advantage that high pressures can be used during the backwashing process and/or during the filtration process as a result of an improved sealing of integral permeate channel, hereinafter also referred to as "IPC" or "permeate channel", at the edge of the membrane IPC membrane by the attachment of the surrounding frame system attached to the IPC membrane. Due to this improved sealing higher pressures can be used in the filtration process resulting in a higher flux of the permeate and a faster filtration process. Due to this improved sealing higher pressures can also be used in the backwashing process resulting in a more efficient cleaning process of the IPC membrane and an improved lifetime of the filter element.

Various embodiments seek~~It is also an object of the present invention~~ to provide a filter element which exhibits an additional internal contour channel, hereinafter also referred to as "additional permeate

channel", in connection with the internal permeate channel. The additional internal contour channel is formed in a longitudinal channel of the frame system along the border of the membrane for collecting and transporting of extracted permeate from the integrated permeate channel to an outlet opening of the membrane. This additional permeate channel has the advantage of an improved flux of permeate during filtration process resulting in reduced pressures losses at the permeate side of the membrane which may result in reduced clogging. This additional permeate channel has also the advantage of an improved rate of backflow of permeate into the integrated permeate channel resulting in a faster backwashing process.

According to a second aspect, there is provided a method for making a filter element comprising the steps of: providing an integrated permeate channel membrane as defined in the first aspect, providing a first frame profile and a second frame profile as defined in the first aspect, mounting the membrane on the first frame profile such that the membrane is in contact with the inner part of the first frame profile, superpose the second frame profile on the first frame profile wherein the membrane is present such that the membrane is in contact with the inner part of the second frame profile and that the outer parts of the first and second frame profiles are in contact with each other, apply an adhesive between the inner part of the first frame profile to one surface of the membrane, between the inner part of the second frame profile to the other surface of the membrane and between the outer parts of the first and second frame profiles, and attach the inner parts of the first and second frame profiles to either surface of the membrane and the outer parts of the first and second frame profiles to each other.~~It is also an object of the present invention to provide a method for making a filter element as defined claim 11.~~ The method has the advantage that the filter elements whereby the frame of the present invention as defined the first aspect~~in claim 1~~ is used to support a membrane and to seal the IPC at the edge of the membrane, can be manufactured easily and at lower cost.

According to a third aspect, there is~~It is also an object of the present invention to~~ provided a filter module comprising a plurality of the filter elements according to the first aspect~~of the present invention~~. This filter module has the advantage that leaking filter elements or clogged filter elements in the module can easily be replaced by other filter elements.

According to a fourth aspect, there is provided a method for improving the pressure applied during filtration process and/or backwashing process and for reducing the risk of leakage of the membrane and/or of damaging of the membrane surfaces by supporting an integrated permeate channel membrane as defined in the first aspect and sealing the integrated permeate channel at the edge of said membrane by a frame system according to the first aspect.

Other specific embodiments of the invention are defined in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a schematic representation of the first frame profile of the first type frame system.

Figure 2 shows a schematic representation of a cross-section of the first frame profile of the first type frame system, along at the axis a-a.

Figure 3 shows a schematic representation of the second frame profile of the first type frame system.

[CLAIMS]

1. A filter element comprising
 - (i) an integrated permeate channel membrane—(4) which has a flexible structure and comprises an upper and lower membrane layer and a substrate material for supporting said membrane layers, wherein said substrate is a 3D spacer fabric having an upper and a lower fabric surface, tied together and spaced apart by monofilament threads at a predefined distance, wherein each of said upper and lower fabric surface is provided with at least one membrane layer forming said upper and lower membrane layer and wherein a permeate channel is interposed between said upper and lower membrane layers and is connected with an outlet opening for discharge of the permeate of the integrated permeate channel, and
 - (ii) a frame system supporting said membrane and sealing said integrated permeate channel at the edge of the membrane, said frame system comprising a first frame profile—(1 or 5) and a second frame profile—(2 or 6), each of them having form and dimensions capable of surrounding the membrane,
 - wherein each of said first and second frame profile has inner parts—(12, 22, or 52, 62) and outer parts—(11, 21, or 54, 64),
 - wherein said membrane—(4) is interposed between said first frame profile—(1 or 5) and said second frame profile—(2 or 6) such that the inner parts are in contact with the surface of the upper and lower membrane layers at the periphery of the membrane, that the outer parts of the two frame profiles are in contact with each other and that the inner parts form a longitudinal channel—(3 or 7) fitting the membrane,
 - wherein the edge of the inner parts in contact with the surfaces of the membrane layers, nearest to the membrane area, has a curved form, and
 - wherein an adhesive is used to attach the inner parts to the membrane layers and the outer parts to each other.
2. A filter element according to claim 1, wherein said inner parts—(12, 22, or 52, 62) of said first and second frame profiles are

provided with an adhesive accepting groove capable for accepting excess of said adhesive used for attaching the inner parts to the membrane layers.

3. A filter element according to claim 2, wherein said adhesive accepting groove is present beside the place where the adhesive is applied for attaching the inner parts to the membrane layers, nearest to the area of the membrane.
4. A filter element according to claim 1, wherein said inner parts ~~(12, 22, or 52, 62)~~ of said first and second frame profiles are provided with at least two adhesive accepting grooves on either side of the place where the adhesive is applied for attaching the inner parts to the membrane layers, said grooves being capable of accepting excess of adhesive.
5. A filter element according to any of the preceding claims 1 to 4, wherein said inner parts ~~(12, 22, or 52, 62)~~ of said first and second frame profiles are provided with at least one adhesive groove for applying adhesive for attaching the inner parts to the membrane layers.
6. A filter element according to claim 1, wherein at least one of said outer parts ~~(11, 21, or 54, 64)~~ of said first or second frame profile is provided with an adhesive accepting groove capable of accepting excess of said adhesive used for attaching the outer parts to each other.
7. A filter element according to claim 1, wherein each of said outer parts ~~(11, 21, or 54, 64)~~ of said first and second frame profiles are provided with an adhesive accepting groove capable of accepting excess of said adhesive used for attaching the outer parts to each other,
8. A filter element according to claim 6 or 7, wherein said adhesive accepting groove is present beside the place where the adhesive

is applied for attaching the outer parts to each other, nearest to the area of the membrane.

9. A filter element according to claim 1, wherein at least one of said outer parts ~~(11, 21, or 54, 64)~~ of said first or second frame profile is provided with at least two adhesive accepting grooves on either side of the place where the adhesive is applied for attaching the outer parts to each other, said grooves being capable of accepting excess of adhesive.
10. A filter element according to claim 1, wherein each of said outer parts ~~(11, 21, or 54, 64)~~ of said first and second frame profiles are provided with at least two adhesive accepting grooves on either side of the place where the adhesive is applied for attaching the outer parts to each other, said grooves being capable of accepting excess of adhesive.
11. A filter element according to any of the preceding claims 1 to 10, wherein said outer parts ~~(11, 21, or 54, 64)~~ of said first and second frame profiles are provided with at least one adhesive groove for applying adhesive for attaching the outer parts to each other.
12. A filter element according to any of the preceding claims 1 to 11, wherein an additional permeate contour channel is formed in said longitudinal channel along the border of the membrane for collecting and transporting of extracted permeate from the integrated permeate channel to said outlet opening of the membrane .
13. A method for making a filter element comprising the steps of:
 - providing an integrated permeate channel membrane ~~(4)~~ as defined in claim 1,
 - providing a first frame profile ~~(1 or 5)~~ and a second frame profile ~~(2 or 6)~~ as defined in any of the claims 1 to 11,
 - mounting the membrane ~~(4)~~ on the first frame profile such that the membrane is in contact with the inner part ~~(12 or 52)~~ of the

first frame profile,

- superpose the second frame profile on the first frame profile wherein the membrane is present such that the membrane is in contact with the inner part ~~(22 or 62)~~ of the second frame profile and that the outer parts ~~(11, 21, or 54, 64)~~ of the first and second frame profiles are in contact with each other,
- apply an adhesive between the inner part ~~(12 or 52)~~ of the first frame profile to one surface of the membrane, between the inner part ~~(22 or 62)~~ of the second frame profile to the other surface of the membrane and between the outer parts ~~(11, 21, or 54, 64)~~ of the first and second frame profiles, and
- attach the inner parts of the first and second frame profiles to either surface of the membrane and the outer parts of the first and second frame profiles to each other.

14. A filter module comprising a plurality of filter elements as defined in any of the preceding claims 1 to 12.
15. Method for improving the pressure applied during filtration process and/or backwashing process and for reducing the risk of leakage of the membrane and/or of damaging of the membrane surfaces by supporting an integrated permeate channel membrane defined in claim 1 and sealing the integrated permeate channel the edge of said membrane by a frame system as defined claim 1.