CLAIMS

1. A filter element comprising

- one or more fluid-pervious layers of a fluid-pervious sheet material having first and second surfaces in a substantially parallel arrangement,
- a fluid-impervious layer arranged in fluid tight contact with at least one of said first and second surfaces of said layer(s) of fluid-pervious sheet material to substantially fully cover the first and/or second surfaces thereof,
- one or more first and second edge portions, said first and second edge portions being arranged at a predefined distance and separated from one another by a predefined area of the fluid-pervious sheet material,
- a fluid flow path limited to and extending essentially parallel to the first and second surfaces from the first edge portion(s) to the second edge portion(s) within each of said layers of fluid-pervious sheet material, said first and second edge portions providing a fluid intake and a fluid drainage at the upstream and downstream ends of said fluid flow path, respectively.

2. The filter element of claim 1, wherein the fluid-impervious layer is materially bonded to the surface(s) of the fluid-pervious sheet material in a fluid tight manner.

3. The filter element of claim 1 or 2, wherein said fluid-impervious layer is in the form of a film.

4. The filter element of any one of claims 1 to 3, wherein said fluid-impervious layer is laminated onto the first and/or the second surface of the layer(s) of fluid-pervious sheet material.

5. The filter element of any one of claims 1 to 4, wherein said fluid-impervious layer is bonded to the first and/or second surface of the layer(s) of fluid-pervious sheet material under vacuum conditions.

6. The filter element of any one of claims 1 to 4, wherein said fluid-impervious layer has been created in situ on the first and/or second surface of the fluid-pervious sheet material, preferably by the application of a granular and/or fibrous polymeric material and processing of the same to form said fluid-impervious layer.

7. The filter element of any one of claims 1 to 6, wherein said fluid-impervious layer is made of a thermoplastic polymer material, said thermoplastic material being preferably selected from polyolefin, especially polyethylene or polypropylene, polyester and polyamide.

8. The filter element of any one of claims 1 to 7, wherein said fluid-impervious layer arranged in between two adjacent layers of fluid-pervious sheet material has a thickness about equal to or larger than the surface roughness of the fluid-pervious sheet material.

9. The filter element of any one of claims 1 to 8, wherein said fluid-pervious sheet material is a fibrous material, preferably comprising fibers selected from cellulosic fibers and polymer fibers, especially polyolefin fibers.

10. The filter element of any one of claims 1 to 9, wherein said fluid previous material comprises one or more additives, especially selected from organic and/or inorganic materials in fibrous, needle and/or granular form, optionally wherein said additives are selected from kieselguhr, perlite, PVPP and silica gel, preferably in particulate form, and preferably bonded to the matrix of the surrounding fluid-pervious sheet material by a resin compatible with the further components of the fluid-pervious layer; and preferably said one or more additives are comprised in the fluid-pervious sheet material in an amount of about 80 % by weight of the fluid-pervious sheet material or less.

11. The filter element of any one of claims 1 to 10, wherein a first fluid-impervious layer is arranged on the first surface of the layer of fluid-pervious sheet material and a second fluid-impervious layer is arranged on

the second surface of the fluid-pervious sheet material, said first and second fluid-impervious layers being preferably made of compatible materials, especially polymer materials, and more preferably are directly bonded to one another.

12. The filter element of any one of claims 1 to 11, wherein said fluid-impervious layer is bonded to the layer(s) of fluid-pervious sheet material with a bonding strength equal to or larger than the peeling strength of the fluid-pervious sheet material in a direction perpendicular to the surfaces of the fluid-pervious sheet material,
optionally wherein the fluid-impervious layers bonded to the first and second surfaces of one of the layers of fluid-pervious sheet material are bonded to one another by a plurality of bonding elements extending from one of the fluid-impervious layers through the layer of fluid-pervious sheet material to the other one of the fluid-impervious layers, said bonding elements being preferably regularly distributed over the area of the layer of fluid-pervious sheet material,
preferably wherein the cross-sectional areas of the bonding elements in a plane parallel to the surface of the fluid-pervious sheet material sum up to about 10 % or less, especially 5 % or less of the surface area of the layer of fluid-pervious sheet material.

13. A filter module comprising one or more filter elements according to any one of claims 1 to 12, said filter module having a fluid inlet arranged in fluid communication with the fluid intake(s) of the filter element(s) and a fluid outlet in fluid communication with the fluid drainage(s) of the filter element(s).

14. The filter module of claim 13, wherein said filter module further comprises two or more of the filter elements arranged in a stack such that said first edge portion(s) of each layer are provided in fluid communication with each other and said second edge portions are provided in fluid communication with each other, preferably directly bonded to one another,
optionally wherein the filter elements in the stack comprise a fluid-

impervious layer only on the first surface of the fluid-pervious sheet material and the second surface of the fluid-pervious sheet material is bonded, especially in a fluid tight manner, to the fluid-impervious layer of an adjacent filter element, a filter element on the bottom or top of the stack preferably comprising a second fluid-impervious layer bonded to the second surface of the fluid-pervious sheet material of said filter element.

15. The filter module of claim 13 or 14, wherein the module comprises on the top and/or on the bottom of the stack a fluid impervious layer in the form of a first and a second end plate, respectively,
optionally said first end plate being designed as a fluid distribution device providing a fluid flow path from the fluid inlet of the module to the fluid intake(s) of the filter elements and/or said second end plate being designed as a fluid collecting device providing a fluid flow path from the fluid drainage(s) of the filter elements to the fluid outlet of the module, wherein in case an endplate is provided on the top and on the bottom of the stack, preferably one of the end plates is in the form of a fluid distribution device and the other end plate is in the form of a fluid collecting device.

16. The filter module of claim 15, wherein said first and second end plates are designed as fluid distribution and fluid collecting devices and comprise a hollow chamber and have an inner rim around a central opening and an outer rim at the outer periphery, one of said rims comprising a plurality of openings providing a fluid communication to and from the hollow chamber in the interior of the end plate whereas the other rim being closed to seal off said hollow chamber to the environment.

17. The filter module of claim 15, wherein said first and second end plates are designed as fluid distribution and fluid collecting devices and one of them having an inner rim around a central opening and the other one an outer rim at the outer periphery, said rims extending from the end plates in a direction away from the respective surface fluid tightly contacting the stack of filter elements.

18. The filter module of claim 13, wherein the sheet material of the one or more filter elements is provided wound around a winding axis in multiple windings to form a spiral roll with an outer and an inner peripheral surface, said inner peripheral surface defining a central channel of the spiral roll, wherein the sheet material is provided with a first set of through-holes defining the first edge portions and being arranged such that they form one or more first channels extending radially in said spiral roll and wherein the sheet material is further provided with a second set of through-holes defining the second edge portions and being arranged such that they form one or more second channels extending radially and spaced apart from the first channels, said first or said second channels being open at the outer peripheral surface of the spiral roll and closed at the inner peripheral surface of the spiral roll;
and said other of said first and said second channels being closed at the outer peripheral surface of the spiral roll and open at the inner peripheral surface of the spiral roll;
preferably wherein adjacent surface areas of subsequent windings of the spiral roll of the filter element(s) are bonded, especially fluid tightly sealed, to one another.

19. The filter module of claim 18, wherein the filter module comprises a first and/or a second end plate attached to the top and bottom front end of the spiral roll, respectively.

20. A filter system comprising a housing and one or more filter modules of any one of claims 13 to 19, said housing comprising an inlet opening in fluid communication with the fluid inlet(s) of the filter module(s) and an outlet opening fluidly isolated from the fluid inlet opening and in fluid communication with the fluid outlet(s) of the filter module(s).

21. A process for manufacturing a filter element according to any one of claims 1 to 12, wherein
- a fluid-pervious sheet material is provided, preferably in the form of a coil, and

- a fluid-impervious layer is bonded at least to the first or the second surface thereof; and
- providing the first and second edge portions at a predefined distance and separated from one another by a predefined area of the fluid-pervious sheet material, preferably by punching.

22. The process of claim 21 wherein the fluid-impervious layer is provided as a film, preferably in the form of a coil, or is created *in situ* on one of the first and second surfaces of the fluid-pervious sheet material, and/or wherein a fluid-impervious layer is bonded to both the first and second surfaces of the fluid-pervious layer.

23. The process of claim 21 or 22, wherein bonding of the fluid-impervious layer to the first and/or second surface to the fluid-pervious layer is effected in a calendering step.

24. The process of any one of claims 21 to 23, wherein the fluid-pervious sheet material is provided with a plurality of small through-holes regularly distributed across the surface area of the layer of fluid-pervious sheet material prior to the application of the fluid-impervious layer(s), and optionally wherein the fluid-impervious layers on the first and second surfaces of the fluid-pervious sheet material are bonded to one another via said small through-holes.

Claims

1. A filter element comprising one or more fluid-pervious layers of a fluid-pervious sheet material having first and second surfaces in a substantially parallel arrangement, the first and second surfaces each having a surface roughness; a fluid-impervious layer arranged in fluid tight contact with at least one of said first and second surfaces of said one or more layers of fluid-pervious sheet material to fully cover the first and/or second surfaces thereof, providing a substantially flat leveled surface on the at least one of said first and second surfaces of said one or more layers of fluid-pervious sheet material; one or more first and second edge portions, said one or more first and second edge portions being arranged at a predefined distance and separated from one another by a predefined area of the fluid-pervious sheet material, a fluid flow path having an upstream end and a downstream end, the fluid flow path limited to and extending essentially parallel to the first and second surfaces from the one or more first edge portion(s) to the one or more second edge portion(s) within each of said one or more layers of fluid-pervious sheet material, wherein fluid flow along the fluid flow path is exclusively limited to flow within each of said one or more layers of fluid-pervious sheet material; said one or more first and one or more second edge portions providing a fluid intake and a fluid drainage at the upstream and downstream ends of said fluid flow path, respectively.

2. The filter element of claim 1, wherein the one or more fluid-impervious layers are materially bonded to the at least one of the first and second surfaces of the fluid-pervious sheet material in a fluid tight manner.

3. The filter element of claim 1, wherein said one or more fluid-impervious layers are in the form of a film.

4. The filter element of claim 1, wherein said one or more fluid-impervious layers are laminated onto the first and/or the second surface of the one or more layers of fluid-pervious sheet material.

5. The filter element of claim 1, wherein said one or more fluid-impervious layers are bonded to the first and/or second surface of the one or more layers of fluid-pervious sheet material under vacuum conditions.

6. The filter element of claim 1, wherein said one or more fluid-impervious layers have been created in situ on the first and/or second surface of the fluid-pervious sheet material.

7. The filter element of claim 1, wherein said one or more fluid-impervious layers are made of a thermoplastic polymer material.

8. The filter element of claim 1, wherein said one or more fluid-impervious layers arranged in between two adjacent layers of fluid-pervious sheet material have a thickness about equal to or larger than the surface roughness of the first and second surfaces of the fluid-pervious sheet material.

9. The filter element of claim 1, wherein said fluid-pervious sheet material is a fibrous depth filter material.

10. The filter element of claim 1, wherein said fluid-pervious sheet material comprises one or more additives.

11. The filter element of claim 1, wherein a first fluid-impervious layer is arranged on the first surface of the layer of fluid-pervious sheet material and a second fluid-impervious layer is arranged on the second surface of the fluid-pervious sheet material.

12. The filter element of claim 1, wherein said one or more fluid-impervious layers are bonded to the layer(s) of fluid-pervious sheet material with a bonding strength equal to or larger than a peeling strength of the fluid-pervious sheet material in a direction perpendicular to the first and second surfaces of the fluid-pervious sheet material.

13. A filter module comprising one or more filter elements according to claim 1, said filter module having a fluid inlet arranged in fluid communication with the fluid intake(s) of the filter element(s) and a fluid outlet in fluid communication with the fluid drainage(s) of the filter element(s).

14. The filter module of claim 13, wherein said filter module further comprises two or more of the filter elements arranged in a stack such that said one or more first edge portions of each layer are provided in fluid communication with each other and said one or more second edge portions are provided in fluid communication with each other.

15. The filter module of claim 13, wherein the module comprises on the top and/or on the bottom of the stack a fluid impervious layer in the form of a first and a second end plate, respectively.

16. The filter module of claim 15, wherein said first and second end plates are designed as fluid distribution and fluid collecting devices and comprise a hollow chamber and have an inner rim around a central opening and an outer rim at the outer periphery, one of said rims comprising a plurality of openings providing a fluid communication to and from the hollow chamber in the interior of the end plate whereas the other rim being closed to seal off said hollow chamber to the environment.

17. The filter module of claim 15, wherein said first and second end plates are designed as fluid distribution and fluid collecting devices and one of them having an inner rim around a central opening and the other one an outer rim at the outer periphery, said rims extending from the end plates in a direction away from the respective surface fluid tightly contacting the stack of filter elements.

18. The filter module of claim 13, wherein the sheet material of the one or more filter elements is provided wound around a winding axis in multiple windings to form a spiral roll with an outer and an inner peripheral surface, said inner peripheral surface defining a central channel of the spiral roll, wherein the sheet material is provided with a first set of through-holes defining the first edge portions and being arranged such that they form one or more first channels extending radially in said spiral roll and wherein the sheet material is further provided with a second set of through-holes defining the second edge portions and being arranged such that they form one or more second channels extending radially and spaced apart from the first channels, said first or said second channels being open at the outer peripheral surface of the spiral roll and closed at the inner peripheral surface of the spiral roll; and said other of said first and said second channels being closed at the outer peripheral surface of the spiral roll and open at the inner peripheral surface of the spiral roll.

19. The filter module of claim 18, wherein the filter module comprises a first and/or a second end plate attached to the top and bottom front end of the spiral roll, respectively.

20. A filter system comprising a housing and one or more filter modules of claim 13, said housing comprising an inlet opening in fluid communication with the fluid inlet(s) of the

filter module(s) and an outlet opening fluidly isolated from the fluid inlet opening and in fluid communication with the fluid outlet(s) of the filter module(s).

21. The filter element of claim 7, wherein said thermoplastic material is selected from polyolefin, polyester and polyamide.

22. The filter element of claim 10, wherein said one or more additives are comprised in the fluid-pervious sheet material in an amount of about 80% by weight of the fluid-pervious sheet material or less.

23. The filter element of claim 12, wherein the one or more fluid-impervious layers bonded to the first and second surfaces of one of the layers of fluid-pervious sheet material are bonded to one another by a plurality of bonding elements extending from one of the fluid-impervious layers through the layer of fluid-pervious sheet material to the other one of the fluid-impervious layers, said bonding elements being essentially regularly distributed over the area of the layer of fluid-pervious sheet material.

24. The filter element of claim 23, wherein the cross-sectional areas of the bonding elements in a plane parallel to the surface of the fluid-pervious sheet material sum up to about 10% or less of the surface area of the layer of fluid-pervious sheet material.

25. The filter module of claim 14, wherein the filter elements in the stack comprise a fluid-impervious layer only on the first surface of the fluid-pervious sheet material and the second surface of the fluid-pervious sheet material is bonded in a fluid tight manner to the fluid-impervious layer of an adjacent filter element.

26. The filter module of claim 15, wherein said first end plate is designed as a fluid distribution device providing a fluid flow path from the fluid inlet of the module to the fluid intake(s) of the filter elements and/or said second end plate is designed as a fluid collecting device providing a fluid flow path from the fluid drainage(s) of the filter elements to the fluid outlet of the module, wherein in case an endplate is provided on the top and on the bottom of the stack, one of the end plates is in the form of a fluid distribution device and the other end plate is in the form of a fluid collecting device.