

FLAT-PLATE MEMBRANE FILTER ELEMENT, MANUFACTURING METHOD THEREOF, FLAT-PLATE MEMBRANE FILTER MODULE AND MEMBRANE BIOREACTOR

5 TECHNICAL FIELD

[0001]

The present disclosure relates to a membrane filter element, in particular to a flat-plate membrane filter element for sewage purification, a manufacturing method thereof, a flat-plate membrane filter module comprising the flat-plate
10 membrane filter element, and a membrane bioreactor.

BACKGROUND

[0002]

The biochemical treatment process is widely applied in the current
15 sewage purification field. Sewage pollutants are removed by the biochemical reaction of microorganisms. The membrane bioreactor, taken as new water treatment technology, can perform sewage treatment by combining the biological treatment and the membrane separation process. As illustrated in FIG. 1, a purification system 1 in the conventional art generally consists of an inlet portion
20 11, a reaction portion 12 and an outlet portion 13, wherein the reaction portion 12 is usually provided with a nonwoven fabric membrane reaction tank 14; an aerator 15 and a membrane module 16 are disposed in the nonwoven fabric membrane reaction tank 14; the membrane module 16 is of a cylindrical shape; a nonwoven fabric membrane is formed on a surface of the membrane module 16; sewage
25 enters the nonwoven fabric membrane reaction tank 14 from an inlet 17, is filtered by the membrane module 16, and is discharged to the outlet portion 13 through an outlet pipe 18.

[0003]

The purification system has the defects that: as the surface strength of the

membrane module 16 is low and membrane fibers on the surface of the membrane module are frangible due to the cylindrical surface, so that the effluent quality can be reduced; and since the volume of the membrane module 16 is large, the placement density of the membrane module 16 in the nonwoven fabric membrane reaction tank 14 is low, so that the water treatment efficiency can be reduced.

[0004]

Moreover, in some purification systems in the conventional art, the membrane module 16 is made into a flat-plate shape. As illustrated in FIG. 2, a central portion of a flat-plate structure of the flat-plate membrane module 16 is hollow to accommodate filtered sewage, and the hollow portion is connected to the outlet pipe. As the flat-plate membrane module 16 adopts a hollow structure, the surface area of the flat-plate membrane module 16 cannot be set to be too large. When the surface area of the flat-plate membrane module is too large, the membrane elements of the flat-panel membrane module 16 cannot be well supported in the hollow portion of the flat-plate membrane module 16, so that the defect of deformed surface of the filter element of the membrane module 16 tends to occur in the center of the filter element. Moreover, as the area of the flat-plate membrane module 16 has to be reduced in order to improve the mechanical strength of the flat-plate membrane module 16, the effective size of the filter module can be greatly limited, and hence the effluent efficiency can be reduced.

SUMMARY

[0005]

One object of the present disclosure is to solve the technical problems of low strength and low filtration efficiency of the traditional flat-plate membrane filter element and provide an improved flat-plate membrane filter element. By modularization of the flat-plate membrane filter element, the number of the modularized flat-plate membrane filter elements can be set according to the actual size of a reaction tank, so as to satisfy the water treatment requirements of

different degrees.

[0006]

Another object of the present disclosure is to provide a method for manufacturing the flat-plate membrane filter element.

5 [0007]

Still another object of the present disclosure is to provide a flat-plate membrane filter module comprising the flat-plate membrane filter elements.

[0008]

10 Still another objective of the present disclosure is to provide a membrane bioreactor comprising the flat-plate membrane filter module.

[0009]

The present disclosure provides a flat-plate membrane filter element, which comprises: a membrane support member, wherein the membrane support member has a flat-plate shape and has a flow channel formed on a surface thereof,
15 an opening of the flow channel is formed on a side of the membrane support member; a nonwoven fabric membrane is placed on a surface of the membrane support member and provided with chemically modified coating layer, and the edges of the nonwoven fabric membrane are bonded to the membrane support member in such a way that the flow channel on the membrane support member is
20 covered by the nonwoven fabric membrane; and an outlet pipe is communicated with the opening of the flow channel.

[0010]

Based on the above concept, the chemically modified coating layer is a layer made of acrylic acid and derivatives thereof.

25 [0011]

Based on the above concept, a protruded structure is disposed at an area on a surface of the membrane support member, covered by the nonwoven fabric membrane.

[0012]

Based on the above concept, a thickness of the nonwoven fabric membrane is within 0.01 mm to 5 mm, and an average pore size is within 0.05 μm to 500 μm .

[0013]

5 Based on the above concept, the flow channels are respectively formed on an upper surface and a lower surface of the membrane support member.

[0014]

10 Based on the above concept, the nonwoven fabric membrane and the membrane support member are chemically or physically connected with each other to be coactive so provide necessary mechanical strength to the nonwoven fabric membrane.

[0015]

15 Based on the above concept, the flat-plate membrane filter element further comprises a supporting net which is disposed between the membrane support member and the nonwoven fabric membrane.

[0016]

20 Based on the above concept, the nonwoven fabric membrane has a stacked structure; and the stacked structure comprises: a substrate layer, a nonwoven fabric filter layer stacked on the substrate layer, and the chemically modified coating layer formed on the nonwoven fabric filter layer.

[0017]

Based on the above concept, the chemically modified coating layer is formed on a surface of the nonwoven fabric filter layer by glycerol polymerization.

25 [0018]

Based on the above concept, the chemically modified coating layer is formed on a surface of the nonwoven fabric filter layer by the implantation of modified hybrid fibers.

[0019]

Based on the above concept, an average pore size of the nonwoven fabric filter layer is within 0.05 μm to 500 μm , and an average pore size of the substrate layer is greater than the average pore size of the nonwoven fabric filter layer.

[0020]

5 Based on the above concept, both the substrate layer and the nonwoven fabric filter layers are made of polymer materials.

[0021]

10 The present disclosure further provides a flat-plate membrane filter module, wherein the flat-plate membrane filter module is formed by the stacking of a plurality of the flat-plate membrane filter elements based on the above concept; the flat-plate membrane filter elements are arranged in parallel, and certain distance is reserved between adjacent flat-plate membrane filter elements.

[0022]

15 The present disclosure further provides a membrane bioreactor, which comprises: an inlet portion, a reaction portion and an outlet portion, wherein the reaction portion comprises the flat-plate membrane filter module.

[0023]

The present disclosure further provides a method for manufacturing the flat-plate membrane filter element, which comprises:

20 providing the membrane support member and the nonwoven fabric membranes;

25 manufacturing the membrane support member into a flat-plate shape, and disposing the flow channel on the surface of the membrane support member in such a way that the opening of the flow channel is formed on the side of the membrane support member; and

 disposing the nonwoven fabric membrane on the surface of the membrane support member, disposing the chemically modified coating layer on the surface of the membrane support member, and bonding the edges of the nonwoven fabric membrane to the membrane support member in such a way that

the flow channel on the membrane support member is covered under the nonwoven fabric membrane.

[0024]

Based on the above concept, the nonwoven fabric membrane is provided with a stacked structure, the stacked structure comprises: a substrate layer, a nonwoven fabric filter layer stacked on the substrate layer, and the chemically modified coating layer formed on the nonwoven fabric filter layer, in which the chemically modified coating layer is formed on a surface of the nonwoven fabric filter layer by glycerol polymerization.

10 [0025]

Based on the above concept, the nonwoven fabric membrane is provided with a stacked structure, the stacked structure includes: a substrate layer, a nonwoven fabric filter layer stacked on the substrate layer, and the chemically modified coating layer formed on the nonwoven fabric filter layer, in which the chemically modified coating layer is formed on a surface of the nonwoven fabric filter layer by the implantation of modified hybrid fibers.

[0026]

The present disclosure has the following advantages.

1. The present disclosure provides the flat-plate membrane filter element with high strength and high filtration efficiency. As the flat-plate design is adopted, the surface tension of the nonwoven fabric membranes can be reduced, and hence the probability of the breakage of membrane fibers of the nonwoven fabric membranes due to tension can be effectively reduced.

[0027]

25 2. As the flat-plate design is adopted by the present disclosure and the serpentine flow channel is formed on the membrane support member, the mechanical strength and the filtration area of the membrane element can be improved and the filtration efficiency of the membrane element can be greatly improved as well.

[0028]

3. In the present disclosure, as the protruded structure or supporting net structure is formed on the surface of the support member of the membrane element, not only the nonwoven fabric membrane is well supported, but also an
5 accommodating space is formed between the nonwoven fabric membrane and the support member, and hence the collection and the discharge of filtered water can be conveniently achieved.

[0029]

4. The present disclosure provides a technical solution for the
10 modularization of the filter elements. In the actual production process, the number of the required filter elements can be set according to the actual device space size, and hence more economical and efficient filter module can be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

15 [0030]

FIG. 1 is a schematic structural view of a biochemical system in the prior art;

FIG. 2 is another schematic structural view of the biochemical system in the prior art;

20 FIG. 3 is a schematic structural view of a flat-plate membrane filter element of the present disclosure;

FIG. 4 is a schematic structural exploded view of the flat-plate membrane filter element of the present disclosure;

25 FIG. 5 is a schematic structural exploded view of another embodiment of the flat-plate membrane filter element of the present disclosure;

FIG. 6 is a schematic diagram of a stacked structure of a nonwoven fabric membrane in another embodiment of the flat-plate membrane filter element of the present disclosure;

FIG. 7 is a front view of a flat-plate membrane filter module of the

present disclosure;

FIG. 8 is a side view of the flat-plate membrane filter module of the present disclosure;

FIG. 9 is a schematic structural view of a membrane bioreactor of the present disclosure; and

FIG. 10 is a schematic structural view of another embodiment of the membrane bioreactor of the present disclosure.

DETAILED DESCRIPTION

10 [0031]

Further description will be given below to the structure of the flat-plate membrane filter element of the present disclosure with reference to FIGS. 3 and 4.

[0032]

The present disclosure provides a flat-plate membrane filter element 2, which comprises a membrane support member 21 and nonwoven fabric membranes 22. The membrane support member 21 has a flat-plate shape, a serpentine flow channel 24 is formed on a surface of the membrane support member 21, openings of the flow channel 24 are formed on the side of the membrane support member 21 and communicated with outlet pipes 25. The nonwoven fabric membranes 22 are disposed on the surfaces of the membrane support member 21 respectively; and the peripheral edge of the nonwoven fabric membranes 22 is bonded to the membrane support member 21 in such a way that the serpentine flow channel 24 on the membrane support member 21 is covered under the nonwoven fabric membrane 22. A protruded structure 23 is disposed at an area on the surface of the membrane support member 21, covered by the nonwoven fabric membranes 22, and is configured to avoid the defects of narrowed space and reduced sewage filtration efficiency caused by the bonding between the nonwoven fabric membrane 22 and the membrane support member 21 as the nonwoven fabric membrane is closely attached to the surface of the

membrane support member 21 during the sewage filtration due to the water pressure. It should be noted that a dotted line portion on the membrane support member 21 as illustrated in FIG. 4 indicates that a plurality of serpentine flow channel structures of the flow channel 24 may be disposed herein, which is not limited to the structure as shown in the figure.

[0033]

The above embodiment is only intended to illustrate the structure of the flat-plate membrane filter element 2 and not intended to limit the present disclosure. The flow channels 24 on the membrane support member 21 of the present disclosure may be respectively distributed on the upper surface and the lower surface of the membrane support member 21. The opening(s) of the flow channel 24 may be one opening at one end or two openings at both ends of the flow channel 24; and the openings of the flow channel 24 may be formed on one side of the membrane support member 21 and may also be formed on different sides of the membrane support member. The outlet pipes 25 are respectively disposed at the openings of the flow channels 24 formed on different surfaces and communicated with the openings; and the openings of the flow channels 24 on different surfaces may converge to share one outlet pipe 25. Meanwhile, the serpentine shape of the flow channels 24 may be the shape as shown in the figure, and the flow channels 24 may also be U-shaped, square or zigzagged and may also adopt a netted structure. The technical solution of the present disclosure includes all the forms which could be thought by those skilled in the art, in which a groove is formed on a flat plate provided with a central support structure. The nonwoven fabric membranes 22 of the present disclosure may be made of many polymer materials such as polyene, polyester, polyamide, polypropylene and acrylics; the thickness of the nonwoven fabric membranes 22 is within 0.01 to 5 mm; and the average pore size is within 0.05 to 500 μm . Moreover, the nonwoven fabric membranes 22 may be formed by many techniques such as electrostatic spinning so that the average pore size of the nonwoven fabric membranes 22 can

be better controlled.

[0034]

The average pore size of the membrane support member 21 of the present disclosure is greater than that of the corresponding nonwoven fabric membranes 22. The membrane support member 21 is chemically or physically connected with the nonwoven fabric membranes 22 to be coactive and provide necessary mechanical strength for the nonwoven fabric membranes 22 on the membrane support member 21.

[0035]

Another embodiment of the present disclosure will be described below with reference to FIGS. 3 to 5. In another embodiment of the present disclosure, the flat-plate membrane filter element 2 further comprises supporting nets 26 which are disposed between the membrane support member 21 and the nonwoven fabric membranes 22, made of resin materials, and provided with netted structures. The function of the supporting nets 26 is the same with the function of the protruded structures 23 on the surfaces of the membrane support member 21, but the technical effect of this case is obviously superior to the technical effect of the case that only the protruded structures are disposed on the surfaces of the membrane support member 21. The supporting nets 26 are configured to smoothly support the nonwoven fabric membranes between the membrane support member 21 and the nonwoven fabric membranes 22, so that sufficient spaces can be reserved between the membrane support member 21 and the nonwoven fabric membranes 22, and hence the filtration area of the nonwoven fabric membranes 22 during the sewage filtration can be increased and the sewage filtration efficiency can be improved. In particular, when the protruded structures on the surfaces of the membrane support member 21 are used together with the supporting nets 26, the effect is better.

[0036]

In still another embodiment of the present disclosure, as illustrated in

FIG. 6, the nonwoven fabric membrane 22 of the flat-plate membrane filter element 2 of the present disclosure has a stacked structure; and the stacked structure includes: a substrate layer 221 on the innermost layer, a nonwoven fabric filter layer 222 stacked on the substrate layer 221, and a chemically modified coating layer 223 formed on the nonwoven fabric filter layer 222, wherein the nonwoven fabric filter layer 222 may be made of many polymer materials such as polyene, polyester, polyamide, polypropylene and acrylics; the thickness of the nonwoven fabric membranes 22 is within 0.01 to 5 mm; and the average pore size is within 0.05 to 500 μm . In addition, the substrate layer 221 may be made of nonwoven fabric membrane materials of which the average pore size is greater than that of the nonwoven fabric filter layer 222. Moreover, the chemically modified coating layer 223 may be formed on a surface on one side of the nonwoven fabric filter layer 222, far away from the substrate layer 221, by glycerol polymerization or by the implantation of modified hybrid fibers, and may be made of acrylic acid and derivatives thereof, such as methacrylic acid, ethylene acrylic acid, acrylate or acrylamide and derivatives thereof. The chemically modified coating layer 223 can improve the hydrophilicity and the surface smoothness of the nonwoven fabric membrane 22, add the effect such as negative surface charges of the flat-plate membrane filter element 2, so as to improve the sewage filtration efficiency of the flat-plate membrane filter element 2. FIG. 6 only illustrates the stacked structure of the nonwoven fabric membrane 22 on one side of the membrane support member 21, and the stacked structure on the other side of the membrane support member 21 is the same with the structure as shown in the figure, and hence symmetrical structures can be formed. All the other structures of the filter element 2 are the same with those of the foregoing embodiments and will not be described herein.

[0037]

The present disclosure further provides a method for manufacturing the flat-plate membrane filter element, which comprises:

providing the membrane support member 21 and the nonwoven fabric membranes 22;

manufacturing the membrane support member 21 into a flat-plate shape, and disposing the flow channels 24 on the surface of the membrane support member 21 in such a way that the openings of the flow channels 24 are formed on the side of the membrane support member 21; and

disposing the nonwoven fabric membranes 22 on the surfaces of the membrane support member 21, disposing the chemically modified coating layer 223 on the surfaces of the membrane support member 21, and bonding the edges of the nonwoven fabric membranes 22 to the membrane support member 21 in such a way that the flow channels 24 on the membrane support member 21 are covered under the nonwoven fabric membranes 22.

[0038]

Preferably, the chemically modified coating layer 223 is formed on the surface of the nonwoven fabric filter layer 222 by glycerol polymerization or by the implantation of modified hybrid fibers.

[0039]

As illustrated in FIGS. 7 and 8, the present disclosure further provides a flat-plate membrane filter module 3, which is formed by a plurality of flat-plate membrane filter elements 2, wherein the plurality of the flat-plate membrane filter elements 2 are arranged in parallel; the flat-plate membrane filter module 3 is provided with a frame 31; the plurality of the flat-plate membrane filter elements 2 are mounted in the frame 31 by mutual stacking, and certain distance is reserved between adjacent flat-plate membrane filter elements 2; whereby the flat-plate membrane filter module 3 can be formed. Moreover, outlet pipes are disposed on the flat-plate membrane filter module 3 and connected with outlet pipes 25 of each flat-plate membrane filter element 2 for the unified collection of filtered sewage.

[0040]

The present disclosure further provides a membrane bioreactor 4, which will be described below with reference to FIGS. 9 and 10. The membrane bioreactor 4 comprises an inlet portion 41, a reaction portion 42 and an outlet portion 43, wherein the inlet portion 41 includes a water pump 411 and a liquid level relay 412; the water pump 411 is configured to pump sewage to be treated at the inlet portion 41 into the reaction portion 42; the liquid level relay 412 is configured to monitor the liquid level position of the inlet portion; the reaction portion 42 comprises a bioreaction tank 421, an aerator 422, a water distribution plate 423, a vacuum detector 425 and the foregoing flat-plate membrane filter module 3 of the present disclosure. The reaction portion 42 is compartmented into an aerobic section A and an anaerobic section B by the water distribution plate 423; the sewage enters the reaction tank 421 from a water inlet 424 of the reaction portion 42, enters the aerobic section A from the anaerobic section B, is aerated by the aerator 422 to achieve staggered flow, and is fully and uniformly mixed with active sludge in the reaction portion 42; a large number of microorganism are propagated, so that biogel layers are quickly formed on the surface of the flat-plate membrane filter module 3 by metabolites of the microorganisms and solid particles, so as to form biomembranes. When the sewage passes through the flat-plate membrane filter module 3, suspended particulate substances are filtered by the flat-plate membrane filter module 3, and organic substances are adsorbed and degraded by the surface biomembranes layer by layer; the sewage is progressively purified and enters spaces formed between the membrane support members 21 and the nonwoven fabric membranes 22 in the flat-plate membrane filter elements 2 of the flat-plate membrane filter module 3, supported by protruded structures 23 on the surfaces of the membrane support members 21, converges in the serpentine flow channels 24 on the surface of the membrane support members 21, and automatically flows out from the outlet pipes 25 under the drive of the height difference between the reaction liquid level of the reaction portion 42 and the outlet portion 43. The vacuum detector 425 is configured to

detect the pressure of the outlet pipes.

[0041]

In another embodiment of the present disclosure, the flat-plate membrane filter element 2 further comprises supporting nets 26, so that spaces wider than those of the above embodiment can be formed between the membrane support member 21 and the nonwoven fabric membranes 22, which is more conducive to the collection of the filtered sewage.

[0042]

In still another embodiment of the present disclosure, chemically modified coating layer 223 is formed on the surface of the nonwoven fabric membrane 22 of the flat-plate membrane filter element 2. In the embodiment, the chemically modified coating layer 223 of the flat-plate membrane filter element 2 can improve the hydrophilicity and the surface smoothness of the nonwoven fabric membranes 22, add the effect such as negative surface charges of the flat-plate membrane filter element 2, and hence improve the sewage filtration efficiency.

[0043]

The flat-plate membrane filter module 3 of the reaction portion 42 of the membrane bioreactor 4 of the present disclosure may be disposed in the bioreaction tank 421 to form an immersed membrane bioreactor, and may also be disposed in a tank having sewage from the reaction tank, except for the bioreaction tank 421, to form a distributed membrane bioreactor 4, as illustrated in FIG. 10. The structure and the principle of other devices are the same with the structure and the principle of the immersed membrane bioreactor, and will not be further described.

[0044]

In the membrane bioreactor 4 of the present disclosure, a negative-pressure pump (not shown in the figure) and a time relay 431 are arranged inside the outlet portion 43 to actively pump out purified water in the

flat-plate membrane filter element 2 through the outlet pipes 25 and form negative pressure in the flat-plate membrane filter element 2, so as to improve the sewage filtration efficiency. Moreover, the time relay 431 is configured to control the operating time of the negative-pressure pump.

5 [0045]

The experimental example adopts an immersed flat-plate nonwoven fabric membrane bioreactor to treat bath water. The analysis of the water quality is as shown in Table 1. The nonwoven fabric membranes 22 of the flat-plate membrane filter element 2 are made of polyethylene materials. The surface pore
10 size of the nonwoven fabric membranes 22 is 30 μm ; the total thickness is 2 mm; and the porosity is 52.2%.

[0046]

The operating conditions of the reaction portion are as follows:

the sludge concentration: 4000 mg/L;

15 the initial flux: 15L/m²h.

[0047]

Table 1: Analysis of the Water Quality of Bath Water

Technical Parameter	COD (mg/L)	BOD5 (mg/L)	SS (mg/L)	pH	Turbidity (mg/L)	LAS (mg/L)	H4+-N (mg/L)	Total nitrogen (mg/L)
Measured Value	90-400	45-70	200-450	7.1-7.5	150-250	5-9	12-20	16-30

[0048]

20 After the operation for a month, the quality of the treated water can be stably reduced to the national standard: the reuse of urban recycling water - water quality standard for urban miscellaneous water consumption (GB/T 18920-2002). The flux is reduced to a certain degree but can be restored to be close to the initial flux after physical backwash, so that the obvious fouling phenomenon can be

avoided.

[0049]

The foregoing is only the detailed description and illustration of preferred
embodiments of the present disclosure. The characteristics of the present
5 disclosure are not limited thereto. The scope of the present disclosure should be
determined by the following scope. All the embodiments in accordance with the
spirit of the scope of protection of the appended claims of the present disclosure
and similar variations thereof should fall within the scope of the present
disclosure. All the variations or adjustments easily obtained by those skilled in the
10 art within the field of the present disclosure should fall within the scope of
protection of the appended claims of the present disclosure.

Claims

1. A flat-plate membrane filter element, comprising:

a membrane support member (21);
a nonwoven fabric membrane (22); and
an outlet pipe (25),

wherein the membrane support member (21) has a flat-plate shape; a flow channel (24) is formed on a surface of the membrane support member (21); an opening of the flow channel (24) is formed on a side of the membrane support member (21);

the nonwoven fabric membrane (22) is placed on a surface of the membrane support member (21) and provided with chemically modified coating layer (223); edges of the nonwoven fabric membrane (22) are bonded to the membrane support member (21) in such a way that the flow channel (24) on the membrane support member (21) is covered under the nonwoven fabric membrane (22); and

the outlet pipe (25) is communicated with the opening of the flow channel (24),

wherein a protruded structure (23) is disposed at an area on a surface of the membrane support member (21), the surface being covered by the nonwoven fabric membrane (22), and

the flat-plate membrane filter element (2) further comprises a supporting net (26) which is disposed between the membrane support member (21) and the nonwoven fabric membrane (22), the supporting net (26) and the nonwoven fabric membrane (22) being positioned over the protruded structure (23).

2. The flat-plate membrane filter element according to claim 1, wherein the chemically modified coating layer (223) is a layer made of acrylic acid and derivatives thereof.

3. The flat-plate membrane filter element according to claim 1,

wherein a thickness of the nonwoven fabric membrane (22) is within 0.01 mm to 5 mm, and an average pore size of the nonwoven fabric is within 0.05 μm to 500 μm .

4. The flat-plate membrane filter element according to claim 1, wherein the flow channels (24) are respectively disposed on an upper surface and a lower surface of the membrane support member (21).

5. The flat-plate membrane filter element according to claim 1, wherein the nonwoven fabric membrane (22) and the membrane support member (21) are chemically or physically connected with each other to be coactive, so as to provide necessary mechanical strength to the nonwoven fabric membrane.

6. The flat-plate membrane filter element according to any one of claims 1 to 5, wherein the nonwoven fabric membrane (22) has a stacked structure; and the stacked structure comprises: a substrate layer (221), a nonwoven fabric filter layer (222) stacked on the substrate layer (221), and the chemically modified coating layer (223) formed on the nonwoven fabric filter layer (222).

7. The flat-plate membrane filter element according to claim 6, wherein the chemically modified coating layer (223) is formed on a surface of the nonwoven fabric filter layer (222) by glycerol polymerization.

8. The flat-plate membrane filter element according to claim 6, wherein the chemically modified coating layer (223) is formed on a surface of the nonwoven fabric filter layer (222) by the implantation of modified hybrid fibers.

9. The flat-plate membrane filter element according to claim 6, wherein an average pore size of the nonwoven fabric filter layer (222) is 0.05 μm to 500 μm , and an average pore size of the substrate layer (221) is greater than the average pore size of the nonwoven fabric filter layer

(222).

10. The flat-plate membrane filter element according to claim 6, wherein both the substrate layer (221) and the nonwoven fabric filter layer (222) are made of polymer material.

11. A flat-plate membrane filter module, comprising:

a plurality of the flat-plate membrane filter elements (2) according to any one of claims 1 to 8,

wherein the flat-plate membrane filter elements (2) are mounted in a frame by stacking, and are arranged in parallel; and a certain distance is reserved between the adjacent flat-plate membrane filter elements (2).

12. A membrane bioreactor, comprising:

an inlet portion (41);

a reaction portion (42); and

an outlet portion (43),

wherein the reaction portion (42) comprises the flat-plate membrane filter module according to claim 11.

13. A method for manufacturing the flat-plate membrane filter element according to claim 1, comprising:

providing the membrane support member (21) and the nonwoven fabric membrane (22);

manufacturing the membrane support member (21) into a flat-plate shape, and disposing the flow channel (24) on the surface of the membrane support member (21) in such a way that the opening of the flow channel (24) is formed on the side of the membrane support member (21); and

disposing the nonwoven fabric membrane (22) on the surface of the membrane support member (21), disposing the chemically modified coating layer (223) on the surface of the nonwoven fabric membrane (22), and bonding the edges of the nonwoven fabric membranes (22) to the

membrane support member (21) in such a way that the flow channel (24) on the membrane support member (21) is covered under the nonwoven fabric membrane (22);

disposing a protruded structure (23) at an area on a surface of the membrane support member (21), the surface being covered by the nonwoven fabric membrane (22), and

disposing a supporting net (26) between the membrane support member (21) and the nonwoven fabric membrane (22).

14. The manufacturing method according to claim 13, wherein the nonwoven fabric membrane (22) is provided with a stacked structure;

the stacked structure comprises: a substrate layer (221), a nonwoven fabric filter layer (222) stacked on the substrate layer (221), and the chemically modified coating layer (223) formed on the nonwoven fabric filter layer (222); and

the chemically modified coating layer (223) is formed on a surface of the nonwoven fabric filter layer (222) by glycerol polymerization.

15. The manufacturing method according to claim 13, wherein the nonwoven fabric membrane (22) is provided with a stacked structure;

the stacked structure comprises: a substrate layer (221), a nonwoven fabric filter layer (222) stacked on the substrate layer (221), and the chemically modified coating layer (223) formed on the nonwoven fabric filter layer (222); and

the chemically modified coating layer (223) is formed on a surface of the nonwoven fabric filter layer (222) by the implantation of modified hybrid fibers.