CLAIMS

1. A separation membrane element for filtration configured to perform solid-liquid separation treatment by being immersed in a liquid to be treated which contains a suspended component, the separation membrane element comprising:

a cylindrical filtration membrane obtained by forming a porous sheet including at least an expanded porous PTFE (polytetrafluoroethylene) membrane into a cylindrical shape and in which a hollow surrounded by the porous sheet serves as a treated-liquid passage;

a support member for maintaining the hollow serving as the treated-liquid passage; and

sealing parts which seal both axial-direction ends of the cylindrical filtration membrane so as to leave at least one treated-liquid takeout opening open.

2. The separation membrane element for filtration according to Claim 1, wherein the cylindrical filtration membrane has a circular cylindrical shape with a diameter of 3 to 50 mm.

3. The separation membrane element for filtration according to Claim 1 or 2, wherein the porous sheet constituting the cylindrical filtration membrane is formed into a cylindrical shape by rolling a sheet and bonding both edges of the sheet, or bonding edges of a plurality of sheets to each other.

4. The separation membrane element for filtration according to any one of Claims 1 to 3, wherein the expanded porous PTFE membrane constituting the porous sheet has a mean pore diameter of 0.01 to 5.0 μm, a mean maximum length of 30 μm or less in a fibrous skeleton which surrounds pores, and an average thickness of 5 to 200 μm.

5. The separation membrane element for filtration according to any one of Claims 1 to 4, wherein the porous sheet is composed of a single layer including the expanded porous PTFE membrane only or a plurality of layers including the expanded porous PTFE membrane and a dense layer provided on the outer surface of the expanded porous PTFE membrane, the dense layer being composed of at least one fluorocarbon resin selected from the group consisting of PTFE, PFA, and FEP and having pores that are finer than those of the layer of the expanded porous PTFE membrane.

6. The separation membrane element for filtration according to any one of Claims 1 to 5, wherein the support member is composed of a metal material coated with a polyolefin

resin or a fluorocarbon resin, a polyolefin resin, a polyester resin, or a fluorocarbon resin, and the support member is in the shape of a mesh, a fiber assembly, a perforated sheet, or a pleated member having continuing v-shaped bent portions.

7. The separation membrane element for filtration according to any one of Claims 1 to 6, wherein the support member is bonded to a part of the internal surface or the entire internal surface of the cylindrical filtration membrane.

8. The separation membrane element for filtration according to any one of Claims 1 to 7, wherein the support member is composed of a worked plate provided with a plurality of outlets in communication with the treated-liquid takeout opening, the support member is arranged at least on the treated-liquid takeout opening side end of the cylindrical filtration membrane, and the outer peripheral surface thereof is fixed to the inner peripheral surface of the cylindrical filtration membrane.

9. The separation membrane element for filtration according to any one of Claims 1 to 8, wherein the sealing parts are formed by closing both axial-direction ends of the cylindrical filtration membrane by sealing using heating under pressure or a laser, and the treated-liquid takeout opening is formed without being closed by sealing.

10. The separation membrane element for filtration according to any one of Claims 1 to 8', wherein the sealing parts are constituted by a pair of frames disposed at both axial-direction ends of the cylindrical filtration membrane, and the frames are fixed to both ends of the cylindrical filtration membrane.

11. The separation membrane element for filtration according to Claim 10, wherein the frames are disc-shaped, and the pair of disc-shaped frames are connected to each other by an interconnecting frame having a length corresponding to the length in the axial direction of the cylindrical filtration membrane.

12. The separation membrane element for filtration according to Claim 10 or 11, wherein the frames are composed of a resin material including a polyolefin resin or a fluorocarbon resin or composed of a metal material coated with the polyolefin resin or the fluorocarbon resin.

13. A membrane module for filtration used for external pressure filtration or immersion-type pressure suction filtration, the membrane module comprising a plurality of separation membrane elements for filtration according to any one of Claims 1 to 12, wherein the separation membrane elements for filtration are connected to each other with a space therebetween.

14. The membrane module for filtration according to Claim 13, wherein the separation membrane elements for filtration are arranged in parallel, a common treated-liquid collecting tube is disposed above the separation membrane elements, and the treated-liquid takeout opening provided on the upper surface of each of the separation membrane elements for filtration arranged in parallel is connected to an end of its corresponding branch tube branched from the common treated-liquid collecting tube so that the separation membrane elements for filtration are suspended and supported.

15. The membrane module for filtration according to Claim 13 or 14, wherein the membrane module for filtration is immersed in a retention tank for a liquid to be treated which includes effluent containing activated sludge.

16. The membrane module for filtration according to Claim 15, wherein the liquid to be treated contains 5,000 to 30,000 mg/L of MLSS (mixed liquor suspended solids).

CLAIMS

1. A separation membrane element for filtration configured to perform solid-liquid separation treatment by being immersed in a liquid to be treated which contains a suspended component, the separation membrane element comprising:

a cylindrical filtration membrane obtained by forming a porous sheet including at least an expanded porous PTFE (polytetrafluoroethylene) membrane into a cylindrical shape and in which a hollow surrounded by the porous sheet serves as a treated-liquid passage;

a support member for maintaining the hollow serving as the treated-liquid passage; and

sealing parts which seal both axial-direction ends of the cylindrical filtration membrane so as to leave at least one treated-liquid takeout opening open,

wherein the support member is in the shape of a nonwoven fabric, a net, or a pleated member having continuing v-shaped bent portions.

2. The separation membrane element for filtration according to Claim 1, wherein the cylindrical filtration membrane has a circular cylindrical shape with a diameter of 3 to 50 mm.

3. The separation membrane element for filtration according to Claim 1 or 2, wherein the porous sheet constituting the cylindrical filtration membrane is formed into a cylindrical shape by rolling a sheet and bonding both edges of the sheet, or bonding edges of a plurality of sheets to each other.

4. The separation membrane element for filtration according to any one of Claims 1 to 3, wherein the expanded porous PTFE membrane constituting the porous sheet has a mean pore diameter of 0.01 to 5.0 μm, a mean maximum length of 30 μm or less in a fibrous skeleton which surrounds pores, and an average thickness of 5 to 200 μm.

5. The separation membrane element for filtration according to any one of Claims 1 to 4, wherein the porous sheet is composed of a single layer including the expanded porous PTFE membrane only or a plurality of layers including the expanded porous PTFE membrane and a dense layer provided on the outer surface of the expanded porous PTFE membrane, the dense layer being composed of at least one fluorocarbon resin selected from the group consisting of PTFE, PFA, and FEP and having pores that are finer than those of the layer of the expanded porous PTFE membrane.

6. The separation membrane element for filtration according to any one of Claims 1 to 5, wherein the support member is composed of a metal material coated with a polyolefin resin or a fluorocarbon resin, a polyolefin resin, a polyester resin, or a fluorocarbon resin.

7. The separation membrane element for filtration according to any one of Claims 1 to 6, wherein the support member is bonded to a part of the internal surface or the entire internal surface of the cylindrical filtration membrane.

8. The separation membrane element for filtration according to any one of Claims 1 to 7, wherein the support member is composed of a worked plate provided with a plurality of outlets in communication with the treated-liquid takeout opening, the support member is arranged at least on the treated-liquid takeout opening side end of the cylindrical filtration membrane, and the outer peripheral surface thereof is fixed to the inner peripheral surface of the cylindrical filtration membrane.

9. The separation membrane element for filtration according to any one of Claims 1 to 8, wherein the sealing parts are formed by closing both axial-direction ends of the cylindrical filtration membrane by sealing using heating under pressure or a laser, and the treated-liquid takeout opening is formed without being closed by sealing.

10. The separation membrane element for filtration according to any one of Claims 1 to 8, wherein the sealing parts are constituted by a pair of frames disposed at both axial-direction ends of the cylindrical filtration membrane, and the frames are fixed to both ends of the cylindrical filtration membrane.

11. The separation membrane element for filtration according to Claim 10, wherein the frames are disc-shaped, and the pair of disc-shaped frames are connected to each other by an interconnecting frame having a length corresponding to the length in the axial direction of the cylindrical filtration membrane.

12. The separation membrane element for filtration according to Claim 10 or 11, wherein the frames are composed of a resin material including a polyolefin resin or a fluorocarbon resin or composed of a metal material coated with the polyolefin resin or the fluorocarbon resin.

13. A membrane module for filtration used for external pressure filtration or immersion-type pressure suction filtration, the membrane module comprising a plurality of separation membrane elements for filtration according to any one of Claims 1 to 12, wherein the separation membrane elements for filtration are connected to each other with a

space therebetween.

14. The membrane module for filtration according to Claim 13, wherein the separation membrane elements for filtration are arranged in parallel, a common treated-liquid collecting tube is disposed above the separation membrane elements, and the treated-liquid takeout opening provided on the upper surface of each of the separation membrane elements for filtration arranged in parallel is connected to an end of its corresponding branch tube branched from the common treated-liquid collecting tube so that the separation membrane elements for filtration are suspended and supported.

15. The membrane module for filtration according to Claim 13 or 14, wherein the membrane module for filtration is immersed in a retention tank for a liquid to be treated which includes effluent containing activated sludge.

16. The membrane module for filtration according to Claim 15, wherein the liquid to be treated contains 5,000 to 30,000 mg/L of MLSS (mixed liquor suspended solids).