

permeability, wherein the rejection rate hardly decreases even when the surface of the separation functional layer is worn; a porous support layer (separation functional layer) is not readily peeled off from a porous substrate such as a nonwoven fabric; and further, even if clogging has once occurred, the clogging substance can be readily removed, has been proposed.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0009]

Patent Document 1: JP 2006-247453 A

Patent Document 2: JP 11-114381 A

Patent Document 3: JP 2010-99590 A

Patent Document 4: JP 2003-144869 A

~~SUMMARY OF THE INVENTION~~

~~PROBLEMS TO BE SOLVED BY THE INVENTION~~

[0010]

However, the separation membrane elements described above are not sufficient in terms of improvement in performance, in particular, stable performance during the operation over a long period of time. For example, for the method described in Patent Document 1, only the flow resistance at the permeate side is reduced, and the flow resistance-reducing effect is not sufficient due to the resistance on the sheet surface. For the method described in Patent Document 2, because of having a hollow passage extending in the direction parallel to the membrane surface in a flat membrane, it is difficult to increase the height of unevenness on the surface, and the uneven shape is limited (a groove with a level difference of 0.15 mm in Examples) and the shape of the permeate flow path is also limited; thus the effect of reducing the flow resistance at the feed side and at the permeate side is not sufficient. For the method described in Patent Document 3, only the membrane performance

when using a cell for flat membrane evaluation is described in Examples of Patent Document 3, and the performance when a separation membrane element is actually constituted is not disclosed in Patent Document 3; when the separation membrane element is actually operated with pressure thereon, the cross-sectional area of the feed fluid and permeate flow path is prone to change, and the performance tends to change during the operation over a long period of time.

[0011]

On the other hand, the separation membrane element described in Patent Document 4 as a separation membrane element suitable for treatment of, for example, sewage has an effect on the improvement of durability but, in terms of water permeability, requires improvement because the design of a spacer is not sufficient.

[0012]

Thus an object of the embodiments disclosed herein~~present invention~~ is to provide a separation membrane element that is able to increase the amount of permeate fluid per unit time and also able to improve stability performance.

MEANS FOR SOLVING THE PROBLEMS

[0013]

The ~~present invention~~disclosure for achieving the object described above has any of the constitution below.

(1) A separation membrane element comprising a separation membrane and a permeate spacer,

wherein a separation functional layer is arranged on the surface of said separation membrane and a nonwoven fabric served as a substrate is arranged on the back surface of said separation membrane,

wherein said permeate spacer is arranged on the back surface side of said substrate,

wherein said permeate spacer is made of a different material from said

(11) The separation membrane element according to any one of (1) to (7) above, wherein the above-described separation membrane is composed of the above-described substrate and the separation functional layer formed on the substrate.

In a first aspect, there is provided a separation membrane element comprising a separation membrane and a permeate spacer.

wherein the separation membrane is either (i) a membrane composed of a separation functional layer, a porous support layer, and a substrate or (ii) a membrane composed of a separation functional layer and a substrate.

wherein said separation functional layer is arranged on the surface of said separation membrane and a nonwoven fabric served as said substrate is arranged on the back surface of said separation membrane.

wherein said permeate spacer is arranged on the back surface side of said substrate,

wherein said permeate spacer is made of a different material from said separation membrane and has a discontinuous structure, wherein said permeate spacer is impregnated into said separation membrane and a projection area ratio of said permeate spacer to said separation membrane is 0.03 to 0.80.

~~EFFECTS OF THE INVENTION~~

[0014]

According to the present ~~invention~~disclosure, by placing a permeate spacer of a different material having a particular projection area ratio to a separation membrane on the permeate side of a separation membrane element, a stable permeate flow path that provides a reduced flow resistance and does not readily undergo a change over time is formed, and a separation membrane element having an enhanced permeation performance while maintaining the separation performance can be obtained.

Consequently, a separation membrane element having both a high separation performance and a high permeation performance can be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Figure 1 is a cross-sectional schematic view illustrating one aspect of the separation membrane and the permeate spacer in the separation membrane element
5 of the present invention; and

Figure 2 is a cross-sectional schematic view illustrating another aspect of the separation membrane and the permeate spacer in the separation membrane element of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

10 [0016]

The present invention will now be described in more detail.

[0017]

The present invention is a separation membrane element comprising a separation membrane and a permeate spacer. The permeate spacer is made of a
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