[0005]

[Patent Literature 1]

WO 2011/111679

[Patent Literature 2]

WO 2013/012024

[Patent Literature 3]

WO 2016/113964

[Summary of Invention]

[Technical Problem]

[0006]

However, the hollow fiber membrane mentioned in Patent Literature 1 has a substantially homogeneous structure and tends to have low pure water permeability.

[0007]

The hollow fiber membranes mentioned in Patent Literatures 2 and 3 contain a copolymer of vinylpyrrolidone and vinyl acetate to suppress clogging due to protein adhesion. However, since both hollow fiber membranes have low permeability, there is a need to treat under high pressure.

[0008]

Embodiments of the present invention provide a hollow fiber membrane which has excellent removing performance of substances to be separated such as viruses, and can be used as a separation membrane having high permeability even in a treatment under low pressure.

[Solution to Problem]

[0009]

According to a first aspect of the present invention, there is provided a porous hollow fiber membrane containing a polysulfone-based polymer as a main component, which has an

asymmetric structure in which the inner surface side is dense and the outer surface side is coarse, wherein an average of a minor axis diameter of pores of an inner surface is 20 nm or more and 40 nm or less, an open porosity of the inner surface is 5% or more and 30% or less, and a polymer including a monocarboxylic acid vinyl ester unit is supported on at least one of the outer surface and the inner surface.

According to a second aspect of the present invention, there is provided a purification system for obtaining desired cells or proteins from a solution containing cells and proteins, comprising the above porous hollow fiber membrane and a separation membrane having pores each having a diameter smaller than that in the hollow fiber membrane, wherein the porous hollow fiber membrane and the separation membrane are arranged such that the solution is sequentially treated by the porous hollow fiber membrane and the separation membrane.

[Advantageous Effects of Invention]

[0010]

According to embodiments of the porous hollow fiber membrane of the present invention, it is possible to perform separation of biological components, particularly separation of proteins such as antibodies, from viruses under low pressure in a short time.

[Brief Description of the Drawings]

[0011]

Fig. 1 is a SEM image of a cross-section of a porous hollow fiber membrane fabricated in Example 1 taken at 10,000 times.