As a result, those portions of the semi-permeable membrane through which a large permeation flow occurs are apt to be fouled, and there is a problem that attempts to inhibit the fouling result in a decrease in overall osmotic permeation amount and this in turn results in a decrease in power generation amount. There are cases where a high-concentration brine, such as a high-concentration discharge water obtained through seawater desalination or Dead Sea brine, is used for the purpose of utilizing a large concentration difference to highly efficiently generate electricity. However, the higher the concentration, the more the problem becomes severe. Consequently, it is difficult to attain stable high-efficiency power generation.

[0012]

Embodiments of the invention~~An object of the invention is to~~ provide an apparatus in which low-concentration water having a low osmotic pressure and high-concentration water having a high osmotic pressure are brought into contact with each other through a semi-permeable membrane interposed therebetween and the permeation flow caused by forward osmosis phenomenon is utilized as energy to efficiently and stably conduct hydroelectric power generation, and is to provide a method for operating the apparatus.

MEANS FOR SOLVING THE PROBLEMS

[0013]

~~In order to solve the above-mentioned problem, a concentration-difference power generation apparatus of the present invention~~According to a first aspect of the present invention, there is provided a concentration-difference power generation in which high-concentration water and low-concentration water which differ in their concentrations are brought into contact with each other through a semi-permeable membrane unit including a semi-permeable membrane, and a resultant increase in an amount of the high-concentration water due to permeation of water from a low-concentration side to a high-concentration side caused by a forward osmotic

pressure is utilized to drive an electric generator to generate electricity, in which the semi-permeable membrane unit is divided into a plurality of subunits and includes a high-concentration-side intermediate channel and a low-concentration-side intermediate channel which connect the subunits, and the concentration-difference power generation apparatus includes a pressure change mechanism disposed on at least one of the high-concentration-side intermediate channel and the low-concentration-side intermediate channel.

[0013a]

According to a second aspect of the present invention, there is provided a method for operating a concentration-difference power generation apparatus, wherein, in the concentration-difference power generation apparatus, high-concentration water and low-concentration water which differ in their concentrations are brought into contact with each other through a semi-permeable membrane unit comprising a semi-permeable membrane, and a resultant increase in an amount of the high-concentration water due to permeation of water from a low-concentration side to a high-concentration side caused by a forward osmotic pressure is utilized to drive an electric generator to generate electricity, the semi-permeable membrane unit is divided into a plurality of subunits and comprises a channel for the high-concentration water and a channel for the low-concentration water which connect the subunits, and the apparatus comprises a pressure change mechanism disposed on at least one of the channel for the high-concentration water and the channel for the low-concentration water, and the method comprises controlling the apparatus so that a maximum value of a permeation amount per membrane area of at least one subunit is kept to a set value or lower.

ADVANTAGE OF THE INVENTION

[0014]

According to embodiments of the invention, it becomes possible to efficiently and stably conduct hydroelectric power generation by a technique in which low-concentration water having a low osmotic pressure and high-concentration water having a high osmotic pressure are brought into contact with each other through a semi-permeable membrane interposed therebetween and the permeation flow caused by forward osmosis phenomenon is utilized as energy.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

[Fig. 1] Fig. 1 is a diagrammatic flowchart which illustrates one embodiment of a concentration-difference power generation apparatus including a plurality of subunits and further including a pressure-regulating valve on a channel for high-concentration water which connects the subunits.

[Fig. 2] Fig. 2 is a diagrammatic flowchart which illustrates one embodiment of a concentration-difference power generation apparatus including a plurality of subunits