CLAIMS

What is claimed is:

1. A cation exchange membrane at least comprising:

a membrane body containing a fluorine-based polymer having an ion-exchange group; and

two or more reinforcing core materials arranged approximately in parallel within the membrane body,

wherein the reinforcing core materials are at least one selected from the group consisting of polytetrafluoroethylene (PTFE), a tetrafluoroethylene-perfluoroalkylvinyl ether copolymer (PFA), a ethylene-tetrafluoroethylene copolymer (ETFE), a tetrafluoroethylene-hexafluoropropylene copolymer, a trifluorochlorethylene-ethylene copolymer and a polyvinylidene fluoride (PVDF), and

wherein the membrane body is provided with two or more elution holes formed between the reinforcing core materials adjacent to each other, and

assuming that a distance between the reinforcing core materials adjacent to each other is represented by a, a distance between the reinforcing core materials and the elution holes adjacent to each other is represented by b, a distance between the elution holes adjacent to each other is represented by c, and the number of the elution holes formed between the reinforcing core materials adjacent to each other is represented by n, then a, b, c, and n satisfying the relationship represented by the following expression (1) or expression (2) are at least present.

$b > a/(n+1)$... (1), and $n=2$

$c > a/(n+1)$... (2), and $n=2$

in the case where a, b and n satisfies the relationship represented by expression (1), a, c, and n further satisfy the relationship represented by the following expression (3)

$0.2a/(n+1) \leq c \leq 0.9a/(n+1)$ ... (3)

; or

in the case where a, c and n satisfy the relationship represented by expression (2), a, c and n further satisfy the relationship represented by the following expression (5)

$$1.1a/(n+1) \leq c \leq 0.8a \quad \ldots (5).$$

~~2. The cation exchange membrane according to claim 1, wherein a, c, and n further satisfy the relationship represented by the following expression (3).~~

~~$0.2a/(n+1) \leq c \leq 0.9a/(n+1) \ldots (3)$~~

~~3~~2. The cation exchange membrane according to claim 1 ~~or 2~~, wherein a, b, and n further satisfy the relationship represented by the following expression (4).

$$a/(n+1) < b \leq 1.8a/(n+1) \ldots (4)$$

~~4. The cation exchange membrane according to claim 1 or 3, wherein a, c, and n further satisfy the relationship represented by the following expression (5).~~

$$~~1.1a/(n+1) \leq c \leq 0.8a \ldots (5)~~$$

~~5~~3. The cation exchange membrane according to ~~any one of~~ claim~~s~~ 1 ~~to 4~~or 2, wherein

a first interval between the reinforcing core materials in which a, b, c, and n satisfy the relationship represented by the expression (1), and

a second interval between the reinforcing core materials in which a, b, c, and n satisfy the relationship represented by the expression (2) are alternately present.

~~6~~4. The cation exchange membrane according to claim ~~5~~3, wherein

in the first interval between the reinforcing core materials, a, b, c, and n further satisfy the relationships represented by the following expression (3) and the following expression (4), and

in the second interval between the reinforcing core materials, a, b, c, and n further satisfy the relationship represented by the following expression (5).

$$0.2a/(n+1) \leq c \leq 0.9a/(n+1) \ldots (3)$$

$a/(n+1) < b \leq 1.8a/(n+1)$... (4)

$1.1a/(n+1) \leq c \leq 0.8a$... (5)

~~7~~5. The cation exchange membrane according to claim ~~5~~ 3 or ~~6~~4, wherein the first interval between the reinforcing core materials satisfying the relationship represented by the following expression (6) and the second interval between the reinforcing core materials satisfying the relationship represented by the following expression (7) are alternately present.

$n=2, b > a/3$... (6)

$n=2, c > a/3$... (7)

~~8~~6. The cation exchange membrane according to any one of claims ~~5~~ 3 to ~~7~~5, wherein the first interval between the reinforcing core materials satisfying the relationship represented by the following expression (8) and the second interval between the reinforcing core materials satisfying the relationship represented by the following expression (9) are alternately present.

$n=2, 0.2a/3 \leq c \leq 0.9a/3, a/3 < b \leq 1.8a/3$... (8)

$n=2, 1.1a/3 \leq c \leq 0.8$... (9)

~~9~~7. The cation exchange membrane according to claim 1, wherein a, b, c, and n satisfying the relationship represented by the above expression (1) or the above expression (2) are at least present in a MD direction and in a TD direction of the cation exchange membrane.

~~10~~8. The cation exchange membrane according to claim ~~6~~4, wherein the first interval between the reinforcing core materials satisfying the

relationships represented by the expression (3) and the expression (4) or the second interval between the reinforcing core materials satisfying the relationship represented by the expression (5) is present in the MD direction and in the TD direction of the cation exchange membrane.

~~11~~9. A method for producing the cation exchange membrane according to claim 1, the method comprising the steps of:

weaving two or more reinforcing core materials, a sacrifice yarn soluble in an acid or an alkali, and a dummy yarn soluble in a predetermined solvent in which the reinforcing core materials and the sacrifice yarn are insoluble, to obtain a reinforcing material having the sacrifice yarn and the dummy yarn arranged between the reinforcing core materials adjacent to each other;

soaking the reinforcing material in the predetermined solvent to remove the dummy yarn from the reinforcing material;

stacking the reinforcing material from which the dummy yarn is removed and a fluorine-based polymer having an ion-exchange group or an ion-exchange group precursor which can be converted into the ion-exchange group by hydrolysis, to form a membrane body having the reinforcing material; and

soaking the sacrifice yarn in an acid or an alkali to remove the sacrifice yarn from the membrane body, thereby forming an elution hole in the membrane body.

~~12~~10. An electrolysis vessel at least comprising: an anode; a cathode; and the cation exchange membrane according to any one of claims 1 to ~~10~~8 arranged between the anode and the cathode.