

Description

The present invention relates to apparatus for drying a wet using a vapour permeable membrane.

As is well known, the polymers of perfluoroethylene sulphonic acid that are available under the trade name Nafion of E. I. DuPont de Nemours, have the useful property of being freely permeable to the passage of water vapour but almost impermeable to nearly all other gases and vapours. Tubing and membranes made of this material are therefore used to add or remove water vapour from gas mixtures or from flowing stream or gas mixtures.

One disadvantage of such a perfluoroethylene sulphonic acid polymer is that it is a very strong acid and somewhat unstable to heat. It can not, for example, be used at the temperature of boiling water 100°C. This temperature limitation limits the use of this material for separating gases and vapours from steam.

Although it has previously been proposed to neutralise perfluoroethylene sulphonic acid polymers by replacing the hydrogen ion of the sulphonic acid by sodium or potassium, the resulting material, while being more heat stable, has been very much less permeable to water vapour.

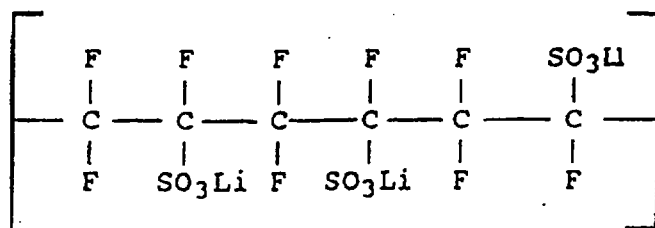
It has also been proposed to use neutralised perfluoroethylene sulphonic acid polymers in alkaline ion-exchange membrane water electrolyzers (see Journal of Applied Electro-Chemistry 10 (1980) 741-747, R.S. Yeo et al) with sodium, potassium or lithium hydroxide being used as the electrolyte. Although increased thermal stability was exhibited by the neutralised polymers, their water vapour permeability was not considered.

It is an object of the invention to provide gas-drying apparatus employing a membrane of a material that is more stable than the foregoing polymer but still water-vapour permeable.

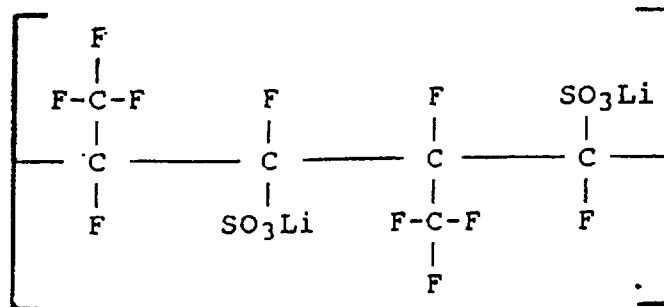
According to the present invention, there is provided apparatus for drying a wet gas including a water-vapour permeable membrane separating a gas to be dried from a drying agent, said membrane being made from a perfluorocarbon polymer having lithium sulphate groups covalently bonded to its carbon skeleton.

The lithium polymer is not only more stable to heat but also neutral and less likely to react with labile compounds or to catalyse their decomposition.

In a preferred embodiment of the invention of the polymer concerned is a polymer of perfluoroethylene of the following form:



However, other perfluorocarbon polymers may be used, for example:



The method of neutralisation is to steep a perfluorocarbon sulphonic acid polymer material in lithium hydroxide solution for a few hours, followed by washing with water and drying.

It is therefore a straightforward matter to produce products made of the lithium-neutralised polymer, since products made of the un-neutralised polymer material (for example, tubes, membranes) can simply be taken and immersed in lithium hydroxide solution to produce improved-stability products.

Gas-drying apparatus embodying the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawing which is a longitudinal cross-section through the apparatus.

Small diameter, thin-walled tubing obtained from E. I. DuPont de Nemours under their trade name "Nafion" was immersed in lithium hydroxide for several hours before being washed and dried. The sulphonic acid groups of the original tubing were converted to lithium sulphate groups.

The tubing was divided into lengths 11 which were used to construct the illustrated gas-drying apparatus.

This apparatus comprises a cylinder 10 surrounding a bundle of the tubing lengths 11. The tubing lengths pass through end seals 12 in the cylinder 10 and terminate in connections 14, 15 that permit a stream of wet gas to be passed through the tubing lengths 11. The body of the cylinder is provided with input and output connectors 16, 17 to enable a drying agent to be passed over the outside of the tubing lengths 11.

In use, a wet gas such as nitrogen and steam is passed through the tubing lengths 11 via the connectors 14, 15 in the direction of the arrows A. A dry gas (dry air) is passed over the outside of the tubing lengths 11 via the connectors 16, 17 in the direction of arrows B. The water vapour in the wet gas stream passes through the walls of the tubing lengths 11 into the dry gas; as a result, the wet gas is substantially dried by the time it exists the apparatus.

Apparatus of the illustrated form has been found to work well and survive at 100°C and to dry steam-saturated nitrogen or other gases at this temperature.

Claims

1. Apparatus for drying a wet gas including a water-vapour permeable membrane (11) separating a gas to be dried from a drying agent, said membrane (11) being made from a perfluorocarbon polymer having lithium sulphate groups covalently bonded to its carbon skeleton.

2. Apparatus according to claim 1, wherein the membrane (11) is made from a perfluoroethylene sulphonic acid polymer neutralized with lithium ions.

3. Apparatus according to either claim 1 or claim 2, wherein the membrane is in the form of tubing (11) through which the gas to be dried is arranged to flow.

4. Apparatus according to claim 3, wherein said drying agent is arranged to pass along the outside of said tubing (11).

5. An apparatus according to claim 4, wherein the drying agent is gaseous.

Patentansprüche

1. Gerät zum Trocknen eines feuchten Gases mit einer Wasserdampf-durchlässigen Membran (11) zum Trennen eines zu trocknenden Gases von einem Trocknungsmittel, wobei die Membran (11) aus einem Perfluorkohlenstoffpolymer hergestellt ist, welche Lithiumsulfatgruppen hat, die in kovalenter Weise mit seinem Kohlenstoffskelett verbunden sind.

2. Gerät nach Anspruch 1, bei dem die Membran (11) aus einem Perfluoräthylen-Schwefelsäure-Polymer, das mit Lithiumionen neutralisiert ist, hergestellt ist.

3. Gerät nach entweder Anspruch 1 oder Anspruch 2, bei dem die Membran die Form einer Röhre (11) hat, durch welche das zu trocknende Gas anordnungsgemäß fließt.

4. Gerät nach Anspruch 3, bei dem das Trocknungsmittel angeordnet ist, um längs der Außenseite der Röhre (11) zu verlaufen.

5. Gerät nach Anspruch 4, bei dem das Trocknungsmittel gasförmig ist.

Revendications

1. Dispositif pour le séchage d'un gaz humide, comportant une membrane perméable à la vapeur d'eau (11) séparant un gaz devant être séché d'un agent de dessiccation, ladite membrane (11) étant réalisée en un polymère perfluorocarboné présentant des groupes sulfate de lithium liés, de façon covalente, à son ossature carbonée.

2. Dispositif selon la revendication 1, dans lequel la membrane (11) est réalisée en un polymère d'acide perfluoroéthylène sulfonique, neutralisé au moyen d'ions lithium.

3. Dispositif selon la revendication 1 ou la revendication 2, dans lequel la membrane présente la forme d'un tube (11) à travers lequel le gaz devant être séché est amené à s'écouler.

4. Dispositif selon la revendication 3, dans lequel ledit agent de séchage est amené à s'écouler le long de la face extérieure dudit tube (11).



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