

Description

[Title of Invention] SWITCHING APPARATUS FOR ADSORPTION TOWERS

[Technical Field]

[0001]

The present invention relates to a switching apparatus that switches adsorption processes between at least two adsorption towers.

[Background Art]

[0002]

In conventional large-scale air separation apparatuses or nitrogen generating apparatuses, a method used include removing moisture and carbon dioxide from compressed air by a refining apparatus, and performing low temperature separation in a cold box. In this refining apparatus, moisture and carbon dioxide are removed by using adsorption towers filled with an adsorbent such as activated alumina and zeolite. Generally, two or more adsorption towers are used in order to operate the air separation apparatus. For example, while refining process of air is performed in a first tower, heat regeneration or pressure regeneration is performed in a second tower that is at a saturation point of adsorption with moisture or carbon dioxide.

Then, these respective processes are switched between the first tower and the second tower. Therefore, such a refining apparatus has at least two adsorption towers, and a switching apparatus including valves and pipes for performing switching operation of these.

[0003]

For example, the switching apparatus has a complicated configuration for switching at least two adsorption towers, and is not easy in construction, and transportation to an installation place after assembly of the switching apparatus in a manufacturing factory is excellent in workability, and economical.

[0004]

Patent Literature 1 discloses a configuration in which a part or all of devices composing an air separation apparatus are housed in at least one container, flange structures are used for connecting parts of pipes between the container and the devices outside the container and between the container and other container, and connector structures are used for connecting parts of wires, for the purpose of simplification of transportation and assembly work. As a specific configuration, an air compressor, a catalyst tube, and a control apparatus are housed in a container 1a, raw material air pretreating facilities such as a chiller unit, an air cooler, a heater, an absorber, and an absorber controller, and a control apparatus are housed

in a container 1b. Patent Literature 1 discloses that this configuration can be applied to a small air liquefying and separating apparatus, and can be also applied to a small pressure fluctuation type adsorbing and separating apparatus. In the description, although containers having various sizes and shapes can be manufactured within the limit of transportation, its object is to merely house a pretreating facility set in a single container.

[0005]

Patent Literature 2 discloses a flexible module type air rectifying facility applicable to almost all air rectifying facilities even a large size. More specifically, Patent Literature 2 discloses a "warm" module (3) connected to two adsorption type air refining bottles. The "warm" module (3) is connected to an air compression module (1) and a low-temperature module (4), and has a function of switching adsorb/regeneration processes in the two adsorption type air refining bottles. However, the "warm" module (3) is disclosed only in a single frame configuration.

[Citation List]

[Patent Literature]

[0006]

[Patent Literature 1]

Japanese Utility Model Laid-Open No. 4-27388

[Patent Literature 2]

Japanese Patent Laid-Open No. 6-347164

[Summary of Invention]

[Technical Problem]

[0007]

Recently, with increase in the size of an air separation apparatus, the switching apparatus increases in size, and there is a concern that transportation becomes impossible due to space restriction of a transport path. In such a case, it is still possible to transport and assemble components of the switching apparatus at an installation place. However, necessary complicated piping construction increases cost of field erection, and construction may substantially become impossible due to the shortage of skilled worker recently.

[0008]

In view of the above problem, an object of the present invention is to provide a switching apparatus enabling transportation even a large switching apparatus, and capable of minimizing site construction.

[Solution to Problem]

[0009]

A switching apparatus according to the present invention includes:

a gas header module (11) having at least a feed-in part (L1, 31) for feeding gas in, and a feed-out part (L6, 32) for feeding gas out; and

a first switching module (12) and a second switching module (13) disposed on opposite sides of the gas header module (11).

[0010]

The gas header module (11) may have piping layout having:

a first branch feed-in pipe (L1a) that branches from a main pipe (L1) of the feed-in part of the gas header module (11) to extend toward the first switching module (12), and a second branch feed-in pipe (L1b) that branches from the main pipe of the feed-in part of the gas header module to extend toward the second switching module (13);

a first branch feed-out pipe (L6a) that corresponds to a pipe (first feed-out side branch pipe (L5a)) extending from the first switching module (12), and a second branch feed-out pipe (L6b) that corresponds to a pipe (third feed-out side branch pipe (L10a)) extending from the second switching module (13); and

a coupling pipe (L12) that connects a pipe (second feed-out side branch pipe (L5b)) extending from the first switching module (12) with a pipe (fourth feed-out side branch pipe (L10b)) extending from the second switching module (13).

The first branch feed-out pipe (L6a) and the second branch feed-out pipe (L6b) may be joined to be connected to the main pipe (L6) of the feed-out part of the gas header module.

[0011]

The first switching module (12) may have: a first feed-in side pipe (L2) coupled to a first branch feed-in pipe (L1a), and coupled to an inlet pipe (L3) of a first adsorption tower (201), and a first feed-out side main pipe (L5) coupled to an outlet pipe (L4) of the first adsorption tower (201); a first feed-out side branch pipe (L5a) that branches from the first feed-out side main pipe (L5) to be coupled to a first branch feed-out pipe (L6a); and a second feed-out side branch pipe (L5b) that branches from the first feed-out side main pipe to be coupled to a coupling pipe (L12).

The "coupling" of the pipes may be a connection made with flanges.

[0012]

The second switching module (13) has: a second feed-in side pipe (L7) coupled to a second branch feed-in pipe (L1b), and coupled to an inlet pipe (L8) of a second adsorption tower (202), and a second feed-out side main pipe (L10) coupled to an outlet pipe (L9) of the second adsorption tower (202); and a third feed-out side branch pipe (L10a) that branches from the second feed-out side main pipe (L10) to be coupled to a second branch feed-out

pipe (L6b); and a fourth feed-out side branch pipe (L10b) that branches from the second feed-out side main pipe (L10) to be coupled to a coupling pipe (L12).

The "coupling" of the pipes may be a connection made with flanges.

[0013]

In the coupling pipe (L12), a pressure balancing valve (pressure balancing valve; 111) may be installed. In place of or in addition to the pressure balancing valve (111), a pressure balancing valve may be installed in at least one of or both the second feed-out side branch pipe (L5b) and the fourth feed-out side branch pipe (L10b). A pressure control valve, and a constant-pressure valve may be disposed in place of the pressure balancing valve.

In the first feed-out side branch pipe (L5a), a valve (123) may be installed. The valve (123) has a function of an isolation valve (isolation valve).

In the third feed-out side branch pipe (L10a), a valve (133) may be installed. The valve (133) has a function of an isolation valve.

In place of or in addition to the valve (123) of the first feed-out side branch pipe (L5a) and the valve (133) of the third feed-out side branch pipe (L10a), an isolation valve may be installed in at least one of or both the first branch feed-out pipe (L6a) and the second branch feed-out pipe (L6b).

[0014]

Piping layout of the first switching module and piping layout of the second switching module may be symmetrical with reference to the gas header module.

Piping layout of the first switching module and piping layout of the second switching module may be asymmetric with reference to the gas header module.

[0015]

In the first feed-in side pipe (L2), a depressurizing valve (depressurizing valve; 122) may be provided.

In the second feed-in side pipe (L7), a depressurizing valve (132) may be provided.

[0016]

The gas header module (11), the first switching module (12), and the second switching module (13) are each dividable into an upper part and a lower part with reference to a height position of the coupling pipe (L12) of the gas header module (11).

The height of the coupling pipe (L12) is not particularly limited, but the height of 20 to 80% of the module height from a lowermost part to an uppermost part is exemplified.

The coupling pipe (L12) may be disposed in any of an upper side and a lower side of the divide gas header module (11).

The second feed-out side branch pipe (L5b) and the fourth feed-out side branch pipe (L10b) coupled to the coupling pipe (L12) may be disposed in any of an upper part and a lower part of the divided module similarly.

The gas header module (11), the first switching module (12), and the second switching module (13) are each configured to be dividable, so that it is possible to previously perform assembly as a small module, and perform easy installation on site.

[0017]

Examples of the shape of a frame (strut) of each module composing the switching apparatus include a column and a prism, but the shape of the frame (strut) of each module is preferably a cube or a rectangular parallelepiped shape in view of assembling easiness and strength.

[0018]

A size of the switching apparatus (size housed in a rectangular parallelepiped shape) may be set on the basis of the pipe diameter of a main pipe (such as L1, L1a, L1b, L6, L6a, L6b, L2, L5, L7, and L10) to be set corresponding to a required raw material air amount.

A size (length a, width b, height c) of each of the modules housed in a rectangular parallelepiped shape may be set on the basis of a pipe diameter of a main pipe (such as L1, L1a, L1b, L6, L6a, L6b, L2, L5, L7, and L10)

to be set corresponding to a required raw material air amount, and a transportation limit size.

According to this, the module size can be determined depending on a pipe diameter set according to a raw material air amount, and transportation limit size, so that module design can be more easily performed.

[0019]

According to the switching apparatus having such a configuration, it is possible to provide a switching apparatus enabling transportation even a large switching apparatus, and capable of minimizing site construction.

[Brief Description of Drawings]

[0020]

[Figure 1] Figure 1 is a diagram illustrating a configuration example of a switching apparatus of Embodiment 1.

[Figure 2A] Figure 2A is a diagram illustrating a module design example of the switching apparatus of Embodiment 1.

[Figure 2B] Figure 2B is a diagram illustrating a module design example of the switching apparatus of Embodiment 1.

[Figure 3] Figure 3 is a diagram illustrating a configuration example of a switching apparatus of Embodiment 2.

[Figure 4] Figure 4 is a diagram illustrating a configuration example of a switching apparatus of Embodiment 3.

[Description of Embodiments]

[0021]

(Embodiment 1)

A switching apparatus 1 of Embodiment 1 will be described with reference to Figure 1. The switching apparatus 1 of Embodiment 1 is divided into three modules. The switching apparatus 1 includes a gas header module 11 having a feed-in part (L1, 31) for feeding gas in, and a feed-out part (L6, 32) for feeding gas out, a first switching module 12 and a second switching module 13 disposed on opposite sides of the gas header module 11. In this embodiment, piping layout of the first switching module 12, and piping layout of the second switching module 13 are symmetrical with reference to the gas header module 11.

A main pipe L1 of the feed-in part is connected to an inlet connection part 31. A main pipe L6 of the feed-out part is connected to an outlet connection part 32. The inlet connection part and the outlet connection part are connectable with other external pipe, and a flange, respectively.

Respective coupling parts (23, 24, 25, 26, 27, 28) of the modules are connectable with flanges.

The gas header module 11 functions so as to feed gas into the first switching module 12 and the second switching module 13, and receive gas fed out from the

first switching module 12 and the second switching module 13 such that adsorption process and regeneration process are alternately performed in a first adsorption tower 201 and a second adsorption tower 202.

[0022]

The gas header module 11 located at the center has a first branch feed-in pipe L1a that branches from the main pipe L1 of the feed-in part of the gas header module 11 to extend toward the first switching module 12, a second branch feed-in pipe L1b that branches from the main pipe L1 of the feed-in part of the gas header module 11 to extend toward the second switching module 13, and a first branch feed-out pipe L6a that corresponds to a first feed-out side branch pipe L5a extending from the first switching module 12, a second branch feed-out pipe L6b that corresponds to a third feed-out side branch pipe L10a extending from the second switching module 13, and a coupling pipe L12 that connects a second feed-out side branch pipe L5b extending from the first switching module 12, and a fourth feed-out side branch pipe L10b extending from the second switching module 13.

The first branch feed-out pipe L6a and the second branch feed-out pipe L6b are joined to be connected to the main pipe L6 of the feed-out part.

[0023]

The first switching module 12 has a first feed-in side pipe L2 coupled to the first branch feed-in pipe L1a,

and coupled to an inlet pipe L3 of the first adsorption tower 201, a first feed-out side main pipe L5 coupled to the outlet pipe L4 of the first adsorption tower 201, a first feed-out side branch pipe L5a that branches from the first feed-out side main pipe L5 to be coupled to the first branch feed-out pipe L6a, and a second feed-out side branch pipe L5b that branches from the first feed-out side main pipe L5 to be coupled to the coupling pipe L12.

[0024]

The second switching module 13 has a second feed-in side pipe L7 coupled to the second branch feed-in pipe L1b, and coupled to an inlet pipe L8 of the second adsorption tower 202, a second feed-out side main pipe L10 coupled to an outlet pipe L9 of the second adsorption tower 202, the third feed-out side branch pipe L10a that branches from the second feed-out side main pipe L10 to be coupled to the second branch feed-out pipe L6b, and a fourth feed-out side branch pipe L10b that branches from the second feed-out side main pipe L10 to be coupled to the coupling pipe L12.

[0025]

In the coupling pipe L12, a pressure balancing valve 111 is installed. In the first feed-out side branch pipe L5a, an isolation valve 123 is installed. In the third feed-out side branch pipe L10a, an isolation valve 133 is installed. In the first feed-in side pipe L2, a

depressurizing valve 122 is provided. In the second feed-in side pipe L7, a depressurizing valve 132 is provided.

[0026]

The shape of a frame (strut) of each of the modules 11, 12, 13 composing the switching apparatus 1 is a rectangular parallelepiped shape, and the module size (length a, width b, height c) is determined depending on a raw material air amount, the pipe diameters of the main pipes (L1, L1a, L1b, L6, L6a, L6b, L2, L5, L7, L10 and the like), and transportation limit size.

[0027]

Respective design examples of the modules are described in Figures 2A and 2B.

In a case in which the respective raw material air amounts were 30000 Nm³/h, 50000 Nm³/h, and 90000 Nm³/h, the respective pipe diameters were set to 18, 24, and 32 inches. In this condition, the entire sizes of the switching apparatus were calculated.

As the transportation limit size, the rectangular parallelepiped shape of the switching apparatus is divided such that one of three orthogonal sides of the rectangular parallelepiped shape is within 3.5 m, and other sides are each within 5 m.

(1) Case in which the raw material air amount is 30000 Nm³/h

Length a: 2.7 m (8 m are divided into three portions)

Width b: 4 m (within 5 m)

Height c: 5 m (within 5 m)

(2) Case in which the raw material air amount is 50000 Nm³/h

Length a: 3.4 m (10 m are divided into three portions)

Width b: 6 m

Height c: 3.5 m (7 m are divided into two portions)

(3) Case in which the raw material air amount is 90000 Nm³/h

Length a: 3.2 m (22 m are divided into seven portions)

Width b: 5 m (10 m are divided into two portions)

Height c: 11 m

A case in which the raw material air amount is 30000 Nm³/h can be accommodated by the module division of Embodiment 1 (Figure 1).

The pipe diameter in accordance with the raw material air amount is an example, and is not particularly limited to numeral values of Figure 2.

The module division is not limited to the division in the length direction, but may be the division in the width direction, or in the height direction.

[0028]

(Embodiment 2)

A switching apparatus 1 of Embodiment 2 will be described with reference to Figure 3.

Components different from the components of Embodiment 1 will be described, and components denoted by the same reference numerals have functions similar to Embodiment 1.

In Figure 3, a gas header module can be divided into an upper part and a lower part, and has a lower gas header module 11a, and an upper gas header module 11b.

In this embodiment, a feed-out pipe L6, a first branch feed-out pipe L6a, a second branch feed-out pipe L6b, and a coupling pipe L12 are disposed in the upper gas header module 11b.

A first switching module is divided into an upper part and a lower part similarly to the gas header module, and has a lower first switching module 12a, and an upper first switching module 12b.

In this embodiment, a first feed-out side main pipe L5, a second feed-out side branch pipe L5a, and a second feed-out side branch pipe L5b are disposed in the upper first switching module 12b.

The second switching module can be divided into an upper part and a lower part similarly to the gas header module, and has a lower second switching module 13a, and an upper second switching module 13b.

In this embodiment, the second feed-out side main pipe L10, the third feed-out side branch pipe L10a, and

the fourth feed-out side branch pipe L10b are disposed in the upper second switching module 13b.

[0029]

(Embodiment 3)

A switching apparatus 1 of Embodiment 3 will be described with reference to Figure 4.

In a configuration in which not dry air (that is, adsorption tower outlet gas), but waste gas discharged from a cold box of an air separation apparatus is used for regeneration of adsorption towers, in the switching apparatus 1, waste gas is led from the air separation apparatus to a pipe L401 inside a gas header module 11 of the switching apparatus 1 through a pipe L400. The pipe L401 is connected to a pipe L402 of the first switching module 12 through a coupling part 411. An isolation valve 401 is installed in the pipe L402. The pipe L402 is connected to a pipe L5b in this embodiment, but may be connected to a pipe L5 or a pipe L5a. The pipe L401 is connected to a pipe L403 of a second switching module 13 through a coupling part 412. An isolation valve 402 is installed in the pipe L403. The pipe L403 is connected to a pipe L10b in this embodiment, but may be connected to a pipe L10 or a pipe L10a. Used waste gas is exhausted from a depressurizing valve 122, and a depressurizing valve 132.

[0030]

(Another Embodiment)

In Embodiments 1, 2, 3, the piping layout is not limited to Figures 1, 2, but may have a linear line, and a curved line. For example, the piping layout may have a straight pipe, an L-shaped pipe, and a U-shaped pipe, and a branch portion may be a T-shaped pipe, and be connected with flanges.

The number of the adsorption towers is two in Embodiments 1, 2, 3, but is not limited to two, and may be three or more. For example, in a case in which the number of the adsorption towers is n ($n = 3, 4, \dots$), the switching apparatus may have a gas header module, a first, a second, and an n -th switching modules. The first, the second, and the n -th switching modules may be disposed around the gas header module. The number of the adsorption towers and the number of the switching modules preferably coincide with each other. The switching modules have the same piping layout, and the gas header module performs feed-out control of gas to the adsorption towers that perform adsorption process and regeneration process.

As illustrated in Figure 2B, the switching apparatus can divide the gas header module into two or more, the first switching module can be divided into two or more, the second switching module may be divided into two. A division method as in Figure 2B is not limited.

Reference Signs List

[0031]

- 1 switching apparatus
- 11 gas header module
- 12 first switching module
- 13 second switching module
- L1 feed-in part
- L6 feed-out part

Claims

[Claim 1]

A switching apparatus comprising:

a gas header module having at least a feed-in part for feeding gas in, and a feed-out part for feeding gas out; and

a first switching module and a second switching module disposed on opposite sides of the gas header module.

[Claim 2]

The switching apparatus according to claim 1, wherein

the gas header module has:

a first branch feed-in pipe that branches from a main pipe of the feed-in part of the gas header module to extend toward the first switching module, and a second branch feed-in pipe that branches from the main pipe of the feed-in part of the gas header module to extend toward the second switching module;

a first branch feed-out pipe that corresponds to a pipe extending from the first switching module, and a second branch feed-out pipe that corresponds to a pipe extending from the second switching module; and

a coupling pipe that connects a pipe extending from the first switching module with a pipe extending from the second switching module.

[Claim 3]

The switching apparatus according to claim 1 or 2,
wherein

the first switching module has:

a first feed-in side pipe coupled to a first branch
feed-in pipe, and coupled to an inlet pipe of a first
adsorption tower, and a first feed-out side main pipe
coupled to an outlet pipe of the first adsorption tower;

a first feed-out side branch pipe that branches from
the first feed-out side main pipe to be coupled to a
first branch feed-out pipe; and

a second feed-out side branch pipe that branches
from the first feed-out side main pipe to be coupled to a
coupling pipe.

[Claim 4]

The switching apparatus according to any one of
claims 1 to 3, wherein

the second switching module has:

a second feed-in side pipe coupled to a second
branch feed-in pipe, and coupled to an inlet pipe of a
second adsorption tower, and a second feed-out side main
pipe coupled to an outlet pipe of the second adsorption
tower; and

a third feed-out side branch pipe that branches from
the second feed-out side main pipe to be coupled to a
second branch feed-out pipe; and

a fourth feed-out side branch pipe that branches from the second feed-out side main pipe to be coupled to a coupling pipe.

[Claim 5]

The switching apparatus according to any one of claims 1 to 4, wherein

piping layout of the first switching module and piping layout of the second switching module are symmetrical with reference to the gas header module.

[Claim 6]

The switching apparatus according to any one of claims 1 to 5, wherein

the gas header module, the first switching module, and the second switching module are each dividable into an upper part and a lower part with reference to a height position of the coupling pipe of the gas header module.

[Claim 7]

The switching apparatus according to any one of claims 1 to 6, wherein

a size of each of the modules housed in a rectangular parallelepiped shape is set on the basis of a pipe diameter of a pipe to be set corresponding to a required raw material air amount, and a transportation limit size.