[Claims]

[Claim 1]

A low-temperature gas supply device, comprising:

a first heat exchanger, in which a mixed gas mixing a vaporization gas of a low-temperature-liquefied gas with a gas of a temperature higher than the low-temperature-liquefied gas and the low-temperature-liquefied gas are introduced and heat-exchanged with each other, and the mixed gas is discharged as a low-temperature gas refrigerant and the low-temperature-liquefied gas is discharged as the vaporization gas;

a mixing unit, in which the gas and the vaporization gas discharged from the first heat exchanger are mixed and discharged as the mixed gas; and

a first control unit, in which, based on the difference between a detected temperature of the low-temperature gas refrigerant and an intended temperature, respective amounts of the gas introduced to the mixing unit and the vaporization gas are adjusted to control the temperature of the low-temperature gas refrigerant to the intended temperature.

[Claim 2]

A low-temperature gas supply device, comprising:

a first heat exchanger, in which a low-temperature-liquefied gas and a gas of a temperature higher than the low-temperature-liquefied gas are introduced and heat-exchanged with each other and a vaporization gas of the low-temperature-liquefied gas is discharged and the gas after heat-exchanging is discharged as a heat-exchanged gas;

a mixing unit, in which the heat-exchanged gas and the vaporization gas discharged from the first heat exchanger are mixed and discharged as a low-temperature gas refrigerant; and

a first control unit, in which, based on the difference between a detected temperature of the low-temperature gas refrigerant and an intended temperature, respective amounts of the gas of a temperature higher than the low-temperature-liquefied gas, the gas being introduced to the first heat exchanger, and the vaporization gas introduced to the mixing unit are adjusted to control the temperature of the low-temperature gas refrigerant to the intended temperature.

[Claim 3]

The low-temperature gas supply device according to Claim 1 or 2, wherein the mixing unit is an ejector.

[Claim 4]

A heat transfer medium-cooling device, comprising:

the low-temperature gas supply device of Claim 1 or the low-temperature gas supply device of Claim 2;

a second heat exchanger, in which the low-temperature gas refrigerant discharged from the low-temperature gas supply device, the temperature of the low-temperature gas refrigerant being controlled, and a heat transfer medium circulated in a circulation route are heat-exchanged with each other; and

a second control unit, in which, based on the difference between a detected temperature of the heat transfer medium and an intended temperature for the heat transfer medium, an amount of the low-temperature gas refrigerant introduced to the second heat exchanger is adjusted to control a temperature of the heat transfer medium to the intended temperature for the heat transfer medium.

[Claim 5]

The low-temperature reaction control device, comprising:

the heat transfer medium-cooling device of Claim 4; and

a low-temperature reaction vessel, in which the heat transfer medium circulated in the circulation route is introduced, the temperature of the heat transfer medium being controlled, a reaction liquid in the low-temperature reaction vessel is cooled and adjusted to the intended temperature.

[Claim 6]

A heat transfer medium-cooling device, comprising:

a first heat exchanger, in which a mixed gas mixing a vaporization gas of a low-temperature-liquefied gas with a gas of a temperature higher than the low-temperature-liquefied gas and the low-temperature-liquefied gas are introduced and heat-exchanged with each other, and the mixed gas is discharged as a low-temperature gas refrigerant and the low-temperature-liquefied gas is discharged as the vaporization gas;

a mixing unit in which the gas and the vaporization gas discharged from the first heat exchanger are mixed and discharged as the mixed gas;

a first control unit, in which, based on the difference between a detected

temperature of the low-temperature gas refrigerant and an intended temperature, an amount of the gas introduced to the mixing unit is adjusted to control a temperature of the low-temperature gas refrigerant to the intended temperature;

a second heat exchanger, in which the low-temperature gas refrigerant discharged from the first heat exchanger, the temperature of the low-temperature gas refrigerant being controlled, and a heat transfer medium circulated in a circulation route are heat-exchanged with each other; and

a second control unit, in which, based on the difference between a detected temperature of the heat transfer medium and an intended temperature for the heat transfer medium, an amount of the gas is adjusted to control a temperature of the heat transfer medium to the intended temperature for the heat transfer medium.

[Claim 7]

A heat transfer medium-cooling device, comprising

a first heat exchanger, in which a low-temperature-liquefied gas and a gas of a temperature higher than the low-temperature-liquefied gas are introduced and heat-exchanged with each other and a vaporization gas of the low-temperature-liquefied gas is discharged and the gas after heat-exchanging is discharged as a heat-exchanged gas;

a mixing unit, in which the heat-exchanged gas and the vaporization gas discharged from the first heat exchanger are mixed and discharged as a low-temperature gas refrigerant;

a first control unit, in which, based on the difference between a detected temperature of the low-temperature gas refrigerant and an intended temperature, an amount of the vaporization gas introduced to the mixing unit is adjusted to control the temperature of the low-temperature gas refrigerant to the intended temperature;

a second heat exchanger, in which the low-temperature gas refrigerant discharged from the first heat exchanger, the temperature of the low-temperature gas refrigerant being controlled, and a heat transfer medium circulated in a circulation route are heat-exchanged with each other; and

a second control unit in which, based on the difference between a detected temperature of the heat transfer medium and an intended temperature for the heat transfer medium, an amount of the gas is adjusted to control a temperature of the heat transfer medium to the intended temperature for the heat transfer medium.

[Claim 8]

A low-temperature reaction control device, comprising:

the heat transfer medium-cooling device of Claim 6 or the heat transfer medium-cooling device of Claim 7; and

a low-temperature reaction vessel, in which the heat transfer medium circulated in the circulation route is introduced, the temperature of the heat transfer medium being controlled, and a reaction liquid in the low-temperature reaction vessel is cooled and adjusted to the intended temperature.

Claims

[Claim 1]

A low-temperature gas supply device, comprising:

a first heat exchanger, in which a mixed gas mixing a vaporization gas of a low-temperature-liquefied gas with a gas of a temperature higher than the low-temperature-liquefied gas and the low-temperature-liquefied gas are introduced and heat-exchanged with each other, and the mixed gas is discharged as a low-temperature gas refrigerant and the low-temperature-liquefied gas is discharged as the vaporization gas;

a mixing unit, in which the gas of a temperature higher than the low-temperature-liquefied gas and the vaporization gas discharged from the first heat exchanger are mixed to discharge the mixed gas introduced to the first heat exchanger; and

a first control unit, in which, based on the difference between a detected temperature of the low-temperature gas refrigerant and an intended temperature, respective amounts of the gas of a temperature higher than the low-temperature-liquefied gas, which is introduced to the mixing unit, and the vaporization gas are adjusted to control the temperature of the low-temperature gas refrigerant to the intended temperature.

[Claim 2]

A low-temperature gas supply device, comprising:

a first heat exchanger, in which a low-temperature-liquefied gas and a gas of a temperature higher than the low-temperature-liquefied gas are introduced and heat-exchanged with each other and a vaporization gas of the low-temperature-liquefied gas is discharged and the gas of a temperature higher than the low-temperature-liquefied gas after heat-exchanging is discharged as a heat-exchanged gas;

a mixing unit, in which the heat-exchanged gas and the vaporization gas discharged from the first heat exchanger are mixed and discharged as a low-temperature gas refrigerant; and

a first control unit, in which, based on the difference between a detected temperature of the low-temperature gas refrigerant and an intended temperature, respective amounts of the gas of a temperature higher than the low-temperature-liquefied

gas, the gas being introduced to the first heat exchanger, and the vaporization gas introduced to the mixing unit are adjusted to control the temperature of the low-temperature gas refrigerant to the intended temperature.

[Claim 3]

The low-temperature gas supply device according to Claim 1 or 2, wherein the mixing unit is an ejector.

[Claim 4]

A heat transfer medium-cooling device, comprising:

the low-temperature gas supply device of Claim 1 or the low-temperature gas supply device of Claim 2;

a second heat exchanger, in which the low-temperature gas refrigerant discharged from the low-temperature gas supply device, the temperature of the low-temperature gas refrigerant being controlled, and a heat transfer medium circulated in a circulation route are heat-exchanged with each other; and

a second control unit, in which, based on the difference between a detected temperature of the heat transfer medium and an intended temperature for the heat transfer medium, an amount of the low-temperature gas refrigerant introduced to the second heat exchanger is adjusted to control a temperature of the heat transfer medium to the intended temperature for the heat transfer medium.

[Claim 5]

The low-temperature reaction control device, comprising:

the heat transfer medium-cooling device of Claim 4; and

a low-temperature reaction vessel, in which the heat transfer medium circulated in the circulation route is introduced, the temperature of the heat transfer medium being controlled, a reaction liquid in the low-temperature reaction vessel is cooled and adjusted to the intended temperature.

[Claim 6]

A heat transfer medium-cooling device, comprising:

a first heat exchanger, in which a mixed gas mixing a vaporization gas of a

low-temperature-liquefied gas with a gas of a temperature higher than the low-temperature-liquefied gas and the low-temperature-liquefied gas are introduced and heat-exchanged with each other, and the mixed gas is discharged as a low-temperature gas refrigerant and the low-temperature-liquefied gas is discharged as the vaporization gas;

a mixing unit, in which the gas of a temperature higher than the low-temperature-liquefied gas and the vaporization gas discharged from the first heat exchanger are mixed to discharge the mixed gas introduced to the first heat exchanger;

a first control unit, in which, based on the difference between a detected temperature of the low-temperature gas refrigerant and an intended temperature, an amount of the vaporization gas introduced to the mixing unit is adjusted to control a temperature of the low-temperature gas refrigerant to the intended temperature;

a second heat exchanger, in which the low-temperature gas refrigerant discharged from the first heat exchanger, the temperature of the low-temperature gas refrigerant being controlled, and a heat transfer medium circulated in a circulation route are heat-exchanged with each other; and

a second control unit, in which, based on the difference between a detected temperature of the heat transfer medium and an intended temperature for the heat transfer medium, an amount of the gas of a temperature higher than the low-temperature-liquefied gas, which is introduced to the first heat exchanger, is adjusted to control a temperature of the heat transfer medium to the intended temperature for the heat transfer medium.

[Claim 7]

A heat transfer medium-cooling device, comprising

a first heat exchanger, in which a low-temperature-liquefied gas and a gas of a temperature higher than the low-temperature-liquefied gas are introduced and heat-exchanged with each other and a vaporization gas of the low-temperature-liquefied gas is discharged and the gas of a temperature higher than the low-temperature-liquefied gas after heat-exchanging is discharged as a heat-exchanged gas;

a mixing unit, in which the heat-exchanged gas and the vaporization gas discharged from the first heat exchanger are mixed and discharged as a low-temperature gas refrigerant;

a first control unit, in which, based on the difference between a detected

temperature of the low-temperature gas refrigerant and an intended temperature, an amount of the vaporization gas introduced to the mixing unit is adjusted to control the temperature of the low-temperature gas refrigerant to the intended temperature;

a second heat exchanger, in which the low-temperature gas refrigerant discharged from the mixing unit, the temperature of the low-temperature gas refrigerant being controlled, and a heat transfer medium circulated in a circulation route are heat-exchanged with each other; and

a second control unit in which, based on the difference between a detected temperature of the heat transfer medium and an intended temperature for the heat transfer medium, an amount of the gas of a temperature higher than the low-temperature-liquefied gas, which is introduced to the first heat exchanger, is adjusted to control a temperature of the heat transfer medium to the intended temperature for the heat transfer medium.

[Claim 8]

A low-temperature reaction control device, comprising:

the heat transfer medium-cooling device of Claim 6 or the heat transfer medium-cooling device of Claim 7; and

a low-temperature reaction vessel, in which the heat transfer medium circulated in the circulation route is introduced, the temperature of the heat transfer medium being controlled, and a reaction liquid in the low-temperature reaction vessel is cooled and adjusted to the intended temperature.