Claims

[Claim 1]

A refrigeration device comprising:

a compressor configured to compress a refrigerant;

a condenser configured to condense the refrigerant compressed by the compressor;

an expansion valve configured to expand the refrigerant condensed by the condenser;

an evaporator configured to evaporate the refrigerant expanded by the expansion valve; and

an expansion valve control unit configured to control an opening degree of the expansion valve, wherein

the evaporator includes

a case forming an outer shell,

a heat transfer tube group accommodated inside the case and including a plurality of heat transfer tubes arranged in a vertical direction,

a refrigerant supply unit configured to supply the refrigerant from above to the heat transfer tube group, and

a circulation unit configured to guide the refrigerant accumulated at a lower portion of the case without being evaporated by the heat transfer tube group to the refrigerant supply unit, and

the expansion valve control unit controls the opening degree of the expansion valve to bring a level of the refrigerant accumulated at the lower portion of the case to a level corresponding to an amount of the refrigerant circulated by the circulation unit, the amount varying depending on an operation condition of the refrigeration device, and

the circulation unit is connected to a downstream end of a first circulation pipe connected to a bottom portion of the evaporator and to a downstream end of a branch pipe branched from an intermediate position of a refrigerant pipe connecting a bottom portion of the condenser and the expansion valve, such that the refrigerant flows in, and is connected to an upstream end of a second circulation pipe connected to an intermediate position of the refrigerant pipe connecting the expansion valve and the evaporator to discharge the refrigerant.

[Claim 2]

The refrigeration device according to claim 1, further comprising:

a circulation unit adjustment device configured to adjust the amount of the refrigerant circulated by the circulation unit; and

an adjustment device control unit configured to control the circulation unit adjustment device, wherein

the adjustment device control unit controls the circulation unit adjustment device to make the amount of the refrigerant circulated by the circulation unit larger than a predetermined amount.

[Claim 3]

A refrigeration device comprising:

a compressor configured to compress a refrigerant;

a condenser configured to condense the refrigerant compressed by the compressor;

an expansion valve configured to expand the refrigerant condensed by the condenser; and

an evaporator configured to evaporate the refrigerant expanded by the expansion valve, wherein

the evaporator includes

a case forming an outer shell,

a heat transfer tube group accommodated inside the case and including a plurality of heat transfer tubes arranged in a vertical direction,

a refrigerant supply unit configured to supply the refrigerant from above to the heat transfer tube group, and

a circulation unit configured to guide the refrigerant accumulated at a lower portion of the case without being evaporated by the heat transfer tube group to the refrigerant supply unit,

the refrigeration device further includes

a circulation unit adjustment device configured to adjust an amount of the refrigerant circulated by the circulation unit, and

an adjustment device control unit configured to control the circulation unit adjustment device, and

the adjustment device control unit controls the circulation unit adjustment device to make the amount of the refrigerant circulated by the circulation unit larger than a predetermined amount , and

the circulation unit is connected to a downstream end of a first circulation pipe connected to a bottom portion of the evaporator and to a downstream end of a branch pipe branched from an intermediate position of a refrigerant pipe connecting a bottom portion of the condenser and the expansion valve, such that the refrigerant flows in, and is connected to an upstream end of a second circulation pipe connected to an intermediate position of the refrigerant pipe connecting the expansion valve and the evaporator to discharge the refrigerant.

[Claim 4]

A refrigeration device comprising:

a low-stage compressor and a high-stage compressor configured to compress a refrigerant;

a condenser configured to condense the refrigerant compressed by the low-stage compressor and the high-stage compressor;

a high-pressure expansion valve configured to expand the refrigerant condensed by the condenser;

an intercooler configured to perform gas-liquid separation of the refrigerant expanded by the high-pressure expansion valve;

a low-pressure expansion valve configured to expand the refrigerant in a liquid phase separated by the intercooler; and

an evaporator configured to evaporate the refrigerant expanded by the low-pressure expansion valve, wherein

the evaporator includes a case forming an outer shell, a heat transfer tube group accommodated inside the case and including a plurality of heat transfer tubes arranged in a vertical direction, a refrigerant supply unit configured to supply the refrigerant from above to the heat transfer tube group, and a circulation unit configured to guide the refrigerant accumulated at a lower portion of the case without being evaporated by the heat transfer tube group to the refrigerant supply unit,

the refrigeration device further includes a circulation unit adjustment device configured to adjust an amount of the refrigerant circulated by the circulation unit, and an adjustment device control unit configured to control the circulation unit adjustment device,

the adjustment device control unit controls the circulation unit adjustment device to make the amount of the refrigerant circulated by the circulation unit larger than a predetermined amount, and

the circulation unit is connected to a downstream end of a first circulation pipe connected to a bottom portion of the evaporator and to a downstream end of a branch pipe branched from an intermediate position downstream of the condenser and upstream of the low-pressure expansion valve, such that the refrigerant flows in, and is connected to an upstream end of a second circulation pipe connected to an intermediate position of a refrigerant pipe connecting the low-pressure expansion valve and the evaporator to discharge the refrigerant.

[Claim 5]

The refrigeration device according to any one of claims 1 to 4, wherein the circulation unit includes an eductor configured to circulate the refrigerant by using a pressure differential between a pressure of the refrigerant in the condenser and a pressure of the refrigerant in the evaporator.