

DESCRIPTION

TITLE OF INVENTION:

Refrigerator-Freezer

5 TECHNICAL FIELD

[0001] The present disclosure relates to a refrigerator-freezer.

BACKGROUND ART

[0002] Conventionally, in a refrigerator-freezer, a defrosting operation is periodically performed in order to prevent decreased performance resulting from frost formed on a cooler. As a defrosting method for a refrigerator-freezer, a mechanism for applying an amount of heat by heating with a heater for completely melting frost on the cooler is generally used. Defrosting with the heater may cause leakage of warm air from a cooler compartment to other chambers inside the refrigerator-freezer and thereby cause a temperature rise, which is not preferable in terms of food quality.

10 [0003] Japanese Patent No. 3633997 (PTL 1) discloses a refrigerator-freezer including chambers each equipped with a damper, in which each damper is closed during heating with a heater to prevent leakage of warm air into each chamber. The damper in each chamber of the refrigerator-freezer in PTL 1 is generally installed at an inlet port (an outlet port) of each chamber to prevent warm air from being blown out. On the other hand, each chamber of the refrigerator-freezer in PTL 1 is provided with a suction port through which air is suctioned from each chamber into a cooler compartment so as to circulate cold air therethrough, but the suction port is often not equipped with a damper. Thus, in the refrigerator-freezer in PTL 1, the suction port opened during defrosting with the heater may cause leakage of warm air through this suction port into each chamber.

25 [0004] In particular, in the refrigerator-freezer in PTL 1, since the freezing compartment located close to the cooler compartment does not have a long air path structure, the warm air leaked from the cooler compartment causes a significant influence. In a refrigerator having a mechanism for preventing leakage of warm air

through the outlet port of the freezing compartment as in PTL 1, leakage of warm air through the outlet port of the freezing compartment is suppressed, but warm air still leaks through the suction port of the freezing compartment, with the result that the food temperature rises in the vicinity of the suction port of the freezing compartment. In this way, only the damper at the outlet port of the freezing compartment cannot prevent the leakage of warm air through the suction port of the freezing compartment, and in particular, the food temperature rise in the vicinity of the suction port of the freezing compartment cannot be suppressed.

[0005] Japanese Patent Laying-Open No. 2013-127345 (PTL 2) discloses a refrigerator-freezer in which a suction port is provided with a damper in order to prevent leakage of warm air through the suction port. In the refrigerator-freezer in PTL 2, providing the damper at the suction port increases cost, and in addition, humid air flowing through the damper in a return air path freezes the damper, which also causes problems during the operation.

CITATION LIST

PATENT LITERATURE

[0006] PTL 1: Japanese Patent No. 3633997

PTL 2: Japanese Patent Laying-Open No. 2013-127345

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0007] The conventional refrigerator-freezer still needs to be improved in terms of opening/closing control for the damper during the defrosting operation.

[0008] An object of the present disclosure is to provide a refrigerator-freezer configured to have a suction port equipped with no damper, in which uneven temperature distribution inside a freezing compartment is prevented while suppressing a temperature rise in the vicinity of the suction port resulting from leakage of warm air from a cooler compartment during a defrosting operation.

SOLUTION TO PROBLEM

[0009] A refrigerator-freezer of the present disclosure includes: a freezing

compartment; a cooler configured to cool air to be sent to the freezing compartment; a cooler compartment in which the cooler is disposed; a heater configured to remove frost adhering to the cooler; a first air path through which the cooler compartment communicates with the freezing compartment; a second air path through which the freezing compartment communicates with the cooler compartment; a first temperature sensor configured to detect a temperature of air blown out from the first air path to an outlet port provided in the freezing compartment; a second temperature sensor configured to detect a temperature of air to be returned to the second air path from a suction port provided in the freezing compartment; a damper provided at a connection portion between the freezing compartment and the first air path, the damper being configured to open or close the first air path; and a controller configured to control the damper. When performing a defrosting operation by driving the heater, the controller is configured to control the damper to be opened or closed based on the temperature detected by the first temperature sensor and the temperature detected by the second temperature sensor.

ADVANTAGEOUS EFFECTS OF INVENTION

[0010] According to the present disclosure, in the configuration in which the suction port is not provided with a damper, uneven temperature distribution inside the freezing compartment can be prevented while suppressing a temperature rise in the vicinity of the suction port resulting from leakage of warm air from the cooler compartment during a defrosting operation.

BRIEF DESCRIPTION OF DRAWINGS

[0011] Fig. 1 is a diagram showing a configuration of a refrigerant circuit of a refrigerator-freezer according to a first embodiment.

Fig. 2 is a diagram for illustrating the configuration of the refrigerator-freezer according to the first embodiment.

Fig. 3 is a diagram for illustrating an outlet port and a suction port of the refrigerator-freezer according to the first embodiment.

Fig. 4 is a graph showing a relation between an outlet port temperature and a

suction port temperature at the time when a damper is kept closed.

Fig. 5 is a graph showing a relation between an outlet port temperature and a suction port temperature at the time when the damper is controlled to be opened or closed.

5 Fig. 6 is a flowchart in a defrosting operation according to the first embodiment.

Fig. 7 is a flowchart in a defrosting operation according to a second embodiment.

DESCRIPTION OF EMBODIMENTS

[0012] Embodiments of the present disclosure will be hereinafter described in detail
10 with reference to the accompanying drawings. In the embodiments described below, when the number, the quantity and the like are mentioned, the scope of the present disclosure is not necessarily limited thereto unless otherwise specified. The same or corresponding components are denoted by the same reference characters, and the description thereof may not be repeated. It has been originally intended to
15 appropriately combine configurations described in respective embodiments.

[0013] First Embodiment

<Configuration of Refrigerant Circuit in Refrigerator-Freezer>

Fig. 1 is a diagram showing a configuration of a refrigerant circuit 10 of a refrigerator-freezer 1 according to the first embodiment. Refrigerator-freezer 1 cools
20 the interior of refrigerator-freezer 1 to a target temperature by refrigerant circuit 10.

[0014] As shown in Fig. 1, refrigerant circuit 10 of refrigerator-freezer 1 is configured by connecting a compressor 2, a condenser 3, a condenser pipe 4, a cabinet pipe 5, a three-way valve 6, a capillary tube 7, and a cooler 8. In refrigerant circuit 10, refrigerant flows through compressor 2, condenser 3, condenser pipe 4, cabinet pipe 5,
25 three-way valve 6, capillary tube 7, and cooler 8 in this order.

[0015] Compressor 2 compresses the refrigerant circulating through refrigerant circuit 10 into a high-temperature and high-pressure state. Compressor 2 discharges the high-temperature and high-pressure refrigerant to condenser 3. The operation of compressor 2 is controlled in accordance with the state inside refrigerator-freezer 1.

[0016] Condenser 3 condenses the refrigerant by heat exchange with air. The refrigerant flowing through condenser 3 is condensed through exchange of heat with air by forced convection generated by a fan provided in refrigerator-freezer 1. Condenser pipe 4 is disposed on the rear surface and the side surface on the inside of refrigerator-freezer 1 and configured to condense refrigerant by exchanging heat with air. Cabinet pipe 5 is disposed on the front surface of refrigerator-freezer 1 and configured to condense the refrigerant by exchanging heat with air. The high-temperature and high-pressure refrigerant flows through condenser 3, condenser pipe 4, and cabinet pipe 5 in this order so as to be gradually cooled.

[0017] Three-way valve 6 switches the flow path of the refrigerant having flowed through cabinet pipe 5. Capillary tube 7 is connected in parallel between cabinet pipe 5 and cooler 8. Capillary tube 7 is formed of a tube having a narrow tube diameter and configured to reduce the pressure of the refrigerant such that the refrigerant condensed by condenser 3, condenser pipe 4, and cabinet pipe 5 is changed into a low-temperature and low-pressure state. The refrigerants having flowed through respective capillary tubes 7 connected in parallel join together and then flow into cooler 8.

[0018] Cooler 8 is connected between capillary tube 7 and compressor 2. Cooler 8 is provided in a cooler compartment formed inside refrigerator-freezer 1. Cooler 8 exchanges heat between the low-temperature and low-pressure refrigerant and the air around cooler 8 to evaporate the refrigerant. Thereby, cooler 8 cools the air around cooler 8.

[0019] A fan is provided in the vicinity of cooler 8 and causes the air cooled by cooler 8 to circulate through refrigerator-freezer 1. Thereby, the air inside refrigerator-freezer 1 is cooled.

[0020] The refrigerant evaporated by cooler 8 is returned to compressor 2, compressed again by compressor 2, discharged to condenser 3, and then circulates through refrigerant circuit 10.

[0021] <Overall Configuration of Refrigerator-Freezer 1>

Fig. 2 is a diagram for illustrating a configuration of refrigerator-freezer 1 according to the first embodiment. Fig. 3 is a diagram for illustrating outlet ports 134a and 134b and a suction port 134c of refrigerator-freezer 1 according to the first embodiment. In Fig. 2, in a front view of refrigerator-freezer 1, the front-rear direction is defined as a Y-axis direction, the left-right direction is defined as an X-axis direction, and the up-down direction is defined as a Z-axis direction.

[0022] Refrigerator-freezer 1 includes a heat insulating box body 1a having a rectangular parallelepiped outer shape, and doors 121, 122, 123, 124, and 125 attached to five openings provided on the front side of heat insulating box body 1a. Heat insulating box body 1a includes: a rectangular outer box made of metal, resin, or the like; an inner box made of metal, resin, or the like and smaller than the external dimensions; and a heat insulating member enclosed between the outer box and the inner box. Heat insulating box body 1a includes therein, for example, a refrigerating compartment 131 for refrigerating food, an ice making compartment 132 for accommodating an ice maker, a switching compartment 133 capable of switching the compartment temperature between a temperature at which ice can be made and a temperature other than that, a freezing compartment 134 for freezing food and storing the frozen food, and a vegetable compartment 135 for storing vegetables. A set of ice making compartment 132 and door 122 and a set of switching compartment 133 and door 123 are arranged laterally in the X-axis direction. Among them, Fig. 2 shows switching compartment 133 and door 123.

[0023] Refrigerator-freezer 1 includes a cooler compartment 16, a machine compartment 18 connected to cooler compartment 16 through a discharge pipe 17, and a controller 100. Cooler compartment 16 is connected to refrigerating compartment 131, ice making compartment 132, switching compartment 133, freezing compartment 134, and vegetable compartment 135 through each of air path ducts 15A and 15B. Cooler compartment 16 accommodates cooler 8, a fan 161, a heater 35, and a cooler thermistor 30. Machine compartment 18 accommodates compressor 2 that compresses the refrigerant flowing thereinto from cooler 8.

[0024] Controller 100 is configured to include a central processing unit (CPU) 51, a memory 52 (a read only memory (ROM) and a random access memory (RAM)), an input/output device (not shown) for inputting various signals, and the like. By CPU 51, a program stored in the ROM is deployed in the RAM or the like for execution.

5 The program stored in the ROM includes a program describing the processing procedure for controller 100. Controller 100 controls each of devices in accordance with these programs. Such control is not necessarily processed by software, but can also be processed by dedicated hardware (an electronic circuit). Controller 100 controls, for example, a damper to be opened or closed, as will be described later.

10 [0025] A condensing unit formed of condenser 3, condenser pipe 4, and cabinet pipe 5 condenses the refrigerant flowing thereinto from compressor 2, and a decompressing unit formed of capillary tube 7 decompresses and expands the refrigerant flowing thereinto from the condensing unit to evaporate part of the refrigerant to thereby separate the refrigerant into a gas-liquid two-phase state. Cooler 8 cools the air
15 around cooler 8 inside cooler compartment 16 by utilizing the heat absorbing effect occurring during evaporation of the liquid refrigerant of the two-phase refrigerant having flowed from the decompressing unit. A suction pipe (not shown) exchanges heat with capillary tube 7 to raise the temperature of the refrigerant having flowed thereinto from cooler 8 to its condensation temperature.

20 [0026] Heater 35 raises the temperature of cooler 8 to melt and remove the frost adhering to cooler 8. Cooler thermistor 30 detects the temperature of cooler 8.

[0027] When fan 161 operates, the air cooled inside cooler compartment 16 (hereinafter also referred to as cold air) is supplied through air path duct 15A to each of refrigerating compartment 131, ice making compartment 132, switching compartment
25 133, freezing compartment 134, and vegetable compartment 135 (see an arrow AR10). The cold air supplied to each of refrigerating compartment 131, switching compartment 133, freezing compartment 134, and vegetable compartment 135 is blown inward from a corresponding one of outlet ports 131a, 133a, 134a, 134b, and 135a provided in respective compartments. The cold air supplied to ice making compartment 132 is

also similarly blown inward from an outlet port (not shown) provided in ice making compartment 132. Thereby, food products disposed inside refrigerating compartment 131, ice making compartment 132, switching compartment 133, freezing compartment 134, and vegetable compartment 135 are cooled.

5 [0028] The air warmed by the storage objects accommodated in refrigerating compartment 131, switching compartment 133, freezing compartment 134, and vegetable compartment 135 is returned to suction ports 131b, 133b, 134b, 134c, and 135b provided in the respective compartments, and then, flows into cooler compartment 16 through air path duct 15B provided in each compartment. Similarly,
10 the air existing inside ice making compartment 132 also flows from a suction port (not shown) provided in ice making compartment 132 through air path duct 15B into cooler compartment 16. In this way, cold air circulates through air path ducts 15A and 15B from/to cooler compartment 16 to/from refrigerating compartment 131, ice making compartment 132, switching compartment 133, freezing compartment 134, and
15 vegetable compartment 135.

[0029] A damper (for example, dampers 1511, 1513, 1514, and 1515) is provided at a portion at which air path duct 15A is connected to each of refrigerating compartment 131, ice making compartment 132, switching compartment 133, freezing compartment 134, and vegetable compartment 135. The dampers are separately opened or closed.

20 When a damper is in the opened state, cold air flows into refrigerating compartment 131, ice making compartment 132, switching compartment 133, freezing compartment 134, or vegetable compartment 135 that corresponds to this opened damper. For example, when damper 1514 is in the opened state, cold air flows into freezing compartment 134 corresponding to damper 1514. In contrast, when a damper is in the
25 closed state, the flow of cold air into refrigerating compartment 131, ice making compartment 132, switching compartment 133, freezing compartment 134, or vegetable compartment 135 that corresponds to this closed damper is blocked. For example, when damper 1514 is in the closed state, the flow of cold air into freezing compartment 134 corresponding to damper 1514 is blocked.

[0030] Freezing compartment 134 is provided with: two outlet ports 134a and 134b through which cold air is blown out to upper and lower two inner regions; and a suction port 134c through which warmed air is suctioned thereinto. An upper case 21 is disposed in an inner area inside freezing compartment 134, and a lower case 22 is

5 disposed in a lower area inside freezing compartment 134.

[0031] The cold air having been blown out through outlet port 134a flows into upper case 21. The cold air having flowed into upper case 21 is warmed by the heat stored in the storage object placed in upper case 21 and the heat coming into freezing compartment 134 through the wall of heat insulating box body 1a from the air existing

10 outside refrigerator-freezer 1. The air inside upper case 21 is discharged through a return port 21a provided in upper case 21 and flows out of upper case 21. In this case, the amount of heat entering into freezing compartment 134 from the air existing outside refrigerator-freezer 1 can be regarded as being constant unless the temperature inside freezing compartment 134 significantly changes. Thus, as the heat stored in the

15 storage object is higher, the temperature of the air discharged through return port 21a becomes higher accordingly. Freezing compartment 134 is provided with a door opening/closing sensing unit 19 for sensing the opened/closed state of door 124.

[0032] The cold air blown out through outlet port 134b flows into lower case 212 and exchanges heat with the storage object disposed inside lower case 22 so as to be

20 warmed. The air inside lower case 22 is discharged through a return port 22a provided in lower case 22 and flows out of lower case 22. The air discharged through return port 21a of upper case 21 and return port 22a of lower case 22 is returned to suction port 134c of freezing compartment 134 and then flows into cooler compartment 16 through air path duct 15B.

[0033] As shown in Fig. 3, freezing compartment 134 is provided below ice making compartment 132 and switching compartment 133. Freezing compartment 134 is provided with: an outlet port thermistor 31 as a first temperature sensor for detecting the temperature of air blown out through outlet ports 134a and 134b; and a suction port thermistor 32 as a second temperature sensor for detecting the temperature of air

25

discharged through return port 21a of upper case 21 and return port 22a of lower case 22 and then returned to suction port 134c. Outlet port thermistor 31 is provided closer to outlet ports 134a and 134b than suction port thermistor 32. Suction port thermistor 32 is provided closer to suction port 134c than outlet port thermistor 31. In the following description, the temperature detected by outlet port thermistor 31 will be also referred to as an outlet port temperature T_e , and the temperature detected by suction port thermistor 32 will be also referred to as a suction port temperature T_r .

[0034] <Damper>

Refrigerator-freezer 1 is operated such that the temperature rises due to the heat entering from outside refrigerator-freezer 1 and the temperature inside refrigerator-freezer 1 is kept constant by the balance with the cooling mechanism through the refrigeration cycle. In refrigerator-freezer 1, the upper and lower limit temperatures are set by a setting dial. Controller 100 controls the temperature of each chamber inside refrigerator-freezer 1 by opening or closing the damper provided at a connection portion between each chamber and air path duct 15A. Controller 100 uses the damper to adjust the flow rate of the cold air blown by fan 161 based on the temperature detected by the thermistor provided in each chamber. When the temperature inside refrigerator-freezer 1 rises and reaches the upper limit temperature, the damper is opened for cooling. When the temperature inside refrigerator-freezer 1 falls and reaches the lower limit temperature, the damper is closed, so that heat comes into refrigerator-freezer 1 from outside to thereby raise the temperature. The temperature inside refrigerator-freezer 1 repeats rising and falling and thus is kept constant at an average temperature.

[0035] <Defrosting Operation>

The defrosting operation of cooler 8 will be hereinafter described. In refrigerator-freezer 1, the air flowing through cooler 8 is circulated by fan 161. The air inside refrigerator-freezer 1 is moistened by water vapor from food or by outside air coming thereinto by opening or closing the door. In cooler 8, the temperature range is below the freezing point. Thus, when air containing a large amount of moisture flows

through cooler 8, moisture in the air freezes on the surface of cooler 8 to form frost. The amount of frost adhering to cooler 8 increases as the operation continues for a long time. Since the frost adhering to cooler 8 inhibits heat transfer, the cooling performance of refrigerator-freezer 1 decreases. Thus, the defrosting operation is periodically performed in refrigerator-freezer 1.

[0036] As a defrosting method, a mechanism for applying an amount of heat by heating with a heater for completely melting the frost on cooler 8 is generally employed. In the first embodiment, heater 35 disposed in the lower portion of cooler 8 applies an amount of heat to frost to thereby melt the frost. The defrosting operation is started when the accumulated time of the operation of refrigerator-freezer 1 reaches a predetermined time. When the temperature detected by cooler thermistor 30 attached to cooler 8 reaches the set temperature, the output of heater 35 is turned off, so that the defrosting operation ends. This defrosting operation sequence is periodically performed during the operation of refrigerator-freezer 1 to suppress performance deterioration.

[0037] On the other hand, in the defrosting operation by heater 35, the temperature rises in and around cooler 8, so that warm air is generated in and around cooler 8. Controller 100 closes the damper in order to suppress leakage of warm air into each chamber.

[0038] In this case, the damper is generally disposed only at the outlet port of each chamber but not disposed at the suction port of each chamber for the reasons such as cost increase, freezing of the damper, and the like. When the air temperature rises, the pressure rises. When the outlet port is closed while the suction port is opened, air flows out through the suction port. During the defrosting operation, closing the dampers can suppress leakage of warm air through the outlet port, but warm air still leaks through the suction port. In this case, inside refrigerator-freezer 1, the food temperature can be suppressed from rising in the vicinity of the outlet port but still rises in the vicinity of the suction port, which causes uneven temperature distribution depending on the position inside refrigerator-freezer 1, thereby deteriorating the

preservability of food.

[0039] In refrigerator-freezer 1 of the first embodiment, during the defrosting operation, damper 1514 provided in outlet ports 134a and 134b is controlled to be opened or closed to thereby control the flow rate of the warm air at each of outlet ports 134a and 134b and suction port 134c. Thereby, in refrigerator-freezer 1 according to the first embodiment, the temperature rise inside refrigerator-freezer 1 during the defrosting operation is rendered uniform, so that the preservability of food is improved.

[0040] <Control of Damper during Defrosting Operation>

The following describes control of the damper executed by controller 100 of refrigerator-freezer 1 during the defrosting operation. Fig. 4 is a graph showing the relation between outlet port temperature T_e and suction port temperature T_r at the time when the damper is kept closed. Fig. 5 is a graph showing the relation between outlet port temperature T_e and suction port temperature T_r at the time when damper 1514 is controlled to be opened or closed. Fig. 6 is a flowchart in the defrosting operation according to the first embodiment.

[0041] As shown in Fig. 4, when damper 1514 provided in front of outlet ports 134a and 134b is kept closed during the time period in which heater 35 overheats during the defrosting operation, outlet port temperature T_e is suppressed from rising, but suction port temperature T_r rises due to the leakage of warm air through suction port 134c. In this way, when controller 100 simply keeps damper 1514 closed during the defrosting operation, the temperature rise in the vicinity of suction port 134c cannot be suppressed.

[0042] Controller 100 switches the state of damper 1514 during the time period in which heater 35 overheats during the defrosting operation. As shown in Fig. 5, controller 100 closes damper 1514 from the start to the middle point of overheating of heater 35, and switches the state of damper 1514 to be opened in the middle of overheating. Thereby, in refrigerator-freezer 1 according to the first embodiment, during the defrosting operation, outlet port temperature T_e can be suppressed from rising during the time period in which damper 1514 is kept closed, and suction port

temperature T_r can be suppressed from rising during the time period in which damper 1514 is kept opened.

[0043] As shown in Fig. 5, at the end of defrosting, outlet port temperature $T_e >$ suction port temperature T_r , in which case outlet port temperature T_e is still lower than suction port temperature T_r at the time when the damper is kept closed. Therefore, the highest temperature inside refrigerator-freezer 1 at the end of defrosting can also be lowered.

[0044] As shown in Fig. 6, controller 100 starts the defrosting operation of cooler 8 when the accumulated time of the operation of refrigerator-freezer 1 reaches a predetermined time (step S1). At the timing of start of the defrosting operation, controller 100 closes damper 1514 (step S2) that is provided between freezing compartment 134 and air path duct 15A and configured to open or close air path duct 15A. Then, controller 100 determines whether or not the temperature detected by cooler thermistor 30 has reached a set temperature set in advance at which frost on cooler 8 can be removed (step S3).

[0045] When controller 100 determines in step S3 that the temperature detected by cooler thermistor 30 has reached the set temperature (YES in step S3), it opens damper 1514 and ends the defrosting operation (step S4), and returns the process from the subroutine shown in Fig. 6 to the main routine. When controller 100 determines in step S3 that the temperature detected by cooler thermistor 30 has not reached the set temperature (NO in step S3), it proceeds the process to step S5.

[0046] In this case, the temperature difference between outlet port temperature T_e and suction port temperature T_r is defined as ΔT , and a determination temperature with respect to ΔT set in advance by experiments or the like is defined as ΔT_a . In step S5, controller 100 determines whether or not the relation between outlet port temperature T_e and suction port temperature T_r satisfies $\Delta T = T_r - T_e > \Delta T_a$. When controller 100 determines in step S5 that $\Delta T = T_r - T_e > \Delta T_a$ is not satisfied (NO in step S5), it proceeds the process to step S2 and keeps damper 1514 closed.

[0047] When controller 100 determines in step S5 that $\Delta T = T_r - T_e > \Delta T_a$ is satisfied

(YES in step S5), it controls the closed damper 1514 to be opened (step S6). In refrigerator-freezer 1, damper 1514 is opened to thereby prevent leakage of warm air through suction port 134c. In refrigerator-freezer 1, outlet ports 134a and 134b are opened to disperse leakage of the warm air through outlet ports 134a and 134b and suction port 134c, to thereby relatively reduce leakage of the warm air through suction port 134c as compared with outlet ports 134a and 134b. Thereby, in refrigerator-freezer 1, the temperature rise in the vicinity of suction port 134c can be reduced when damper 1514 is opened.

[0048] Then, in step S7, controller 100 determines whether or not the relation between outlet port temperature T_e and suction port temperature T_r satisfies $\Delta T = T_r - T_e \leq -\Delta T_a$. When controller 100 determines in step S7 that $\Delta T = T_r - T_e \leq -\Delta T_a$ is not satisfied (NO in step S7), it proceeds the process to step S6 to keep damper 1514 opened. When controller 100 determines in step S7 that $\Delta T = T_r - T_e \leq -\Delta T_a$ is satisfied (YES in step S7), it proceeds the process to step S2 and controls the opened damper 1514 to be closed.

[0049] In refrigerator-freezer 1, damper 1514 is closed to thereby prevent leakage of warm air through outlet ports 134a and 134b. In refrigerator-freezer 1, outlet ports 134a and 134b are closed to thereby reduce leakage of warm air through outlet ports 134a and 134b. Thereby, in refrigerator-freezer 1, the temperature rise in the vicinity of outlet ports 134a and 134b can be reduced when the damper is closed.

[0050] Controller 100 in refrigerator-freezer 1 repeatedly controls damper 1514 to be opened or closed during the defrosting operation. On condition that the temperature detected by cooler thermistor 30 has reached a set temperature set in advance, controller 100 opens damper 1514 and ends the defrosting operation. Thereby, refrigerator-freezer 1 can suppress the temperature rise in the vicinity of suction port 134c as compared with the case where damper 1514 is kept closed during the defrosting operation. In refrigerator-freezer 1, by controlling damper 1514 to be opened or closed during the defrosting operation, the temperature difference between outlet port temperature T_e and suction port temperature T_r can be reduced as compared

with the case where the damper is kept closed or the case where the damper is kept opened. Thus, in refrigerator-freezer 1, the temperature distribution inside freezing compartment 134 can be rendered uniform and the food storage quality can be improved.

5 [0051] Second Embodiment

Fig. 7 is a flowchart in the defrosting operation according to the second embodiment. Controller 100 according to the second embodiment can change the degree of opening of the damper during the defrosting operation. Controller 100 can change the degree of opening of damper 1514 such that $X_c < X_1 < X_2 < \dots < X_n < \dots < X_o$ ($X = c$ degree of opening 0%, $X_o =$ degree of opening 100%).

10 [0052] As shown in Fig. 7, controller 100 starts the defrosting operation of cooler 8 when the accumulated time of the operation of refrigerator-freezer 1 reaches a predetermined time (step S11). At the timing of start of the defrosting operation, controller 100 sets the degree of opening of damper 1514 at a certain degree of opening X_i (step S12). In this case, damper 1514 is provided between freezing compartment 134 and air path duct 15A and configured to open or close air path duct 15A. Then, controller 100 determines whether or not the temperature detected by cooler thermistor 30 has reached a set temperature set in advance at which frost on cooler 8 can be removed (step S13).

20 [0053] When controller 100 determines in step S13 that the temperature detected by cooler thermistor 30 has reached the set temperature (YES in step S13), the degree of opening of damper 1514 is $X_o =$ degree of opening 100%, and thus, controller 100 ends the defrosting operation (step S14), and further, returns the process from the subroutine shown in Fig. 7 to the main routine. When controller 100 determines in step S13 that the temperature detected by cooler thermistor 30 has not reached the set temperature (NO in step S13), it proceeds the process to step S15.

25 [0054] In this case, the temperature difference between outlet port temperature T_e and suction port temperature T_r is defined as ΔT , and the determination temperature with respect to ΔT set in advance by experiments or the like is defined as ΔT_a . In step S15,

controller 100 determines whether or not the relation between outlet port temperature T_e and suction port temperature T_r satisfies $-\Delta T_a < \Delta T = T_r - T_e < \Delta T_a$. When controller 100 determines in step S15 that $-\Delta T_a < \Delta T = T_r - T_e < \Delta T_a$ is satisfied (YES in step S15), it keeps the degree of opening X_i of damper 1514 (step S16) and then proceeds the process to step S17.

[0055] When controller 100 determines in step S15 that $-\Delta T_a < \Delta T = T_r - T_e < \Delta T_a$ is not satisfied (NO in step S15), it determines whether or not the relation between outlet port temperature T_e and suction port temperature T_r satisfies $\Delta T = T_r - T_e \geq \Delta T_a$ (step S18). When controller 100 determines in step S18 that $\Delta T = T_r - T_e \geq \Delta T_a$ is satisfied (YES in step S18), it sets the degree of opening of damper 1514 at $X_i + \Delta X$ (step S19), and then proceeds the process to step S17. In this case, ΔX represents an amount of increase per unit of the degree of opening X_i .

[0056] In refrigerator-freezer 1, the degree of opening of damper 1514 kept at X_i is relatively small, and warm air significantly leaks through suction port 134c. Thus, in refrigerator-freezer 1, the degree of opening of damper 1514 is set at $X_i + \Delta X$ to be increased from X_i , to thereby disperse leakage of warm air through outlet ports 134a and 134b and suction port 134c, and thus, relatively reduce leakage of the warm air through suction port 134c as compared with outlet ports 134a and 134b. In this case, in refrigerator-freezer 1, when $\Delta T = T_r - T_e \geq \Delta T_a$ and the degree of opening of the damper reaches $X_o =$ the degree of opening 100%, the degree of opening is kept at X_o until defrosting is completed.

[0057] When controller 100 determines in step S18 that $\Delta T = T_r - T_e \geq \Delta T_a$ is not satisfied (NO in step S18), it determines that the relation between outlet port temperature T_e and suction port temperature T_r is $\Delta T = T_r - T_e \leq -\Delta T_a$, and then proceeds the process to step S20. In step S20, controller 100 sets the degree of opening of damper 1514 at $X_i - \Delta X$ (step S19), and then proceeds the process to step S17.

[0058] In refrigerator-freezer 1, the degree of opening of damper 1514 kept at X_i is

relatively large, and warm air significantly leaks through outlet ports 134a and 134b. Thus, in refrigerator-freezer 1, the degree of opening of damper 1514 is set at $X_i - \Delta X$ to be decreased from X_i , to thereby relatively reduce leakage of the warm air through outlet ports 134a and 134b as compared with suction port 134c. In this case, in refrigerator-freezer 1, when $\Delta T = T_r - T_e \leq -\Delta T_a$ and the degree of opening of the damper reaches X_c = the degree of opening 0%, the degree of opening is kept at X_c until defrosting is completed.

[0059] In step S17, controller 100 sets the degree of opening X_i of the damper at the degree of opening set in steps S16, S19, and S20. Then, controller 100 executes the processes of step S12 and the subsequent steps at the set degree of opening.

Controller 100 in refrigerator-freezer 1 executes the process shown in Fig. 7 for changing the degree of opening of damper 1514 during the defrosting operation.

Thus, in refrigerator-freezer 1, by controlling the degree of opening of damper 1514 to be adjusted during the defrosting operation, the temperature difference between outlet port temperature T_e and suction port temperature T_r can be reduced as compared with the case where the damper is kept closed or the case where the damper is kept opened. Thus, in refrigerator-freezer 1, the temperature distribution inside freezing compartment 134 can be rendered uniform and the food storage quality can be improved.

[0060] <Summary>

The present disclosure relates to a refrigerator-freezer 1. Refrigerator-freezer 1 includes: a freezing compartment 134; a cooler 8 configured to cool air to be sent to freezing compartment 134; a cooler compartment 16 in which cooler 8 is disposed; a heater 35 configured to remove frost adhering to cooler 8; an air path duct 15A through which cooler compartment 16 communicates with freezing compartment 134; an air path duct 15B through which freezing compartment 134 communicates with cooler compartment 16; an outlet port thermistor 31 configured to detect a temperature of air blown out from air path duct 15A to outlet ports 134a and 134b provided in freezing compartment 134; a suction port thermistor 32 configured to detect a temperature of air

to be returned to air path duct 15B from a suction port 134c provided in freezing compartment 134; a damper 1514 provided at a connection portion between freezing compartment 134 and air path duct 15A, damper 1514 being configured to open or close air path duct 15A; and a controller 100 configured to control damper 1514.

5 When performing a defrosting operation by driving heater 35, controller 100 is configured to control damper 1514 to be opened or closed based on the temperatures detected by outlet port thermistor 31 and suction port thermistor 32.

[0061] By providing the configuration as described above, in refrigerator-freezer 1 in which the suction port is not provided with a damper, uneven temperature distribution
10 inside freezing compartment 134 can be prevented while suppressing a temperature rise in the vicinity of suction port 134c resulting from leakage of warm air from cooler compartment 16 during the defrosting operation.

[0062] Preferably, controller 100 is configured to control damper 1514 to be opened or closed. In refrigerator-freezer 1, a temperature detected in a vicinity of outlet ports
15 134a and 134b by outlet port thermistor 31 is defined as T_e , a temperature detected in a vicinity of suction port 134c by suction port thermistor 32 is defined as T_r , a temperature difference between temperature T_e in the vicinity of outlet ports 134a and 134b and temperature T_r in the vicinity of suction port 134c is defined as ΔT , and a first temperature set in advance is defined as ΔT_a . During the defrosting operation,
20 controller 100 is configured to control damper 1514 to be opened when $\Delta T = T_r - T_e > \Delta T_a$ is satisfied, and control damper 1514 to be closed when $\Delta T = T_r - T_e \leq -\Delta T_a$ is satisfied.

[0063] By providing the configuration as described above, in refrigerator-freezer 1, by controlling damper 1514 to be opened or closed during the defrosting operation, the
25 temperature difference between outlet port temperature T_e and suction port temperature T_r can be reduced as compared with the case where the damper is kept closed or the case where the damper is kept opened. Thus, in refrigerator-freezer 1, the temperature distribution inside freezing compartment 134 can be rendered uniform and the food storage quality can be improved.

[0064] Preferably, controller 100 is configured to variably control a degree of opening of damper 1514. In refrigerator-freezer 1, a temperature detected in a vicinity of outlet ports 134a and 134b by outlet port thermistor 31 is defined as T_e , a temperature detected in a vicinity of suction port 134c by suction port thermistor 32 is defined as T_r , a temperature difference between temperature T_e in the vicinity of outlet ports 134a and 134b and temperature T_r in the vicinity of suction port 134c is defined as ΔT , and a first temperature set in advance is defined as ΔT_a . During the defrosting operation, controller 100 is configured to set the degree of opening of damper 1514 at X_i when $-\Delta T_a < \Delta T = T_r - T_e < \Delta T_a$ is satisfied, and, in a case where an amount of increase per unit is defined as ΔX , controller 100 is configured to set the degree of opening of damper 1514 at $X_i + \Delta X$ when $\Delta T = T_r - T_e \geq \Delta T_a$ is satisfied, and set the degree of opening of damper 1514 at $X_i - \Delta X$ when $\Delta T = T_r - T_e \leq -\Delta T_a$ is satisfied.

[0065] By providing the configuration as described above, in refrigerator-freezer 1, by controlling the degree of opening of damper 1514 to be adjusted during the defrosting operation, the temperature difference between outlet port temperature T_e and suction port temperature T_r can be reduced as compared with the case where the damper is kept closed or the case where the damper is kept opened. Thus, in refrigerator-freezer 1, the temperature distribution inside freezing compartment 134 can be rendered uniform and the food storage quality can be improved.

[0066] Preferably, a cooler thermistor 30 configured to detect a temperature of air in cooler compartment 16 is further provided. When the temperature detected by cooler thermistor 30 reaches a set temperature determined in advance, controller 100 is configured to stop the defrosting operation and open damper 1514.

[0067] By providing the configuration as described above, in refrigerator-freezer 1, damper 1514 is opened when the set temperature is reached, and thereby, cold air can be reliably sent to freezing compartment 134 in the subsequent operation.

[0068] <Modifications>

Refrigerator-freezer 1 may perform the above-described control using the dampers in respective chambers other than freezing compartment 134 inside

refrigerator-freezer 1. In such a case, first temperature ΔT_a set in advance may be changed depending on each chamber.

[0069] In refrigerator-freezer 1, dampers may be provided separately at outlet ports 134a and 134b. Controller 100 may control these dampers separately.

5 [0070] It should be understood that the embodiments disclosed herein are illustrative and non-restrictive in every respect. The scope of the present disclosure is defined by the terms of the claims, rather than the description of the aforementioned embodiments, and is intended to include any modifications within the meaning and scope equivalent to the terms of the claims.

10 REFERENCE SIGNS LIST

[0071] 1 refrigerator-freezer, 1a heat insulating box body, 2 compressor, 3 condenser, 4 condenser pipe, 5 cabinet pipe, 6 three-way valve, 7 capillary tube, 8 cooler, 10 refrigerant circuit, 15A, 15B air path duct, 16 cooler compartment, 17 discharge pipe, 18 machine compartment, 19 door opening/closing sensing unit, 21 upper case, 21a, 22a return port, 22 lower case, 30 cooler thermistor, 31 outlet port thermistor, 32 suction port thermistor, 35 heater, 100 controller, 131 refrigerating compartment, 134a, 134b outlet port, 134c suction port, 132 ice making compartment, 133 switching compartment, 134 freezing compartment, 135 vegetable compartment, 161 fan, 1514 damper.

20

CLAIMS

[Claim 1] A refrigerator-freezer comprising:

a freezing compartment;

5 a cooler configured to cool air to be sent to the freezing compartment;

a cooler compartment in which the cooler is disposed;

a heater configured to remove frost adhering to the cooler;

a first air path through which the cooler compartment communicates with the
freezing compartment;

10 a second air path through which the freezing compartment communicates with
the cooler compartment;

a first temperature sensor configured to detect a temperature of air blown out
from the first air path to an outlet port provided in the freezing compartment;

15 a second temperature sensor configured to detect a temperature of air to be
returned to the second air path from a suction port provided in the freezing
compartment;

a damper provided at a connection portion between the freezing compartment
and the first air path, the damper being configured to open or close the first air path;
and

20 a controller configured to control the damper, wherein

when performing a defrosting operation by driving the heater, the controller is
configured to control the damper to be opened or closed based on the temperature
detected by the first temperature sensor and the temperature detected by the second
temperature sensor.

25

[Claim 2] The refrigerator-freezer according to claim 1, wherein

the controller is configured to control the damper to be opened or closed, and

in a case where a temperature detected in a vicinity of the outlet port by the first
temperature sensor is defined as T_e , a temperature detected in a vicinity of the suction

port by the second temperature sensor is defined as T_r , a temperature difference between the temperature in the vicinity of the outlet port and the temperature in the vicinity of the suction port is defined as ΔT , and a determination temperature with respect to ΔT is defined as ΔT_a ,

5 during the defrosting operation, the controller is configured to
 open the damper when $\Delta T = T_r - T_e > \Delta T_a$ is satisfied, and
 close the damper when $\Delta T = T_r - T_e \leq -\Delta T_a$ is satisfied.

[Claim 3] The refrigerator-freezer according to claim 1, wherein
10 the controller is configured to variably control a degree of opening of the
 damper, and

 in a case where a temperature detected in a vicinity of the outlet port by the first
 temperature sensor is defined as T_e , a temperature detected in a vicinity of the suction
 port by the second temperature sensor is defined as T_r , a temperature difference
15 between the temperature in the vicinity of the outlet port and the temperature in the
 vicinity of the suction port is defined as ΔT , and a determination temperature with
 respect to ΔT is defined as ΔT_a ,

 during the defrosting operation,
 the controller is configured to set the degree of opening of the damper at
20 X_i when $-\Delta T_a < \Delta T = T_r - T_e < \Delta T_a$ is satisfied, and

 in a case where an amount of increase per unit is defined as ΔX , the
 controller is configured to
 set the degree of opening of the damper at $X_i + \Delta X$ when $\Delta T = T_r - T_e$
 $\geq \Delta T_a$ is satisfied, and

25 set the degree of opening of the damper at $X_i - \Delta X$ when $\Delta T = T_r - T_e$
 $\leq -\Delta T_a$ is satisfied.

[Claim 4] The refrigerator-freezer according to any one of claims 1 to 3,

further comprising a third temperature sensor configured to detect a temperature of air in the cooler compartment, wherein

when the temperature detected by the third temperature sensor reaches a set temperature determined in advance, the controller is configured to stop the defrosting operation and open the damper.

5