

DESCRIPTION

REFRIGERANT REGULATION DEVICE

TECHNICAL FIELD

[0001]

The present invention relates generally to an air conditioner, a refrigerating device and a freezing device, all of which may herein collectively be referred to as "refrigeration device," and more particularly, to a refrigerant regulation device for improving the property of a refrigerant circulating in an air conditioner, a refrigerating device and a freezing device.

BACKGROUND

[0002]

In Japan, its hot and humid climates are associated with the widespread use of refrigeration devices, such as air conditioners, refrigerating devices and freezing devices, as an essential device for mitigating summer heat.

Refrigeration devices are roughly divided into two distinct categories: compression-type freezing devices and absorption-type freezing devices.

The compression-type freezing device is often used for cooling relatively small spaces such as individual houses and automobiles, whereas the absorption-type freezing device is largely employed for cooling relatively large spaces such as

private/public buildings and large-scale retail stores.

[0003]

In recent years, a growing public awareness of environmental protection and energy conservation has led to increased demands for minimizing the energy consumption for the operation of refrigeration devices, including air conditioners, refrigerating devices and freezing devices. Such demands are satisfied by technological improvements such as the introduction of automatic control of a section for circulating hot and cold air flowing out of a refrigeration device and automatic control of the operating time of air conditioners to reduce unwanted energy consumption.

The standard automatic control units, unfortunately, are extremely complex in structure and require a sophisticated system, thereby increasing cost for manufacturing refrigeration devices.

In addition, the conventional technical level fails to develop such a complex and sophisticated control system for existing refrigeration devices to reduce energy consumption.

[0004]

Other prior arts include compression-type air conditioners capable of achieving energy-saving operations having means for detecting an activity amount of a human body as disclosed in Patent Document 1. Nevertheless, the compression-type air conditioner requires complex detection means and a control mechanism for reducing energy consumption.

On the other hand, Patent Document 2 discloses a different

type of absorption-type air conditioner for improving cooling performance by improving the regeneration capacity of an adsorption agent. The absorption-type air conditioner can be very complex in structure.

Under the circumstances, air conditioners having a simple construction capable of reducing energy consumption and readily applicable to existing refrigeration devices are desired, but these demands are not being satisfied.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0005]

Patent Document 1: JP-A-2014-130004

Patent Document 2: JP-A-2014-118007

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0006]

In view of the problems with the above-mentioned prior arts, an object of the present invention is to provide a refrigerant regulation device having a simple construction capable of reducing the energy consumption of a refrigeration device and readily applicable to existing refrigeration devices.

MEANS FOR SOLVING THE PROBLEM

[0007]

A refrigerant regulation device (2) of the present invention comprises a mixture of a polar material in spontaneous polarization (e.g., garnet typically selected from precious stones and semiprecious stones) and a material containing a radioactive substance (excitation material: selected from natural rare earth ores and the like), wherein the refrigerant regulation device (2) is inserted into a refrigerant piping (1) of either a compression-type refrigeration device or an absorption-type refrigeration device.

The quantity of negative ions generated in the refrigerant regulation device (2) of the present invention is preferably 1000 to 10000/cm³.

The refrigerant regulation device (2) of the present invention preferably comprises a powder of a conductive material.

[0008]

The refrigerant regulation device (2) of the present invention preferably comprises a base material (e.g., rubber, resin and nonwoven fabric) and a mixture of a powder of a polar material in spontaneous polarization (e.g., garnet typically selected from precious stones and semiprecious stones) and a powder of a material containing a radioactive substance (excitation material: selected from natural rare earth ores and the like), wherein the refrigerant regulation device (2) is made of a flexible sheet as a whole.

[0009]

In the refrigerant regulation device (2) of the present

invention, a mixture of a powder of a polar material in spontaneous polarization (e.g., garnet typically selected from precious stones and semiprecious stones) and a powder of a material containing a radioactive substance (excitation material: selected from natural rare earth ores and the like) is preferably sealed in a bag body or a pack.

[0010]

In the above-mentioned refrigerant regulation device (2) of the present invention, a material to be mixed with a base material (e.g., rubber, resin and nonwoven fabric) or a material to be sealed in a bag body or a pack can be selected from natural radioactive rare earth minerals, or can be selected only from radioactive substances such as thoria (ThO_2).

The selected material can be a polar material in spontaneous polarization and any one of a natural radioactive rare earth mineral and a radioactive substance.

Further, a rare earth mineral (e.g., granite porphyry used for water purification to produce mineral water) containing no radioactive element may be added to said material.

[0011]

The refrigerant regulation device (2) of the present invention comprises a semiconductor-including member (2A) containing a semiconductor in an elastic material, a DC-voltage generating member (2B), a negative electrode (2C) of the DC-voltage generating member (2B) and a conductive wire (2D) for connecting the negative electrode (2C) and the semiconductor-including member (2A). Said semiconductor may be

formed by mixing an additive for generating lattice defect in the crystal structure of an insulator with the insulator composed of a mixture of an inorganic polymer material mainly containing silicon oxide or an organic polymer material.

Said insulator may preferably be a silicon rubber, and said additive may preferably be a mixture of yttrium oxide and gadolinium oxide.

[0012]

The refrigerant regulation device of the present invention can be obtained by filling in a bag body made of a flexible material a heteropolyacid catalyst containing dimethyl polysiloxane and a lanthanoid phosphate compound in the form of a gel.

EFFECT OF THE INVENTION

[0013]

The refrigerant regulation device (2) of the present invention based on the above-mentioned configuration is inserted into the refrigerant piping (1) to supply negative ions from the refrigerant regulation device (2) to a refrigerant circulating in the refrigerant piping (1). The refrigerant supplied with the negative ions is provided with an improved heat exchange efficiency to reduce the power consumption of a refrigeration device.

In the compression-type refrigeration device, an improvement in heat exchange efficiency of a refrigerant can shorten the refrigeration cycle by driving a compressor 4 to

reduce the power consumption of the compressor. Accordingly, the overall operating efficiency of the refrigeration device can be improved.

The refrigerant regulation device (2) requires no external power supply to generate negative ions. The refrigeration device can successively generate negative ions as long as the excitation material emits radiation.

[0014]

It is believed that the use of a polar material in spontaneous polarization and a material containing a radioactive substance (excitation material) in the refrigerant regulation device (2) of the present invention causes disarray in the electrolysis of a crystal grain in spontaneous polarization by radiation emission to generate negative ions.

Herein, the quantity of such negative ions is 1000 to 10000/cm³, and the corresponding radiation level is extremely low, which is equivalent to that in radium spa. The radioactive level in the excitation material is not harmful to human body.

[0015]

A natural radioactive rare earth mineral or a rare earth mineral containing no radioactive element (e.g., granite porphyry used for water purification to produce mineral water) may be selected so as to be contained as a material to be mixed with a base material (e.g., rubber, resin and nonwoven fabric) or a material to be sealed in a bag body or a pack. The selected material emits far infrared rays from the refrigerant regulation device (2) and provides the far infrared rays to a

refrigerant circulating in the refrigerant piping (1) to further improve the performance of the refrigerant.

[0016]

The refrigerant regulation device (2) of the present invention may be configured to contain a powder of a conductive material therein. Use of a non-conductive material (insulator material) as a base material (e.g., rubber, resin) of the refrigerant regulation device (2) may reduce attenuation of negative ions generated by a powder of a conductive material and supply negative ions to the refrigerant, which is favorable enough to improve the heat exchange efficiency of the refrigerant.

[0017]

According to the inventors of the present invention, even supply of electrons to a refrigerant circulating in the refrigerant piping (1) may improve the heat exchange efficiency of the refrigerant.

While the energy level of free electrons in a material having favorable thermal conductivity such as copper and aluminum is 0.9eV, the energy level of a refrigerant used in conventional refrigeration devices such as R-22 substitute refrigerant "R-404A" is 0.08eV. This difference is associated with the disadvantage of the conventional refrigeration device having lower heat exchange efficiency of the refrigerant than that based on copper and aluminum.

The refrigerant regulation device (2) of the present invention may supply electrons, particularly solvated

electrons with an energy level of 0.9eV to a refrigerant circulating in the refrigerant piping (1). Accordingly, the energy level of the solvated electrons increases to 0.9eV, which is the energy level of free electrons of copper or aluminum, thereby improving the heat exchange efficiency of the refrigerant.

[0018]

The refrigerant regulation device (2) of the present invention comprises a semiconductor-including member (2A) containing a semiconductor in an elastic material, a DC-voltage generating member (2B), a negative electrode (2C) of the DC-voltage generating member (2B) and a conductive wire (2D) for connecting the negative electrode (2C) and the semiconductor-including member (2A). Said semiconductor may be manufactured by mixing an additive for generating lattice defect in a crystal structure of an insulator with the insulator composed of an inorganic polymer material containing a silicon oxide as a main ingredient or an organic polymer material. Accordingly, the voltages in the negative electrode (2C) of the DC-voltage generating member (2B) are applied to the semiconductor to generate a number of electrons (electrons having an energy level of 0.9eV: solvated electron) from the semiconductor having lattice defect and supply the electrons to a refrigerant circulating in the refrigerant piping (1) where the refrigerant regulation device (2) is inserted.

According to the configuration of the present invention, a number of electrons (electrons having an energy level of

0.9eV: solvated electron) are generated and supplied to a refrigerant circulating in the refrigerant piping (1) where the refrigerant regulation device (2) is inserted. It is believed that this operation allows the energy level of electrons of a refrigerant to increase to 0.9eV, which is the energy level of free electrons of copper or aluminum, thereby improving the heat exchange efficiency of the refrigerant.

[0019]

The refrigerant regulation device of the present invention may be configured by filling in a bag body made of a flexible material a heteropolyacid catalyst containing dimethyl polysiloxane and a lanthanoid phosphate compound in the form of a gel. Accordingly, electrons (electrons having an energy level of 0.9eV: solvated electron) generated by the heteropolyacid catalyst are supplied to a refrigerant circulating in the refrigerant piping (1) where the refrigerant regulation device is inserted. This operation allows the energy level of the electrons of the refrigerant to increase to 0.9eV, which is the energy level of free electrons of copper or aluminum, thereby improving the heat exchange efficiency of the refrigerant.

[0020]

In addition, the above-mentioned refrigerant regulation device (2) having the semiconductor-including member (2A) is readily applicable to existing refrigeration devices by winding the semiconductor-including member (2A) about the refrigerant piping (1) to improve the heat exchange efficiency in a simple

construction.

The above-mentioned refrigerant regulation device having a gel heteropolyacid catalyst filled in a bag body made of a flexible material is readily applicable to existing refrigeration devices in a simple construction by securing the bag body to the refrigerant piping (1).

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

FIG. 1 is a block diagram illustrating a compression-type freezing device including a refrigerant regulation device in accordance with a first example of the present invention;

FIG. 2 is a block diagram illustrating an absorption-type freezing device including a refrigerant regulation device in accordance with the first example of the present invention;

FIG. 3 is an explanatory diagram illustrating a refrigerant regulation device in accordance with a third example of the present invention; and

FIG. 4 is a block diagram illustrating a refrigeration device for use in Example 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022]

Examples of the present invention will be described with reference to the accompanying drawings.

Referring now to FIGS. 1 and 2, a first example of the

present invention will be described. In FIG. 1, a refrigeration device indicated by reference numeral 10 is a compression-type freezing device, comprising an indoor unit 3, a compressor 4, an outdoor unit 5 and an expansion valve 6, each connected to a refrigerant piping 1.

In the refrigeration device 10, a refrigerant regulation device 2 of the present invention is inserted into the refrigerant piping 1 of a known refrigeration device. In FIG. 1, arrow "A" indicates the direction of a refrigerant circulating in the refrigerant piping 1.

In the refrigeration device 10, the refrigerant (e.g., R-22 substitute refrigerant "R-404A") compressed by the compressor 4 is fed into the outdoor unit 5 as a high-temperature and pressure gas-phase refrigerant, and said high-temperature and pressure gas-phase refrigerant is cooled by a fan of the outdoor unit 5 and condensed (or liquefied) to be a low-temperature and high-pressure liquid-phase refrigerant.
[0023]

The low-temperature and high-pressure liquid-phase refrigerant coming out of the outdoor unit 5 is subject to pressure reduction and flow control by the expansion valve 6 to be a low-temperature and pressure liquid-phase refrigerant, which will be fed into the indoor unit 3. The indoor unit 3 conducts heat exchange with the air in a section (room) to be cooled through the low-temperature and pressure liquid-phase refrigerant to allow the refrigerant to absorb latent heat (heat of vaporization required for a low-temperature and pressure

liquid-phase refrigerant to vaporize into a low-temperature and pressure gas-phase refrigerant) from the indoor air. This process decreases the temperature of the indoor air. The refrigerant which has absorbed heat of vaporization (latent heat) from the indoor air will be a low-temperature and pressure gas-phase refrigerant to return to the compressor 4.

The low-temperature and pressure gas-phase refrigerant, after returning to the compressor 4, will be a high-temperature and pressure gas-phase refrigerant compressed by the compressor 4 to be fed into the outdoor unit 5. This cycle will be repeated as a cooling operation.

[0024]

FIG. 1 illustrates the refrigerant regulation device 2 inserted into a section between the outdoor unit 5 and the expansion valve 6 of the refrigerant piping 1 of the refrigeration device 10.

Further, the refrigerant regulation device 2 is inserted into a section between the outdoor unit 5 and the expansion valve 6, and the refrigerant regulation device 2 may be inserted into any section of the refrigerant piping, particularly preferably inserted into the refrigerant piping 1 in which a liquid-phase refrigerant circulates. For example, the refrigerant regulation device 2 can be inserted into the refrigerant piping 1 within the outdoor unit 5.

[0025]

The refrigerant regulation device 2 in accordance with a first example of the present invention is overall made of a

flexible sheet. The sheet may be formed by mixing a mixture of a powder of a natural rare earth mineral (rare earth element mineral) and a powder of a polar material in spontaneous polarization with any one of a silicon rubber, a resin and a fiber.

Illustrative examples of the rare earth element include lanthanoid elements having an atomic number (at.no.) of 57 to 71, such as lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), lutetium (Lu); and group 3 elements such as scandium (Sc: at.no. 21) and yttrium (Y: at.no. 39).

[0026]

Examples of the polar material in spontaneous polarization include garnet typically selected from precious stones and semiprecious stones.

The general chemical formula of garnet is expressed by $X_3Y_2(SiO_4)_3$.

"X₃" is selected from calcium (Ca), magnesium (Mg), iron (Fe: divalent) and manganese (Mn), and "Y₂" is selected from aluminum (Al), iron (Fe: trivalent) and chromium (Cr).

[0027]

The above-mentioned natural rare earth mineral contains an extremely small quantity of radioactive substance (thorium Th, uranium U and radium Ra). The natural rare earth mineral is used as an excitation material for generating negative ions.

The experiments by the inventors found that when a powder of a natural rare earth mineral containing a radioactive substance, such as thorium Th, uranium U and radium Ra, is mixed with a powder in spontaneous polarization (crystal grain), negative ions are generated.

It is believed that when a powder of a natural rare earth mineral containing a radioactive substance is mixed with a crystal grain in spontaneous polarization as an excitation material (a material promoting generation of negative ions), the electrolysis of a crystal grain in spontaneous polarization by radiation demonstrates disarray to generate negative ions.
[0028]

Herein, when a mixed powder composed of a powder of a rare earth mineral and a rare earth oxide and a powder of an excitation material is mixed with a silicon rubber or a resin, the rubber or resin functions as an insulator to absorb negative ions for attenuation. Consequently, the quantity of the negative ions generated from the refrigerant regulation device 2 in the form of a flexible sheet will be smaller.

The refrigerant regulation device 2 in the form of a flexible sheet in accordance with the first example is made of the above mixed powder (a mixed powder obtained by mixing a powder of an excitation material with a powder of a rare earth mineral and a rare earth oxide) and a powder of an electrical conductor (e.g., metal such as silver and copper, and carbon powder) added thereto.

The attenuation of the negative ions generated by adding

the powder of an electrical conductor is reduced to maintain the heat exchange efficiency of a refrigerant running through the refrigerant regulation device 2 at a predetermined level.

[0029]

The radiation level by a radioactive substance contained in the flexible sheet forming the refrigerant regulation device 2 in accordance with the first example is extremely small, which is the same level e.g., at Tamagawa Hot Spring (radium spa) in Akita Prefecture found by the measurement experiments by the inventors.

The quantity of negative ions generated in the refrigerant regulation device 2 is set at $1000/\text{cm}^3$ to $6000/\text{cm}^3$ in compression-type air conditioners, and $3000/\text{cm}^3$ to $10000/\text{cm}^3$ in household refrigerators or refrigerating equipment. The total range of the quantity of negative ions generated in the refrigerant regulation device 2 is 1000 to $10000/\text{cm}^3$.

[0030]

When the quantity of negative ions generated in the refrigerant regulation device 2 is $1000/\text{cm}^3$ or less, the heat exchange efficiency of a refrigerant stays at the same level by supplying negative ions to the refrigerant, thereby failing to provide sufficient effects of improving the heat efficiency of the refrigeration device, shortening the time for executing the refrigeration cycle by driving the compressor (4) and reducing the power consumption of the compressor.

When the quantity of negative ions generated in the refrigerant regulation device 2 exceeds $10000/\text{cm}^3$, the effects

of improving the heat exchange efficiency of the refrigerant, shortening the time for driving the compressor (4) and reducing the power consumption are smaller than a case where the quantity of negative ions is $10000/\text{cm}^3$. On the other hand, the quantity of such negative ions is proportional to the radiation level, and an increase in radiation level can lead to psychological adverse effects on general users of refrigeration devices. It is generally believed that when the quantity of negative ions generated is $10000/\text{cm}^3$ or less, the resulting radiation level can be harmless to human body, with no such psychological adverse effects.

[0031]

In the production of the refrigerant regulation device 2 in the form of a flexible sheet, the mixing ratio of a base material (made of silicon rubber, resin or fiber) of a sheet, a powder of a rare earth mineral and a rare earth oxide, a powder of an excitation material and a powder of an electrical conductor heavily depends on the choice of materials.

Thus, the mixing ratio is preferably determined by the quantity of the above-mentioned negative ions generated.

The experiments by the inventors found that the mixing ratio of a powder of a natural rare earth mineral as an excitation material to a polar material in spontaneous polarization was 1:99 to 99:1 in terms of weight ratio. Therefore, in order to manufacture the refrigerant regulation device of the invention, the mixing ratio (weight ratio) of a powder of an excitation material and a polar material in spontaneous polarization was

determined by the quantity of negative ions generated.

[0032]

The experiments by the inventors found that the quantity of a mixture (mixture of a powder of a natural rare earth mineral and a powder of an excitation material) was preferably 5 to 40 parts by weight relative to 100 parts by weight of a base material of a sheet (made of silicon rubber, resin or fiber).

When the quantity of the mixture was under 5 parts by weight relative to 100 parts by weight of the base material, the quantity of negative ions generated was small, and the effects of improving the heat exchange efficiency of the refrigerant, shortening the time for driving the compressor (4) and reducing the power consumption were not sufficiently obtained.

On the other hand, when the quantity of the powder mixture exceeds 40 parts by weight relative to 100 parts by weight of the base material, the specific surface area of the overall mixture will increase. Thus, when a powder mixture (dispersion-mixed) is mixed with a base material (particularly rubber, resin) to be cast into a mold, the resulting low fluidity makes it difficult to mold the product into a sheet.

[0033]

The experiments by the inventors found that the mixing ratio of a powder of an electrical conductor (e.g., metallic powder and carbon powder) to a base material of a sheet must be 10 to 100 parts by weight relative to 100 parts by weight of a base material of a sheet.

When the electrical conductor powder is under 10 parts by weight relative to 100 parts by weight of a base material of a sheet, the electrical conductivity of the refrigerant regulation device 2 is low enough to decrease the quantity of negative ions generated under $1000/\text{cm}^3$. On the other hand, when the electrical conductor powder exceeds 100 parts by weight relative to 100 parts by weight of a base material of a sheet, the moldability degrades.

[0034]

Further, the experiments by the inventors found that a smaller molding thickness of the refrigerant regulation device 2 in the form of a flexible sheet generally generates negative ions more efficiently. The thickness is preferably 0.5 to 5mm.

When the molding thickness of the refrigerant regulation device 2 in the form of a sheet is under 0.5mm, molding is difficult and the strength of the molded refrigerant regulation device 2 in the form of a sheet degrades. On the other hand, when the molding thickness of the refrigerant regulation device 2 in the form of a sheet exceeds 5mm, the quantity of negative ions doesn't always increase in proportion to the thickness, resulting in rising ingredient cost and being less cost-effective.

[0035]

According to the above-mentioned first example, the refrigerant regulation device 2 in the form of a sheet is wound about the refrigerant piping 1 to supply negative ions to a refrigerant circulating in the refrigerant piping 1. The

refrigerant supplied with such negative ions improves the heat exchange efficiency and reduces the power consumption of the freezing device.

In a compression-type refrigeration device, the heat exchange efficiency of a refrigerant is improved to shorten the time for executing the refrigeration cycle by driving the compressor 4 and reduce the power consumption of the compressor. Accordingly, the operating efficiency of the overall refrigeration device is improved.

Further, it is believed that radiation from an excitation material causes disarray in the electrolysis of a crystal grain in spontaneous polarization to generate negative ions. Consequently, the refrigerant regulation device 2 requires no external power supply to generate negative ions. The refrigeration device can successively generate negative ions as long as the excitation material emits radiation.

The experiments by the inventors found that the power consumption was reduced by about 20 to 40% by winding the flexible refrigerant regulation device 2 in the form of a sheet about a section of the refrigerant piping 1 downstream of a heat exchanger in the outdoor unit 5.

[0036]

FIG. 1 illustrates a refrigerant regulation device in accordance with the first example of the present invention for use in a compression-type freezing device, but the refrigerant regulation device can also be used as an absorption-type refrigeration device. In FIG. 2, the refrigerant regulation

device in accordance with the first example of the present invention is used in an absorption-type refrigeration device.

In FIG.2, the refrigeration device indicated by reference numeral 20 is an absorption-type freezing device, comprising an evaporator 21, an absorbent system 22, an air conditioner 23 in each room and a cold water (refrigerant) piping 24 in communication with the evaporator 21. The refrigerant regulation device 2 is inserted into the cold water (refrigerant) piping 24. The absorbent system 22 comprises an absorber, a regenerator, a condenser and an absorbent solution piping system (each not shown).

In FIG. 2, the refrigerant regulation device 2 can be any one of a type shown in FIG. 2 (indicated by reference numeral 2) and a type to be filled in a bag body made of a flexible material by forming a heteropolyacid catalyst into a gel.

Further, reference numeral 25 in FIG.2 indicates a pump for feeding cold water as a refrigerant.

[0037]

In the absorption-type refrigeration device 20, a liquid-phase refrigerant (water) in the low-pressure evaporator 21 takes heat of vaporization (latent heat) from the cold water (refrigerant) flowing in the cold water (refrigerant) piping 24 to vaporize. Then, the cold water (refrigerant) of the piping 24 which has lost heat of vaporization is cooled, and the pressure is raised by the pump 25 inserted into the cold water (refrigerant) piping 24 to feed the water into the air conditioner 23 in each room for cooling

purposes.

The air conditioner 23 conducts heat exchange with the air in each room through said cold water and the resulting heated water returns to the evaporator 21 to be cooled again and circulated. In this process, the resulting successively cooled cold water (refrigerant) can be used in an air conditioner in each room.

The refrigerant (vapor) in the low-pressure evaporator 21 which has taken heat of vaporization (latent heat) from the cold water (refrigerant) flowing in the cold water (refrigerant) piping 24 to vaporize passes through the piping 27 to return to the absorbent system 22. The vapor returns to a liquid-phase refrigerant (water) in the absorbent system 22, returns to the low-pressure evaporator 21 through the piping 26 and cool the cold water (refrigerant) flowing in the cold water (refrigerant) piping 24.

[0038]

In FIG. 2, the refrigerant regulation device 2 is inserted into a section of the cold water piping 24, which circulates the refrigerant of the air conditioner 23 in each room as mentioned above.

The absorbent system 22 of the absorption-type freezing device 20 is not shown in FIG. 2, and may be water (refrigerant)-LiBr (lithium bromide: absorbent) combination, water-ammonia combination, or a combination of other refrigerant and absorbent.

[0039]

In FIG.2, the refrigerant regulation device 2 is inserted into a section at the outlet of the evaporator 21 of the cold water (refrigerant) piping 24, but the position of the refrigerant regulation device 2 is not restricted thereto.

The experiments by the inventors found that the refrigerant regulation device 2 is inserted into a section at the outlet of the evaporator 21 of the cold water piping 24 to reduce the electric energy by about 20%.

[0040]

Then, a second example of the refrigerant regulation device 2 will be described.

The refrigerant regulation device 2 in accordance with the first example is overall made of a flat, flexible sheet. In the second example, however, the refrigerant regulation device 2 in accordance with the second example in the form of "pack" is configured by sealing in a bag body a mixture (mixed powder) of a powder of the above-mentioned polar material in spontaneous polarization and a powder of an excitation material (natural rare earth ore containing radioactive substance).

The powder of a polar material in spontaneous polarization and the excitation material (natural rare earth ore containing radioactive substance) are the same as the above-mentioned first example.

[0041]

The bag body or the pack for sealing a mixed powder is made of polymer, or a laminated material of aluminum and polymer material. An antistatic aluminum pack material is preferable

to prevent attenuation of negative ions generated by a polymer material as an insulator.

In order to uniformly generate negative ions in the refrigerant regulation device 2 in accordance with the second example, a mixed powder (mixture of a powder of a polar material in spontaneous polarization and a powder of an excitation material) is preferably uniformly dispersed and sealed in said bag body.

Examples of existing methods for sealing a mixed powder in the bag body with uniform dispersion include "dipping method" and "doctor blade method." A dispersed slurry of said mixed powder is manufactured, applied to a holding material such as nonwoven fabric, and dried according to these methods. Subsequently, the dried holding material (holding material in which a dispersed slurry of a mixed powder is applied) is preferably integrated into a bag body made of an antistatic aluminum pack material to perform (vacuum) packing under reduced pressure.

[0042]

Said mixed powder may directly be packed in the bag body.

To facilitate molding and handling processes, a binder component such as polyethylene glycol (PEG) is preferably spray-mixed with said mixed powder, uniformly held on an embossed nonwoven fabric and received within an antistatic aluminum pack to perform (vacuum) packing under reduced pressure.

Further, said mixed powder is dispersed over purified

water to prepare a slurry, which will be formed into a granule using a granulator such as spray dryer and uniformly held on an embossed nonwoven fabric. Then, the nonwoven fabric is preferably received within the antistatic aluminum pack and (vacuum) packed under reduced pressure.

[0043]

According to the refrigerant regulation device 2 in accordance with the second example, a bag body in itself is made of polymer or a laminated material of aluminum and a polymer material, thereby providing flexibility. The bag body, if deformed as required, may adhere to the refrigerant piping of the refrigeration device to be secured with a string member such as a wire.

Other configurations and effects of the refrigerant regulation device 2 in accordance with the second example are the same as the refrigerant regulation device 2 in accordance with the first example.

[0044]

A refrigerant regulation device in accordance with a third example is illustrated in FIG. 3.

In FIG.3, the refrigerant regulation device 2 comprises a semiconductor-including member 2A containing a semiconductor (not shown) in an elastic material, a DC-voltage generating member 2B and a conductive wire 2D. The conductive wire 2D connects a negative electrode 2C of the DC-voltage generating member 2B and the semiconductor-including member 2A. Further, the semiconductor-including member 2A is made of a sheet, but

may be formed of other shapes such as a cylinder.

The DC-voltage generating member 2B is provided with a positive terminal 2E and a negative terminal 2C. The DC-voltage generating member 2B functions as an AC/DC converter. Alternating voltages supplied from a predetermined supply power (e.g., plug for household outlet) are converted into direct-current voltages, and direct-current voltages of the negative electrode can be applied to the semiconductor of the semiconductor-including member 2A through the conductive wire 2D.

In FIG. 3, reference numeral F indicates a plug for alternator.

[0045]

The refrigerant regulation device 2 shown in FIG. 3 is capable of generating a number of solvated electrons having the same energy level (0.9eV) as the energy level of free electrons of copper or aluminum (used as a material of a refrigerant piping and having excellent thermal conductivity).

When the refrigerant regulation device 2 shown in FIG. 3 is inserted into the refrigerant piping 1 (see FIG. 1), the refrigerant regulation device 2 supplies solvated electrons (particularly, with an energy level of 0.9eV) to a refrigerant circulating in the refrigerant piping 1. When the refrigerant circulating in the refrigerant piping 1 is an R-22 substitute refrigerant "R-404A," for example, the refrigerant regulation device 2 supplies solvated electrons having an energy level of 0.9eV to a refrigerant to increase the energy level of the

electrons in the refrigerant (R-22 substitute refrigerant "R-404A") from 0.08 to 0.9eV. The energy level of 0.9eV is the same as that of free electrons of copper or aluminum.

[0046]

After the solvated electrons are supplied to the refrigerant circulating in the refrigerant piping 1 to increase the energy level of the refrigerant, the heat exchange efficiency of the refrigerant is improved to reduce the power consumption in the refrigeration device 10.

The improvement in heat exchange efficiency of the refrigerant is confirmed by the later-described experiments by the inventors.

[0047]

The semiconductor-including member 2A contains a semiconductor, which is connected to an electrode (not shown) provided in the semiconductor-including member 2A. The electrode (not shown) provided in the semiconductor-including member 2A is electrically connected to the negative terminal 2C of the DC-voltage generating member 2B.

The semiconductor contained in the semiconductor-including member 2A can be obtained by mixing said additive with an insulator to generate lattice defect in a crystal structure of the insulator. For example, a mixture of yttrium oxide and gadolinium oxide is mixed with an insulator made of a silicon rubber (inorganic polymer material containing silicon oxide as main component) as an additive to manufacture a semiconductor to be contained in the semiconductor-including

member 2A.

[0048]

A method for manufacturing a semiconductor-including member 2A will be described.

First, a predetermined amount of a silicon rubber as an insulator (e.g., 10g) is prepared.

Then, yttrium oxide (e.g., 0.2g) and gadolinium oxide (e.g., 0.3g), each in the form of a powder, is mixed with the silicon rubber. The mixed powder, as an additive, is slowly mixed with a predetermined amount of silicon rubber (e.g., 10g) until it is sufficiently stirred.

The resulting mixture as mentioned above (a mixture obtained by mixing and stirring a silicon rubber as an insulator and a mixed powder of yttrium oxide and gadolinium oxide) is cast into a mold.

When casting the mixture in the mold, said electrode (an electrode in the semiconductor-including member 2A: not shown) is connected to a conductive wire 2D, immersed and secured in said mixture (a mixture obtained by mixing and stirring a silicon rubber as an insulator and a mixed powder of yttrium oxide and gadolinium oxide).

[0049]

A mold in which a mixture having an immersed electrode (an electrode in a semiconductor-including member 2A) has been cast is dried in a dry furnace (e.g., at 70°C for 30 minutes) to obtain a desired semiconductor-including member 2A (a semiconductor-including member containing semiconductor).

FIG. 3 illustrates the semiconductor-including member 2A in the form of a sheet, which can be formed of a cylinder. In the above-mentioned method for manufacturing the semiconductor-including member 2A, the semiconductor-including member 2A may e.g., be a cylinder with a diameter of 15mm and a height of 20mm, to which the size of said mold corresponds. The electrode within said semiconductor-including member is substantially cuboid made of copper.

[0050]

Then, a method for supplying solvated electrons to a refrigerant of the refrigerant piping 1 from the refrigerant regulation device 2 will be described.

When direct-current voltages of the negative electrode 2C of the DC-voltage generating member 2B are applied to the semiconductor of the refrigerant regulation device 2, the semiconductor generates a number of electrons (solvated electrons having an energy level of 0.9eV) from the semiconductor due to its inherent lattice defect. The electrons generated (solvated electrons having an energy level of 0.9eV) are supplied to a refrigerant circulating in the refrigerant piping 1.

Consequently, the energy level of the electrons of the refrigerant increases to 0.9eV, which is the energy level of free electrons of copper or aluminum, thereby improving the heat exchange efficiency of the refrigerant. This improvement shortens the time for executing the refrigeration cycle by

driving the compressor (4) and reduces the power consumption of the compressor.

[0051]

The supply of solvated electrons from the refrigerant regulation device 2 to the refrigerant circulating in the refrigerant piping 1 generates ions having a reduction element in the refrigerant. When the refrigerant circulates in the refrigerant piping 1, the ions affect each apparatus of the refrigeration device 10, thereby preventing oxidation of a lubricant. The resulting improvement in lubrication efficiency in each apparatus improves the operating efficiency of the refrigeration device 10. It is believed that this process contributes to reducing the power consumption of the refrigeration device 10.

In addition, in the refrigerant regulation device 2 having the semiconductor-including member 2A, the semiconductor-including member 2A made of a sheet is wound about the refrigerant piping 1 to readily be attachable to existing refrigeration devices.

Experimental Example 1

[0052]

A comparative test was performed, using a refrigeration device including the refrigerant regulation device 2 described in FIG. 3 and a refrigeration device including no refrigerant regulation device 2.

In Experimental Example 1, the refrigerant regulation

device 2, as shown in FIG. 4, was disposed near the outlet of the outdoor unit 5 in the refrigerant piping system of the outdoor unit 5. Specifically, the configuration of “refrigeration device including the refrigerant regulation device 2” (FIG. 4) in Experimental Example 1 is the same as that of the compression-type refrigeration device 10 shown in FIG. 1 except the position of the refrigerant regulation device 2. [0053]

The comparative test was performed in a food manufacturing company. Two units of compression-type refrigeration devices were prepared. One was provided with the refrigerant regulation device 2 shown in FIG. 3, and the other was provided with no refrigerant regulation device 2.

The intensity of the two refrigeration devices was set at “strong.” To place a high load on the refrigeration devices, electric heaters were placed in each of the refrigerators and their intensity was set at “strong.” The duration from the start of the test and the temperature inside were measured.

The test results (by comparison) are shown in Table 1 below.

Table 1

Duration from the start of test	Temperature inside of refrigerating device	
	No refrigerant regulation device placed	Refrigerant regulation device placed

Upon start of test	6.5°C	6.9°C
20 min. later	8.5°C	3.1°C
37 min. later	18.8°C	3.1°C

[0054]

As shown in Table 1, the refrigerating device including no refrigerant regulation device 2 (no refrigerant regulation device placed) demonstrates increases in the temperature inside from 6.5°C upon start of test, and the temperature was 8.5°C 20 minutes later and 18.8°C 37 minutes later.

On the other hand, in the refrigerating device having the refrigerant regulation device 2 (refrigerant regulation device placed), the temperature inside upon start of test was 6.9°C, which was substantially the same temperature as "no refrigerant regulation device placed." As time elapsed, however, the temperature inside declined until it showed the stable value of 3.1°C 20 minutes later. The use of the refrigerant regulation device reduced the temperature by 5 to 15°C.

These observations found that the refrigerant regulation device 2 described in FIG. 3 highly contributes to improving the heat exchange efficiency of the refrigeration device.

[0055]

A refrigerant regulation device in accordance with another Example (fourth Example) will be described. In this Example, a catalyst in the form of a gel can be filled in a bag body of a flexible member (e.g., synthetic resin) to manufacture a refrigerant regulation device.

Preferable examples of the catalyst include a

heteropolyacid catalyst containing dimethyl polysiloxane and a lanthanoid phosphate compound. The catalyst in the form of a gel is filled in a bag body made of a flexible material to manufacture a refrigerant regulation device in accordance with the fourth Example.

[0056]

It is well known that a heteropolyacid catalyst has effects of increasing the combustion speed by generating chemical activated species in combustion air, increasing the combustion speed by reforming a liquid fuel and improving the performance and life by reducing an oxidation molecule of a lubricant.

The heteropolyacid catalyst contains a number of solvated electrons having an energy level of about 0.9eV.

[0057]

A refrigerant regulation device in which a catalyst in the form of a gel is filled in a bag body made of a flexible member is secured to a refrigerant piping 1 (see FIG. 1). Accordingly, electrons generated by the heteropolyacid catalyst (solvated electrons having an energy level of 0.9eV) are supplied to a refrigerant circulating in the refrigerant piping 1 into which the refrigerant regulation device is inserted. This process increases the energy level of electrons of the refrigerant to 0.9eV, which is the energy level of free electrons of copper or aluminum. Accordingly, the heat exchange efficiency of the refrigerant circulating in the refrigerant piping 1 is improved to reduce the power consumption of the

refrigeration device.

A refrigerant regulation device in which a heteropolyacid catalyst in the form of a gel is filled in a bag body made of a flexible material is readily applicable to existing refrigeration devices in a simple construction where a bag body is secured to the refrigerant piping 1.

Experimental Example 2

[0058]

A comparative test was performed, using a refrigeration device including a refrigerant regulation device in accordance with the fourth Example and a refrigeration device including no refrigerant regulation device.

The refrigeration device for use in Experimental Example 2 is a compression-type cooling equipment (air conditioner) as shown in FIG. 4, and a refrigerant regulation device is inserted into the refrigerant piping 1 (FIG. 4). More specifically, the refrigerant regulation device was disposed near the outlet of the refrigerant piping system of the outdoor unit 5, as in Experimental Example 1.

[0059]

The comparative test was performed in a gym under the same conditions as Experimental Example 1, using the same air conditioner. In the comparison between the use and no use of a refrigerant regulation device, the temperature of the air outlet of an indoor unit louver was measured.

The temperature of the air conditioner was set at 20°C,

and the temperature of the air outlet of the indoor unit louver was measured 15 minutes after the refrigerant regulation device 2 was inserted into the piping.

The measurement results are shown in Table 2 below.

Table 2

	Temperature at air outlet of indoor unit louver	
	Prior to insertion of refrigerant regulation device	After insertion of refrigerant regulation device
	14.5°C	9.0°C*
Difference in temperature	5.5°C	

*Temperature measured 15 minutes after insertion of refrigerant regulation device.

[0060]

As a result, the temperature of the air outlet of the indoor unit louver was 14.5°C prior to the insertion of the refrigerant regulation device, but it was 9.0°C after the insertion of the refrigerant regulation device 2. The temperature decreased by 5.5°C by the insertion.

That is, a comparison was made between a case where the air conditioner's preset temperature was 20°C prior to the

insertion of the refrigerant regulation device and a case where the air conditioner's preset temperature was 22 to 23°C after the insertion of the refrigerant regulation device. Both cases were found to provide the same effect of cooling.

Based on the official statements of "10% energy saved by increasing the preset temperature of an air conditioner by 2°C" released by the Agency for Natural Resources and Energy and "10% energy saved by increasing the preset temperature of an air conditioner by 1°C" released by private companies on air conditioner production and sales, the energy saved by use of a refrigerant regulation device may be 15 to 30%.

[0061]

Although the invention has been described through its specific form, it is to be understood that the described example is only illustrative and is not intended to limit the scope of the invention.

In the illustrative example, a material to be mixed with a base material (e.g., rubber, resin and nonwoven fabric) and a material to be sealed in a bag body or a pack may be selected only from natural radioactive rare earth minerals, or selected only from radioactive substances such as thorium (ThO_2).

In addition, any one of a polar material in spontaneous polarization, a natural radioactive rare earth mineral and a radioactive substance may be selected.

Further, a material to be mixed with a base material (e.g., rubber, resin and nonwoven fabric), and a rare earth mineral containing no radioactive element (e.g., granite porphyry used

for water purification to produce mineral water) as a material to be sealed in a bag body or a pack, may be added.

EXPLANATIONS OF LETTERS AND REFERENCE NUMERALS

[0062]

- 1 Refrigerant piping
- 2 Refrigerant regulation device
- 2A Semiconductor-including member
- 2B DC-voltage generating member
- 2C Negative electrode, negative terminal
- 2D Conductive wire
- 2E Positive electrode, positive terminal
- 2F Plug for alternator
- 3 Indoor unit
- 4 Compressor in compression-type refrigeration device
- 5 Outdoor unit
- 6 Expansion valve
- 10 Compression-type refrigeration device
- 20 Absorption-type refrigeration device
- 21 Evaporator
- 22 Absorbent system (collectively referred to for absorbent system equipment)
- 23 Air conditioner in each room
- 24 Cold water (refrigerant) piping
- 25 Pump
- 26, 27 Piping

CLAIMS

1. A refrigerant regulation device, comprising a mixture of a polar material in spontaneous polarization and a material containing a radioactive substance, wherein the refrigerant regulation device is inserted into a refrigerant piping of either a compression-type refrigeration device or an absorption-type refrigeration device.
2. The refrigerant regulation device according to claim 1, comprising a powder of a conductive material.
3. The refrigerant regulation device according to any one of claims 1 and 2, comprising a base material and a mixture of a powder of a polar material in spontaneous polarization and a powder of a material containing a radioactive substance, wherein the refrigerant regulation device is made of a flexible sheet as a whole.
4. The refrigerant regulation device according to claim 1, wherein a mixture of a powder of a polar material in spontaneous polarization and a powder of a material containing a radioactive substance is sealed in a bag body or a pack.