

Patent description

[Title of invention] **Temperature control device, electrostatic rectifier for temperature control device and efficiency improvement method for temperature control device**

[Field of invention]

[0001]

This invention relates to a temperature control device, an electrostatic rectifier for a temperature control device and an efficiency improvement method for a temperature control device. More specifically, it is preferably applicable to products such as air-conditioning devices.

[Background of invention]

[0002]

When storing various materials such as food, storing them at low temperatures is very important. Refrigerators, cooling systems and other cooling devices are commonly available as equipment for storing at such low temperatures.

[0003]

A cooling device is generally capable of cooling a material that is subject to be cooled (material to be cooled) by cooling a refrigerant and supplying the coolness of the refrigerant directly or indirectly to the material to be cooled.

[0004]

Refrigerants for this purpose need to have high stability and heat transfer efficiency, etc., and in recent years, the need and demand to reduce the impact on the global environment has become extremely high, making HFCs (hydrofluorocarbons), etc., the mainstream refrigerants. These refrigerants are described, for example, in Patent document 1 below and other documents.

[Prior art document]

[Patent document]

[0005]

[Patent document 1] Japanese Patent Publication No. 2010-121927.

[Summary of invention]

[Problems to be solved by invention]

[0006]

While the above refrigerants are capable of satisfying the required performances as refrigerants, the electric power consumption, i.e., the cooling efficiency of the refrigerants, remains an issue.

[0007]

More specifically, since a fluorine atom in the molecular structure of these refrigerants gives

them a polarity when their molecular structure has no symmetry, static electricity is generated by friction, etc. between the refrigerant and the refrigerant pipe or between the refrigerant molecules when the refrigerant flows through the refrigerant pipe. This static electricity remains on the inner surface of the refrigerant pipe, trapping the refrigerant and reducing the fluidity of the refrigerant. In addition, the refrigerant itself may aggregate into clusters due to its polarity and static electricity, worsening this problem.

[0008]

Although grounding the refrigerant pipe to release static electricity has been considered regarding this issue, this poses a problem in that any electrical measures to the refrigerant pipe are difficult to implement due to the shielding of the refrigerant pipe.

[0009]

This problem can be seen not only for refrigerants but also for media in general. In other words, this is true not only for cooling media (refrigerants) but also for media for heating (heating media) .

[0010]

The present invention was made in view of the above problems to provide a temperature control device, an electrostatic rectifier for a temperature control device and an efficiency improvement method that solve electrical problems of media and can achieve high heat

transfer efficiency.

[Means to solve problems]

[0011]

A temperature control device according to one aspect of the present invention to solve the above problems is a temperature control device comprising: a medium pipe formed of a conductive material to house and circulate a medium; a case that houses the medium pipe; and an electrostatic rectifier that is electrically connected to the medium pipe and supplies a pulsed signal that is repeated at a frequency of 20-60 kHz.

[0012]

In this aspect, the medium is preferably a polar medium.

[0013]

In this aspect, the case and the medium pipe are preferably electrically insulated or connected via a resistor.

[0014]

In this aspect, the pulsed signal is preferably an attenuated wave, and the period of the attenuated wave is preferably 2-10 MHz.

[0015]

An electrostatic rectifier for a temperature control device according to another aspect of the

present invention supplies a pulsed signal that is repeated at a frequency of 20-60 kHz.

[0016]

In this aspect, the pulsed signal is preferably an attenuated wave, and the period of the attenuated wave is preferably 2-10 MHz.

[0017]

An efficiency improvement method for a temperature control device according to another aspect of the present invention is an efficiency improvement method for a temperature control device having a medium pipe formed of a conductive material to house and circulate a medium, a case to house the medium pipe, and an electrostatic rectifier connected to the medium pipe, wherein the electrostatic rectifier supplies a pulsed signal repeated at a frequency of 20-60 kHz to the medium pipe.

[0018]

In this aspect, the pulsed signal is preferably an attenuated wave, and the attenuated wave signal with a period of 2-10 MHz is preferably supplied to the media pipe.

[Effects of invention]

[0019]

The present invention can provide a temperature control device, an electrostatic rectifier for a temperature control device and an efficiency improvement method for a temperature

control device that solve electrical problems of media and can achieve high heat transfer efficiency.

[Brief description of drawings]

[0020]

FIG. 1 is a functional block diagram of a temperature control device in an embodiment.

FIG. 2 is an illustration of clusters of media to be formed.

FIG. 3 is an illustration of clusters of media with smaller sizes.

FIG. 4 is an example of a waveform of a pulsed attenuated wave signal generated by an electrostatic rectifier for the temperature control device in the embodiment.

FIG. 5 is a diagram showing an example of a circuit of the electrostatic rectifier for the temperature control device in the embodiment.

FIG. 6 is a diagram showing another example of the temperature control device in the embodiment.

FIG. 7 is a waveform signal generated by the electrostatic rectifier in the embodiment.

FIG. 8 is a schematic of an experimental system in the embodiment.

FIG. 9 is a graph showing a result of an experiment in the embodiment.

[Description of embodiments]

[0021]

The following is a detailed description of the embodiment of the present invention with reference to the drawings. Note that the invention can be implemented in many different embodiments and is not limited to the specific examples described in the embodiments and examples shown below, which can also be changed and modified as appropriate.

[0022]

FIG. 1 is a functional block diagram of a temperature control device in an embodiment (hereafter referred to as "the device"). As shown in this figure, a temperature control device 1 comprises a medium pipe 2 that is formed from a conductive material to house and circulate a medium, a case 3 that houses the medium pipe 2, wherein the case 3 and the medium pipe 2 are electrically insulated, and an electrostatic rectifier 4 that is connected to the medium pipe 2.

[0023]

The temperature control device may be either a cooling device that cools or a heating device that heats an object to be housed or the like, but for simplicity of explanation, an example will be described for a cooling device. In other words, the temperature control device includes the concept of a cooling device and a heating device, and the term "cooling device" in the example below can be read as "temperature control device" if necessary, and the term "refrigerant" can be read as "medium" if necessary.

[0024]

When the temperature control device 1 is a cooling device, various forms can be adopted as a product. For example, a refrigerator, a freezer, air conditioners and other air conditioning systems (an A/C, a cooling system, an air conditioning system for a clean room and the like for semiconductor manufacturing equipment processes and the like), a chiller, a heat pump and the like can be applied. For simplicity of explanation, an example of a specific refrigerator will be used in this embodiment. Note that a cooling device is generally a device that cools something by using the refrigeration cycle of compression, condensation liquefaction, expansion vaporization and compression of the refrigerant.

[0025]

As shown in this figure, the temperature control device 1 comprises the medium pipe 2, the case 3 and the electrostatic rectifier 4. Besides these, the temperature control device 1 preferably comprises a temperature-keeping chamber 5 that houses the object to be cooled or heated. The temperature-keeping chamber 5 can store an object to be cooled inside to cool it. When the temperature control device is a cooling device, it corresponds to a refrigerating or freezing chamber, while when the temperature control device is a heating device, it corresponds to a heating chamber.

[0026]

In the temperature control device 1, the medium pipe 2 forms a circulation path and is connected to a compressor 6, a heat radiator 7, a cooler 8, etc. along the way. The medium housed in the medium pipe 2 is compressed and liquefied by a compressor 7 as it circulates inside the medium pipe 2, releases heat outside by a heat radiator 7 and further absorbs ambient heat (specifically, heat in the temperature-keeping chamber 5) by a cooler 8 to be vaporized. This means that the device can supply coolness to the area around the cooler 8, functioning as a temperature control device, i.e., a cooling device.

[0027]

In this temperature control device 1, the medium is not limited to but preferably a polar medium from the viewpoint that the effects of the temperature control device 1 can be significant. Polar media are high in media efficiency due to their polarity but have the problem of forming media clusters due to their polarity. More specifically, the high polarity of halogens such as chlorine and fluorine present in media molecules causes them to interact with neighboring media molecules to form clusters. These clusters cause flow in the media pipe on a cluster-by-cluster basis, lowering their heat exchange efficiency and preventing them from fully demonstrating their function as media. FIG. 2 is an illustration of the clusters. However, the temperature control device and the electrostatic rectifier, as described later, will eliminate this interaction between media molecules and help to resolve the clusters. This

improves the heat transfer efficiency. Therefore, the medium is preferably a polar medium.

[0028]

Here a detailed explanation of the resolution of clusters will be provided, although some parts will be repetitive. As mentioned above, a polar medium generates a bonding force between molecules due to the unbalanced electric charge in the medium molecules. However, since these molecules within the population form clusters while changing the pairing partners at each time, adding free electrons (solvated electrons) in a model with a certain dynamism can make the clusters smaller and improve the efficiency of the medium. The illustration of this case is shown in FIG. 3.

[0029]

The polar medium in the temperature control device 1 can be, but is not limited to, R32 (CH_2F_2), R125 (C_2HF_5) or their mixtures for refrigerants.

[0030]

In the temperature control device 1, the case 3 is a part that can house the cooling pipe 2, the temperature-keeping chamber 5, the compressor 6, the heat radiator 7, the cooler 8, etc. The case 3 can house these elements as an integrated body. The case 3 may comprise a sliding part and a door part to access the temperature-keeping chamber while holding the temperature-keeping chamber 5, and may further comprise a packing part or the like to

secure the sealing of the temperature-keeping chamber 5.

[0031]

In the temperature control device 1, the case 3 and the medium pipe 2 are electrically insulated as described above. Specifically, this means that the medium pipe 2 is not grounded or earthed in its circulation path. In general temperature control devices, the cooling pipe 2 itself is grounded or electrically connected to the case 3 which houses it to be grounded to avoid problems caused by charging as it tends to be charged if not grounded. However, in the temperature control device 1, it is electrically insulated from the case 3 and kept ungrounded because the charging state needs to be controlled by the electrostatic rectifier described later. The medium pipe 2 needs to be physically contacted to and held by the case 3 due to the need to be housed in it. An electrically insulating material such as an insulating rubber can be used to have the cooling pipe 2 contacted to and held by the case 3 in and around it. However, even if they are not completely electrically insulated, they may be electrically connected to each other via a resistor, as long as they are sufficiently capable of transmitting the signal from the electrostatic rectifier.

[0032]

The electrostatic rectifier 4 for the temperature control device 1 supplies a pulsed signal. The electrostatic rectifier 4 in this temperature control device 1 supplies an electrical signal whose

voltage (amplitude) changes with time, with the waveform of this electrical signal being a pulsed signal, although some parts are repetitive. The term "pulsed" means that the signal appears at regular intervals. In addition, the pulsed signal is preferably an attenuated wave signal to achieve higher heat transfer efficiency in the temperature control device . The term "attenuated wave signal" means a signal that is periodically repeated with its amplitude decreasing with time, which may include pulses and overlapping harmonics. FIG. 4 is an example of a pulsed attenuated wave signal generated by the electrostatic rectifier 4.

[0033]

In the temperature control device 1, the electrostatic rectifier 4 preferably supplies a pulsed attenuated wave signal that is repeated at a frequency of 20-40 kHz, more preferably at 33 kHz or lower. This frequency is a so-called pulse frequency. The pulsed attenuated wave signal is supplied at intervals of 20-50 μ s, more preferably 30 μ s or shorter, in terms of repetition time. The pulsed signal in the above range can supply the medium with solvated electrons in a pulsatile manner, resulting in vibrations that are transmitted to the clusters in the medium to help resolve the clusters, although this effect is partly speculative. By making it an attenuated wave, this effect becomes more significant. The term "solvated electrons" refers to electrons used to make a medium neutral.

[0034]

In the temperature control device 1, when the signal is an attenuated wave, the period of the signal within a single attenuated wave signal is preferably 2-10 MHz, more preferably 5 MHz or lower. This frequency refers to the period within a single attenuated wave signal, and its time interval is 0.1-0.5 μ s, preferably 0.2 μ s or shorter. Although the effect of adding waves in this range is partly speculative, as with the pulsed attenuated wave signal described above, the attenuated wave signal will help to effectively transmit the impact of the pulses to the medium.

[0035]

The electrostatic rectifier 4 for the temperature control device 1 receives power from a power source, specifically an external power source, and more specifically a household power source, generates the above pulsed attenuated wave signal and makes electrical contact with the medium pipe to supply this attenuated wave signal to the medium via the medium pipe .

The structure of the electrostatic rectifier 4 is not limited as long as it can generate an attenuated wave signal as described above, and can be realized, for example, with a circuit shown in FIG. 5.

[0036]

As shown in this figure , as shown in this circuit diagram, the electrostatic rectifier 4 comprises at least an AD converter 41 that is connected to an external AC power source and converts

the AC power to DC power, a signal generator 42 that generates the basic signals, an operational amplifier 43 that receives these inputs, and an output end 44 that transmits the output of the operational amplifier 43. This configuration makes it possible to receive power from the power source and supply the above signal to the cooling pipe from the output end . Capacitors and resistors may be arranged between these elements to adjust voltage, etc., as appropriate.

[0037]

In the temperature control device 1, the electrostatic rectifier 4 is electrically connected to the periphery of the medium pipe 2 and is capable of supplying an electrical charge to the medium. More specifically, the output end of the electrostatic rectifier is in contact with the medium pipe , enabling the supply of an electric charge. In this case, although the position at which the output end is in contact can be anywhere in the circulation path of the conductive medium pipe , considering the efficiency of the supply of electric charge, the position is preferably closer to a site in which the medium is in a liquid state than to a site in a gaseous state, more preferably in a cooled position. In other words, it is preferably arranged between the compressor and the heat radiator .

[0038]

The temperature control device 1 is at least partly characterized by being equipped with an

electrostatic rectifier 4, while commercially available products can be used for other elements.

Specifically, after applying insulation treatment to the case and medium pipe of a temperature control device such as a commercially available refrigerator, the electrostatic rectifier 4 may be installed to supply the signal described above. This allows for easy improvement.

[0039]

Although the above description clearly shows how a cooling efficiency improvement method for a temperature control device using the temperature control device 1 (hereinafter referred to as "the method") works, the method will be explained to be safe. As is clear from the above description, the method is an efficiency improvement method for a temperature control device having a medium pipe formed of a conductive material to house and circulate a medium, a case to house the medium pipe, wherein the case and the medium pipe are electrically insulated, and an electrostatic rectifier connected to the medium pipe, wherein the electrostatic rectifier supplies a pulsed attenuated wave signal repeated at a frequency of 20-40 kHz with a period of the signal within the attenuated wave of 2-10 MHz to the medium pipe. The effects of these are described above.

[0040]

As described above, the temperature control device 1 and the method can solve the electrical

problems of the medium and can achieve higher heat transfer efficiency.

[0041]

The above temperature control device 1 is described using the example of a refrigerator, is not limited as long as it comprises an electrostatic rectifier 4 and a cooling pipe that forms a circulation path for circulating a medium, and can also be applied to a cooling system using, for example, a so-called tower for cooling (cooling tower) . The schematic of this case is shown in FIG. 6.

[0042]

The cooling system shown in this figure can be installed inside a structure such as a building, for example, consisting of medium pipes that branch and extend all over the building and a cooling tower installed on the roof of the building or the like. The medium pipes extend all over the building and contact objects to be cooled to absorb their heat. The cooling tower then radiates this absorbed heat to cool at least either the inside of the building or the objects to be cooled in the building. Then, as described above, connecting an electrostatic rectifier to the cooling pipe and applying the above signal to the medium to supply it with an electric charge can increase and improve the cooling efficiency. Furthermore, in the case when water is used as the medium for a cooling tower, the pulsed signal can remove scale deposited on the pipe wall caused by calcium, magnesium, etc., contained in the water.

[0043]

Although the cooling device is used as an example for simplicity of explanation as described above in this embodiment, it can also be applied as a heating device. The heating system can be, but is not limited to, floor heating systems, water heaters, boilers, or the like.

[Example]

[0044]

Here, a prototype of the above temperature control device was actually prepared and tested to check its effectiveness. The following is an explanation.

[0045]

First, an electric circuit of an electrostatic rectifier shown in the figure above was actually prepared to generate a pulsed attenuated wave signal. FIG. 7 is a pulsed attenuated wave signal that is actually generated. This figure is the observed result of the signal wave using an oscilloscope. Figure (B) is a partially enlarged view of figure (A). As a result, a pulsed signal was applied every 40 μ s, and a detailed check within this pulsed signal demonstrated that the signal was an attenuated wave with a period of 200 ns (0.2 μ s).

[0046]

Next, the output of the above prepared electrostatic rectifier was connected to an electrode and put into a water tank filled with water as an example of a polar medium to check each

physical property such as its oxidation-reduction potential and pH. FIG. 8 is a schematic of this experimental system, and FIG. 9 shows the oxidation-reduction potential (ORP potential).

[0047]

As shown in this figure, the ORP potential decreases with time by applying a pulsed attenuated wave using the electrostatic rectifier, with little effect on the other physical properties.

[0048]

Then, cold heat was applied to the water connected to the electrode in this condition to check the cooling efficiency, showing that the temperature decreased by only about 3°C when not connected to the electrostatic rectifier, while it decreased by about 6°C when connected. Consequently, the example demonstrated the effectiveness of the temperature control device and the electrostatic rectifier.

[Industrial applicability]

[0049]

The invention has industrial applicability as a temperature control device, an electrostatic rectifier and a cooling efficiency improvement method for a temperature control device.

[Reference signs list]

[0050]

1 temperature control device

2 medium pipe

3 case

4 electrostatic rectifier

5 temperature-keeping chamber 5

6 compressor

7 heat radiator

8 cooler

Claims

What is claimed is:

1. A temperature control device comprising:

a medium pipe formed of a conductive material to house and circulate a polar medium;

a case electrically insulated from the medium pipe or connected to the medium pipe via a resistor to house the medium pipe; and

an electrostatic rectifier having an output end that is electrically connected to the medium pipe,

wherein the electrostatic rectifier comprises a circuit that supplies free electrons to the polar medium by transmitting a pulsed attenuated wave signal repeated at a frequency of 20-60 kHz to the medium pipe.

2. The temperature control device according to claim 1, wherein the period of the attenuated wave is 2-10 MHz.

3. The temperature control device according to claim 1, which is an air-conditioning device.

4. An electrostatic rectifier for a temperature control device comprising:

an output end for connecting to a medium pipe,

further supplying free electrons to the polar medium in the medium pipe by transmitting a pulsed attenuated wave signal repeated at a frequency of 20-60 kHz to the medium pipe by means of the output end.

5. The electrostatic rectifier for a temperature control device according to claim 4, wherein the period of the attenuated wave is 2-10 MHz.

6. An efficiency improvement method for a temperature control device having a medium pipe formed of a conductive material to house and circulate a polar medium, a case electrically insulated from the medium pipe or connected to the medium pipe via a resistor to house the medium pipe, and an electrostatic rectifier having a circuit with an output end electrically connected to the medium pipe,

wherein the electrostatic rectifier supplies free electrons to the polar medium by transmitting a pulsed attenuated wave signal repeated at a frequency of 20-60 kHz to the medium pipe.

7. The efficiency improvement method for a temperature control device according to claim 6, wherein an attenuated wave signal with a period of the attenuated wave of 2-10 MHz is

supplied to the medium pipe.

8. The efficiency improvement method for a temperature control device according to claim

6, wherein the temperature control device is an air-conditioning device.