

COOLING METHOD AND COOLING SYSTEM FOR ELECTRONIC DEVICE

BACKGROUND OF THE INVENTION

Field of the Invention

5 The present invention relates to a cooling method and a cooling system for an electronic device, and more particularly, to a cooling method and a cooling system for an electronic device which are used for locally cooling electronic devices such as a computer and a server placed in a server room by naturally circulating a refrigerant between an evaporator and a cooling tower (or a condenser).

Description of the Related Art

10 In a server room, a large number of electronic devices such as a computer and a server are installed in an intensive state. The electronic devices are installed generally in a rack mount system, that is, in a system in which the electronic devices are divided on a functional unit basis to be housed in a rack (casing) and such racks are stacked on top
15 of one another in a cabinet. Then, a large number of such cabinets are arranged in a line on a floor of the server room.

 These electronic devices require a given temperature environment for a normal operation thereof, and if a high temperature state occurs, a trouble such as a system halt may be caused. For this reason, the server room is controlled by air-conditioning
20 equipment so as to have the given temperature environment. However, in recent years, along with a rapid increase in processing speed and processing ability of the electronic devices, an amount of heat generated from the electronic devices steadily continues to increase, and the running cost of the air-conditioning equipment is also significantly increasing.

25 Against such a backdrop, various technologies for efficiently cooling an electronic device have been proposed. For example, National Publication of International Patent Application No. 2006-507676 proposes a method of locally cooling an electronic device by forming a closed loop flow passing through the electronic device and cooling the closed loop flow with a heat exchanger.

In addition, a method of cooling a server room by floor blow-out air conditioning using package air-conditioning equipment has been also adopted, but in order to suppress a local increase in temperature due to exhaust heat from the electronic device, it is necessary to air-condition the entire server room, which thus leads to a problem that the cooling efficiency is low. Therefore, the ratio of the blowing power required for heat transfer to the air-conditioning power is high. Accordingly, how to reduce the heat transfer power is important for energy saving measures.

Under the circumstances, a cooling system which uses a refrigerant natural circulation system as disclosed in Japanese Patent Application Laid-Open No. 01-121641 has been proposed. Japanese Patent Application Laid-Open No. 01-121641 proposes that a flow rate adjusting valve is provided for each evaporator in order to enable each evaporator to deal with an individual heat load, the supply amount of a refrigerant liquid to be supplied to the evaporator is valve-controlled, and the ability of the evaporator is individually adjusted, whereby energy saving is achieved. In this way, the supply amount of the refrigerant liquid to be supplied to the evaporator is valve-controlled, whereby high-temperature exhaust hot air from a server can be properly cooled by the evaporator to be released to the server room. As a result, the server room is controlled so as to meet set temperature conditions.

However, the valve control has a mechanism in which the flow rate of the refrigerant is adjusted by changing a pipe resistance of piping through which the refrigerant flows. Therefore, the refrigerant natural circulation system in which an operation state of the cooling system is significantly affected by the pipe resistance has a problem that the valve control may cause fluctuations in evaporation temperature. For example, an evaporation pressure inside of the evaporator is decreased by the valve control, and accordingly a decrease in evaporation temperature more than necessary is caused, so that a considerable decrease in temperature at an exit of the evaporator may occur. There is fear that this considerable decrease in temperature at the exit of the evaporator causes dew condensation on a surface of the evaporator. If dew condensation is caused on the surface of the evaporator, there arise not only a problem that dew condensation water adversely affects the electronic device and accordingly the reliability is deteriorated but also a problem that an energy loss for preventing dew condensation occurs.

Moreover, in the case where the refrigerant is naturally circulated between the evaporator and the cooling tower (or the condenser), it is important in terms of the stabilization of the natural circulation to properly maintain a pressure difference between a refrigerant condensation side (the cooling tower or the condenser) corresponding to the low pressure side and a refrigerant evaporation side (the evaporator) corresponding to the high pressure side, and the condensation pressure and the evaporation pressure follow the condensation temperature and the evaporation temperature.

Accordingly, if the evaporation temperature fluctuates, the evaporation pressure also fluctuates, which thus leads to a problem that the natural circulation of the refrigerant becomes unstable.

The present invention has been made in view of the above-mentioned circumstances, and therefore has an object to provide a cooling method and a cooling system for an electronic device which can stably maintain natural circulation of a refrigerant and can prevent dew condensation from being caused on a surface of an evaporator, even when a flow rate of the refrigerant of the evaporator is valve-controlled in a cooling system having a refrigerant natural circulation system.

SUMMARY OF THE INVENTION

In order to achieve the above-mentioned object, a first aspect of the present invention provides a cooling method for an electronic device, comprising:

naturally circulating a refrigerant between: an evaporator which vaporizes the refrigerant by heat exchange with exhaust hot air from the electronic device, and cools the exhaust hot air; and one of a cooling tower and a condenser which is placed at a position higher than the evaporator, and liquefies the vaporized refrigerant; and

valve-controlling a flow rate of a refrigerant liquid to be supplied to the evaporator so that an air temperature after heat has been exchanged for cooling by the evaporator becomes a temperature suited to an operating environment of the electronic device, wherein

one of a condensation temperature and a condensation pressure of a refrigerant gas in one of the cooling tower and the condenser do not fluctuate even when the flow rate of the refrigerant liquid to be supplied to the evaporator is valve-controlled.

According to the first aspect of the present invention, even when the flow rate of the refrigerant liquid to be supplied to the evaporator is valve-controlled, one of the condensation temperature and the condensation pressure of the refrigerant gas in one of the cooling tower and the condenser corresponding to the low pressure side of the cooling system is controlled so as not to fluctuate. In this way, in parallel with the valve control of the evaporator, one of the condensation temperature and the condensation pressure in one of the cooling tower and the condenser is controlled so as not to fluctuate, whereby the fluctuations in evaporation pressure of the evaporator can be suppressed. As a result, it is possible to stably maintain the natural circulation of the refrigerant and to prevent dew condensation from being caused on a surface of the evaporator.

The evaporation pressure inside of the evaporator in the refrigerant natural circulation system depends on the condensation pressure in the condenser and a difference in height between the evaporator and the condenser. That is, the pressure inside of the evaporator = the condensation pressure + a head differential pressure. Accordingly, if the head differential pressure is constant, the pressure inside of the evaporator fluctuates due to the fluctuations in condensation pressure. Accordingly, even when the flow rate of the refrigerant liquid to be supplied to the evaporator is valve-controlled, the condensation pressure of the refrigerant gas in one of the cooling tower and the condenser corresponding to the low pressure side of the cooling system is controlled so as not to fluctuate, whereby it is possible to stably maintain the natural circulation of the refrigerant. In addition, because the condensation temperature follows the condensation pressure, when the condensation temperature is controlled so as not to fluctuate, it is possible to stably maintain the natural circulation of the refrigerant.

In addition, the evaporator is placed at a position lower than the condenser, and hence the pressure inside of the evaporator always has a value higher than that of the condensation pressure. Therefore, when the pressure inside of the condenser is set to a refrigerant saturation temperature on the basis of a dew-point temperature in a room, the evaporation temperature of the evaporator always becomes equal to or higher than the dew-point temperature of air in the room. Accordingly, it is possible to prevent dew condensation from being caused on the surface of the evaporator.

In order to achieve the above-mentioned object, a second aspect of the present invention provides a cooling system for an electronic device, comprising:

an evaporator which vaporizes the refrigerant by heat exchange with exhaust hot air from the electronic device, and cools the exhaust hot air; and

5 a cooling tower which is placed at a position higher than the evaporator, and liquefies the vaporized refrigerant;

wherein a refrigerant is naturally circulated between the evaporator and the cooling tower, and a flow rate of a refrigerant liquid to be supplied to the evaporator is valve-controlled so that an air temperature after heat has been exchanged for cooling by
10 the evaporator becomes a temperature suited to an operating environment of the electronic device, and

wherein

the cooling tower comprises:

a cooling tower main body in which a take-in port and an exhaust port for
15 outside air are formed;

a heat exchange coil which is provided inside of the cooling tower main body, and includes: an entrance connected to gas piping through which a refrigerant gas returning from the evaporator flows; and an exit connected to liquid piping through which a refrigerant liquid to be supplied to the evaporator flows;

20 a sprinkler which sprinkles water to the heat exchange coil;

a blower which takes in the outside air from the take-in port to blow the taken-in outside air to the heat exchange coil, and exhausts the air from the exhaust port;

a blowing amount adjustment device which adjusts a blowing amount of the blower;

25 a refrigerant liquid temperature sensor which measures a temperature of the refrigerant liquid at the exit of the heat exchange coil; and

a controller which controls the blowing amount adjustment device on a basis of the temperature measured by the refrigerant liquid temperature sensor; and

the controller controls the blowing amount of the blower by means of the
30 blowing amount adjustment device so that the temperature measured by the refrigerant liquid temperature sensor is maintained at a predetermined temperature without

fluctuating so as to follow fluctuations in evaporation temperature of the evaporator due to valve control in the evaporator.

The second aspect describes a specific apparatus configuration for preventing the condensation temperature of the refrigerant gas in one of the cooling tower and the condenser from fluctuating, even when the flow rate of the refrigerant liquid to be supplied to the evaporator is valve-controlled.

According to the second aspect of the present invention, the supply amount of the refrigerant liquid to be supplied to the evaporator is valve-controlled. Therefore, even when the evaporation temperature of the evaporator fluctuates, the controller controls the blowing amount of the blower which cools the heat exchange coil in the cooling tower corresponding to the low pressure side of the cooling system, whereby the temperature of the refrigerant liquid at the exit of the heat exchange coil in the cooling tower is kept at the predetermined temperature without fluctuating.

As a result, it is possible to stably maintain the natural circulation of the refrigerant and to prevent dew condensation from being caused on the surface of the evaporator, even when the flow rate of the refrigerant of the evaporator is valve-controlled in the cooling system having the refrigerant natural circulation system.

According to a third aspect of the present invention, in the second aspect, the refrigerant liquid temperature sensor is replaced with a refrigerant liquid pressure sensor, and the controller controls the blowing amount of the blower by means of the blowing amount adjustment device so that a pressure measured by the refrigerant liquid pressure sensor is maintained at a predetermined pressure without fluctuating so as to follow the fluctuations in evaporation temperature of the evaporator due to the valve control in the evaporator.

According to the third aspect, instead of the temperature of the refrigerant liquid at the exit of the heat exchange coil, the condensation pressure at the exit of the heat exchange coil is controlled so as to become the predetermined pressure.

In order to achieve the above-mentioned object, a fourth aspect of the present invention provides a cooling system for an electronic device, comprising:

an evaporator which vaporizes the refrigerant by heat exchange with exhaust hot air from the electronic device, and cools the exhaust hot air; and

a cooling tower which is placed at a position higher than the evaporator, and liquefies the vaporized refrigerant;

wherein a refrigerant is naturally circulated between the evaporator and the cooling tower, and a flow rate of a refrigerant liquid to be supplied to the evaporator is valve-controlled so that an air temperature after heat has been exchanged for cooling by the evaporator becomes a temperature suited to an operating environment of the electronic device, and

wherein

the cooling tower comprises:

a cooling tower main body in which a take-in port and an exhaust port for outside air are formed;

a heat exchange coil which is provided inside of the cooling tower main body, and includes: an entrance connected to gas piping through which a refrigerant gas returning from the evaporator flows; and an exit connected to liquid piping through

which a refrigerant liquid to be supplied to the evaporator flows;

a sprinkler which sprinkles water to the heat exchange coil;

a blower which takes in the outside air from the take-in port to blow the taken-in outside air to the heat exchange coil, and exhausts the air from the exhaust port;

a refrigerant liquid temperature sensor which measures a temperature of the refrigerant liquid at the exit of the heat exchange coil;

a circulation duct which returns part of the exhaust outside air exhausted from the exhaust port to a vicinity of the take-in port, and mixes the part of the exhaust outside air with the taken-in outside air from the take-in port;

a circulation air amount adjustment device which adjusts an air amount of the exhaust outside air flowing through the circulation duct; and

a controller which controls the circulation air amount adjustment device on a basis of the temperature measured by the refrigerant liquid temperature sensor; and

the controller controls the circulation air amount of the exhaust outside air flowing through the circulation duct by means of the circulation air amount adjustment device so that the temperature measured by the refrigerant liquid temperature sensor is maintained at a predetermined temperature without fluctuating so as to follow

fluctuations in evaporation temperature of the evaporator due to valve control in the evaporator.

The fourth aspect is another aspect which describes a specific apparatus configuration for preventing the condensation temperature of the refrigerant gas in the cooling tower from fluctuating, even when the flow rate of the refrigerant liquid to be
5 supplied to the evaporator is valve-controlled.

According to the fourth aspect of the present invention, the supply amount of the refrigerant liquid to be supplied to the evaporator is valve-controlled. Therefore, even when the evaporation temperature of the evaporator fluctuates, the controller controls the
10 circulation air amount of the exhaust outside air circulating through the circulation duct, whereby the temperature of the refrigerant liquid at the exit of the heat exchange coil in the cooling tower is kept at the predetermined temperature without fluctuating so as to follow the fluctuations. That is, when the circulation duct is provided, the part of the exhaust outside air having a temperature increased by the heat exchange at the heat
15 exchange coil is returned to the vicinity of the take-in port of the cooling tower main body, and mixes with the taken-in outside air taken in from the take-in port. This changes a temperature of the air blown to the heat exchange coil. In addition, the temperature of the blown air can be adjusted by adjusting the circulation air amount of the circulation duct. As a result, it is possible to maintain the condensation temperature
20 in the cooling tower corresponding to the low pressure side of the cooling system constantly at the predetermined temperature.

Accordingly, it is possible to stably maintain the natural circulation of the refrigerant and to prevent dew condensation from being caused on the surface of the evaporator, even when the flow rate of the refrigerant of the evaporator is valve-
25 controlled in the cooling system having the refrigerant natural circulation system.

According to a fifth aspect of the present invention, in the fourth aspect, the refrigerant liquid temperature sensor is replaced with a refrigerant liquid pressure sensor, and the controller controls the circulation air amount of the exhaust outside air flowing through the circulation duct by means of the circulation air amount adjustment device so
30 that a pressure measured by the refrigerant liquid pressure sensor is maintained at a predetermined pressure without fluctuating so as to follow the fluctuations in evaporation temperature of the evaporator due to the valve control in the evaporator.

According to the fifth aspect, instead of the temperature of the refrigerant liquid at the exit of the heat exchange coil, the condensation pressure at the exit of the heat exchange coil is controlled so as to become the predetermined pressure.

5 In order to achieve the above-mentioned object, a sixth aspect of the present invention provides a cooling system for an electronic device, comprising:

an evaporator which vaporizes the refrigerant by heat exchange with exhaust hot air from the electronic device, and cools the exhaust hot air; and

a cold water type condenser which is placed at a position higher than the evaporator, and liquefies the vaporized refrigerant;

10 wherein a refrigerant is naturally circulated between the evaporator and the cold water type condenser, and a flow rate of a refrigerant liquid to be supplied to the evaporator is valve-controlled so that an air temperature after heat has been exchanged for cooling by the evaporator becomes a temperature suited to an operating environment of the electronic device, and

15 wherein

the cold water type condenser includes: an entrance connected to gas piping through which a refrigerant gas returning from the evaporator flows; and an exit connected to liquid piping through which a refrigerant liquid to be supplied to the evaporator flows, and is a condenser which obtains cold energy for condensing the refrigerant gas into the refrigerant liquid by using cold water which is supplied to the cold water type condenser via cold water supply piping;

the cold water type condenser comprises:

20 a cold water amount adjustment device which is provided to the cold water supply piping, and adjusts a flow rate of the cold water to be supplied to the cold water type condenser;

a refrigerant liquid temperature sensor which measures a temperature of the refrigerant liquid at the exit of the cold water type condenser; and

a controller which controls the cold water amount adjustment device on a basis of the temperature measured by the refrigerant liquid temperature sensor; and

30 the controller controls the flow rate of the cold water to be supplied to the cold water type condenser by means of the cold water amount adjustment device so that the temperature measured by the refrigerant liquid temperature sensor is maintained at a

predetermined temperature without fluctuating so as to follow fluctuations in evaporation temperature of the evaporator due to valve control in the evaporator.

The sixth aspect is an aspect which describes a specific apparatus configuration for preventing the condensation temperature of the refrigerant gas in the cold water type condenser from fluctuating, even when the flow rate of the refrigerant liquid to be
5 supplied to the evaporator is valve-controlled.

According to the sixth aspect of the present invention, the supply amount of the refrigerant liquid to be supplied to the evaporator is valve-controlled. Therefore, even when the evaporation temperature of the evaporator fluctuates, the controller controls the
10 flow rate of the cold water to be supplied to the cold water type condenser corresponding to the low pressure side of the cooling system, whereby the temperature of the refrigerant liquid at the exit of the cold water type condenser is prevented from fluctuating so as to follow the fluctuations.

Accordingly, it is possible to stably maintain the natural circulation of the
15 refrigerant and to prevent dew condensation from being caused on the surface of the evaporator, even when the flow rate of the refrigerant of the evaporator is valve-controlled in the cooling system having the refrigerant natural circulation system.

According to a seventh aspect of the present invention, in the sixth aspect, the refrigerant liquid temperature sensor is replaced with a refrigerant liquid pressure sensor, and the controller controls the flow rate of the cold water flowing through the cold water
20 supply piping by means of the cold water amount adjustment device so that a pressure measured by the refrigerant liquid pressure sensor is maintained at a predetermined pressure without fluctuating so as to follow the fluctuations in evaporation temperature of the evaporator due to the valve control in the evaporator.

According to the seventh aspect, instead of the temperature of the refrigerant liquid at the exit of the cold water type condenser, the condensation pressure at the exit of the cold water type condenser is controlled so as to become the predetermined
25 pressure.

According to an eighth aspect of the present invention, in the sixth aspect, the cooling system for an electronic device operates such that the water supplied to the cold
30 water type condenser is cooled by using outside air when a temperature of the outside air is equal to or lower than 10°C.

According to this configuration, when the temperature of the outside air is equal to or lower than 10°C, it is possible to utilize "free cooling" in which a so-called chiller is not used and the cold water can be cooled by using only the outside air, and hence electric power costs for an air-conditioning system can be further reduced.

As described above, according to the cooling method and the cooling system for the electronic device of the present invention, it is possible to stably maintain the natural circulation of the refrigerant and to prevent dew condensation from being caused on the surface of the evaporator, even when the flow rate of the refrigerant of the evaporator is valve-controlled in the cooling system having the refrigerant natural circulation system.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a conceptual diagram illustrating an overall configuration of a first embodiment of a cooling system for an electronic device according to the present invention;

Fig. 2 is a conceptual diagram illustrating an overall configuration of a second embodiment of the cooling system for the electronic device according to the present invention;

Fig. 3 is an explanatory diagram for describing a structure of a circulation duct type cooling tower; and

Fig. 4 is a conceptual diagram illustrating an overall configuration of a third embodiment of the cooling system for the electronic device according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, preferred embodiments of a cooling method and a cooling system for an electronic device according to the present invention are described in details with reference to the attached drawings.

In the present embodiments, description is given by taking an example of a server placed in a server room as the electronic device.

[First Embodiment of the Present Invention]

Fig. 1 is a conceptual diagram illustrating an overall configuration of a first embodiment of a cooling system 10 for an electronic device.

The cooling system 10 illustrated in Fig. 1 is a system which locally cools the vicinity of a server 14 provided in each of server rooms 12X and 12Y on lower and upper two floors. It should be noted that X attached to reference numeral in the following description designates a member relating to a cooling system on the lower floor, and Y attached to reference numeral in the following description designates a member relating to a cooling system on the upper floor. In addition, in Fig. 1, although one server 14 is illustrated in each of the server rooms 12X and 12Y, in reality, a large number of the servers 14 are placed therein. Further, normally, the servers 14 are stacked on top of one another to be housed in a server rack (not shown), and thus are installed in the server rooms 12X and 12Y.

The server 14 is provided with a suction port 14A and an exhaust port 14B for air, and is also provided with a fan 14C inside of the server 14. When the fan 14C is driven, air is suctioned from the suction port 14A, and exhaust hot air involving exhaust heat of the server 14 is exhausted from the exhaust port 14B. As a result, the server 14 can be cooled. On the other hand, if the exhaust hot air is exhausted into the server rooms 12X and 12Y as it is, the room temperatures of the server rooms 12X and 12Y increase, and the temperature of air suctioned into the server 14 becomes higher. Accordingly, it is necessary to exhaust the exhaust hot air into the server rooms 12X and 12Y after the exhaust hot air has been cooled by evaporators 20X and 20Y.

Underfloor chambers 18X and 18Y are formed under floor surfaces 13 of the server rooms 12X and 12Y, respectively, and the underfloor chambers 18X and 18Y and the server rooms 12X and 12Y are communicated with each other via a plurality of blow out ports (not shown) formed on the floor surfaces 13, respectively. Conditioning air cooled by package air-conditioning equipment or the like (not shown) is fed to the underfloor chambers 18X and 18Y, and the conditioning air is blown out of the blow out ports into the server rooms 12X and 12Y. It should be noted that the blow out ports are formed in the vicinity of the suction port 14A of the server 14, and the conditioning air is suctioned into the server 14, whereby the server 14 can be efficiently cooled.

Further, the server 14 is locally cooled by the cooling system 10.

The cooling system 10 configures a natural circulation cycle of a refrigerant which is mainly formed of the evaporators 20X and 20Y, a cooling tower 22 serving as a

condenser, liquid piping 24 through which a refrigerant liquid flows, and a gas piping 26 through which a refrigerant gas flows.

Each of the evaporators 20X and 20Y is provided in the vicinity of the exhaust port 14B of the server, and a coil (not shown) is provided inside of each of the

5 evaporators 20X and 20Y. The exhaust hot air exhausted from the exhaust port 14B of the server flows outside of this coil, and the refrigerant liquid flows inside of this coil, so that heat is exchanged. As a result, the refrigerant liquid flowing inside of the coil absorbs heat of vaporization from the exhaust hot air to thereby evaporate, and hence the exhaust air exhausted into the server rooms 12X and 12Y is cooled. In this way,
10 combined with the conditioning air blown out of the blow out ports into the server rooms 12X and 12Y, temperature environments of the server rooms 12X and 12Y can be set to temperature environments necessary to allow the servers 14 to normally operate.

The cooling tower 22 is an apparatus which cools and condenses the refrigerant gas which has been vaporized by the evaporators 20X and 20Y, and is installed at a
15 position higher than the evaporators 20X and 20Y, for example, on a roof of a building of the server rooms 12.

The evaporators 20X and 20Y and the cooling tower 22 are connected to each other by the liquid piping 24 (including branched pipes 24X and 24Y) and the gas piping 26 (including branched pipes 26X and 26Y). An upper end of the gas piping 26 is
20 connected to an entrance of a heat exchange coil 28 inside of the cooling tower 22. A lower end of the gas piping 26 is branched into the branched pipes 26X and 26Y. The branched pipes 26X and 26Y are connected to one ends of the coils (not shown) of the evaporators 20X and 20Y, respectively. On the other hand, an upper end of the liquid piping 24 is connected to an exit of the heat exchange coil 28 inside of the cooling tower
25 22. A lower end of the liquid piping 24 is branched into the branched pipes 24X and 24Y. The branched pipes 24X and 24Y are connected to another ends of the coils (not shown) of the evaporators 20X and 20Y, respectively. Accordingly, the refrigerant gas which is vaporized by the evaporators 20X and 20Y flows up through the gas piping 26 to be naturally fed to the cooling tower 22. After the refrigerant gas has been liquefied
30 by the cooling tower 22, the liquefied refrigerant flows down through the liquid piping 24 to be naturally fed to the evaporators 20X and 20Y. In this way, the natural circulation of the refrigerant is realized.

CFC, HFC (hydrofluorocarbon) as alternative CFC, and the like can be used as the circulating refrigerant. In addition, in the case of the use at a pressure lower than an atmospheric pressure, it is possible to use water.

Then, the supply amount of the refrigerant liquid to be supplied to the
5 evaporators 20X and 20Y is controlled, to thereby decrease the air temperature after
high-temperature air exhausted from the servers 14 has been cooled by the evaporators
20X and 20Y (the temperature of the exhaust air which is exhausted from the servers 14
into the server rooms 12X and 12Y via the evaporators 20X and 20Y), so that the server
rooms 12X and 12Y are maintained in the temperature environments suited to the servers
10 14. That is, temperature sensors 23X and 23Y are provided in the vicinities of exits of
exhaust air 21 which is exhausted from the evaporators 20X and 20Y into the server
rooms 12X and 12Y, respectively. Flow rate adjusting valves 25X and 25Y which
adjust the flow rate of the refrigerant liquid are provided to the branched pipes 24X and
24Y of the liquid piping 24, respectively. Then, measurement temperatures measured
15 by the temperature sensors 23X and 23Y are inputted to a controller 17, and the
controller 17 individually controls the opening degrees of the flow rate adjusting valves
25X and 25Y on the basis of the measurement temperatures. This makes it possible to
supply a proper flow rate of the refrigerant which enables the temperature of the exhaust
air to be the same between the evaporators 20X and 20Y at different heights on the lower
20 floor and the upper floor. As a result, it is possible to adjust the temperature of the
exhaust air which is exhausted from the servers 14 into the server rooms 12X and 12Y
via the evaporators 20X and 20Y, to the temperature environments suited to the
operation of the servers 14.

Next, the cooling tower 22 is described.

25 As illustrated in Fig. 1, in the cooling tower 22, a cooling tower main body
(casing) 30 is provided as a horizontal type, a take-in port 30A which takes in outside air
is formed at one end of the cooling tower main body 30, and an exhaust port 30B of the
outside air is formed at another end thereof. The heat exchange coil 28 is provided
inside of the cooling tower main body 30, the entrance of the heat exchange coil 28 is
30 connected to the gas piping 26 through which the refrigerant gas returning from the
evaporators 20X and 20Y flows, and the exit of the heat exchange coil 28 is connected to

the liquid piping 24 through which the refrigerant liquid to be supplied to the evaporators 20X and 20Y flows.

In addition, a sprinkler 34 is provided on the take-in port 30A side of the heat exchange coil 28, and a blower fan 36 is provided further on the take-in port 30A side of the sprinkler 34. Then, taken-in outside air X which is taken in from the take-in port 30A of the cooling tower main body 30 is blown by the blower fan 36 to the heat exchange coil 28, and water is sprinkled by the sprinkler 34 onto the heat exchange coil 28. As a result, the refrigerant gas flowing through the heat exchange coil 28 is cooled by the outside air and the sprinkled water to be condensed, and thus is liquefied into the refrigerant liquid. On the other hand, the taken-in outside air X taken into the cooling tower main body 30 absorbs heat from the refrigerant gas flowing through the heat exchange coil 28 to have an increased temperature, and is exhausted from the exhaust port 30B as exhaust outside air Y.

In the case where the cooling system of the refrigerant natural circulation system is applied to server cooling in a data center, the air temperatures at exits of the evaporators 20X and 20Y which cool exhaust from the servers 14 are set to 22°C to 28°C which is a general set temperature of the server room in many cases, and the evaporation temperature of the refrigerant inside of the evaporators 20X and 20Y requires approximately 18°C to 24°C.

In the refrigerant natural circulation system, the temperature of the heat exchange coil 28 inside of the cooling tower 22 serving as the condenser needs to have a temperature lower by approximately 2°C to 6°C than the temperatures of the evaporators 20X and 20Y, and hence the condensation temperature of the refrigerant inside of the heat exchange coil 28 serving as the condenser requires approximately 12°C to 18°C.

On the other hand, in the cooling tower 22, low-temperature outside air in winter seasons and intermediate seasons is used, and further water is sprinkled in the low-temperature outside air, whereby the low-temperature outside air is made cooler by the heat of vaporization of the sprinkled water. After that, the air thus cooled is blown through the heat exchange coil 28 inside of the cooling tower 22, to thereby cool the refrigerant. Here, in the case of outside air having a temperature lower than the condensation temperature of the refrigerant required by the heat exchange coil 28, it is possible to cool the refrigerant without using heat source equipment which produces cold

water. In a general design, the condensation temperature of the refrigerant is approximately 12°C to 18°C, and in consideration of the heat exchange efficiency in the heat exchange coil, when the temperature of the outside air is equal to or lower than 15°C, cooling can be sufficiently performed using only the outside air.

5 In addition, the cooling tower 22 is provided with a control mechanism 42 which maintains the temperature of the refrigerant liquid at the exit of the heat exchange coil 28 constantly at a predetermined value.

The control mechanism 42 includes: a refrigerant liquid temperature sensor 44 which measures the temperature of the refrigerant liquid at the exit of the heat exchange
10 coil 28; a blowing amount adjustment device 36A which changes the number of revolutions of the blower fan 36, to thereby adjust the blowing amount of air to be blown from the blower fan 36 to the heat exchange coil 28; and a controller 46 which controls the blowing amount adjustment device 36A on the basis of the measurement temperature of the refrigerant liquid temperature sensor 44. It should be noted that the controller 46
15 may double as the controller 17, and as illustrated in Fig. 1, the controller 46 for the cooling tower 22 may be provided separately. In the present embodiment, description is given of the case where the controllers are provided separately from each other.

Next, description is given of an action of the cooling system 10 for the electronic device having the configuration as described above.

20 The refrigerant liquid is vaporized by the evaporators 20X and 20Y, whereby high-temperature exhaust hot air from the server 14 is cooled. On the other hand, the cooling tower 22 cools and condenses the refrigerant gas from the evaporators 20X and 20Y to thereby liquefy the refrigerant gas, and the liquefied refrigerant liquid flows down to the evaporators 20X and 20Y by gravity. As a result, the natural circulation of the
25 refrigerant is formed. Then, the controller 17 monitors the air temperatures measured by the temperature sensors 23X and 23Y, that is, the air temperatures after the exhaust hot air from the servers 14 has been cooled by the evaporators 20X and 20Y. Further, the controller 17 controls the flow rate adjusting valves 25X and 25Y to thereby adjust the flow rate of the refrigerant gas flowing through the liquid piping so that the air
30 temperatures become a temperature suited to the operating environment of the servers 14. This valve control enables the air temperatures after the cooling by the evaporators 20X and 20Y to be properly controlled.

However, the valve control is an operation of adjusting a resistance of the liquid piping, and hence the evaporation pressures inside of the evaporators 20X and 20Y fluctuate. The fluctuations in evaporation pressure cause problems that the natural circulation of the refrigerant becomes unstable and that a decrease in evaporation temperature more than necessary is caused and accordingly a considerable decrease in temperature of the refrigerant gas at the exits of the evaporators 20X and 20Y occurs. In addition, along with the decrease in evaporation temperature, dew condensation is caused on surfaces of the evaporators 20X and 20Y, and then may adversely affect the server 14 which is a precision machine.

In view of the above, in the present invention, even when the flow rate of the refrigerant liquid to be supplied to the evaporators 20X and 20Y is valve-controlled by the flow rate adjusting valves 25X and 25Y, the condensation temperature of the refrigerant gas in the cooling tower 22 is controlled so as not to fluctuate.

That is, the controller 46 monitors whether or not the condensation temperature measured by the refrigerant liquid temperature sensor 44 provided at the exit of the heat exchange coil 28 fluctuates with respect to a predetermined temperature. Here, the predetermined temperature may be set to, for example, a condensation temperature necessary to allow the refrigerant to naturally circulate in a stable manner.

Then, if the measurement temperature fluctuates with respect to the predetermined temperature, the controller 46 controls the blowing amount adjustment device 36A of the cooling tower 22, to thereby change the number of revolutions of the blower fan 36, and adjusts the blowing amount for cooling the heat exchange coil 28 so that the measurement temperature of the refrigerant liquid temperature sensor 44 becomes the predetermined temperature.

In this way, in parallel with the valve control of the evaporators 20X and 20Y, the condensation temperature of the cooling tower 22 is controlled so as not to fluctuate, whereby the fluctuations in evaporation pressure of the evaporators 20X and 20Y can be suppressed. That is, when the fluctuations in temperature of the cooling tower 22 are eliminated, it is possible to stably maintain the pressure on the high pressure side in the natural circulation of the refrigerant, so that the natural circulation of the refrigerant can be made stable.

As a result, it is possible to stably maintain the natural circulation of the refrigerant and to prevent dew condensation from being caused on the surfaces of the evaporators, even when the flow rate of the refrigerant of the evaporators 20X and 20Y is valve-controlled in the cooling system having the refrigerant natural circulation system.

It should be noted that it is possible to make appropriate setting as to how many fluctuations in measurement temperature of the refrigerant liquid temperature sensor 44 with respect to the predetermined temperature allows the controller 46 to perform control and drive, and it is preferable to set the fluctuation temperature so as to fall within, for example, $\pm 1^{\circ}\text{C}$ of the set temperature. The same holds true for embodiments of the present invention described below.

[Second Embodiment of the Present Invention]

Fig. 2 is a conceptual diagram illustrating an overall configuration of a second embodiment of the cooling system 10 for the electronic device, and illustrates the case where a circulation duct type cooling tower is provided as the apparatus which condenses the refrigerant gas.

It should be noted that elements common to those of the first embodiment are denoted by the same reference symbols, and description thereof is omitted.

As illustrated in Fig. 2 and Fig. 3, a coupling hole 30C is opened on a side surface of the cooling tower main body 30 on the take-in port 30A side, and part of the exhaust port 30B and the coupling hole 30C are coupled to each other by a circulation duct 38. With this configuration, part of the exhaust outside air Y which has an increased temperature and is exhausted from the exhaust port 30B passes through the circulation duct 38 to be circulated to the vicinity of the take-in port 30A, and hence the exhaust outside air Y and the taken-in outside air X are mixed with each other. As a result, the outside air temperature of blown outside air Z which is blown by the blower fan 36 to the heat exchange coil 28 increases.

In this case, it is preferable that the gas piping 26 which returns from the evaporators 20X and 20Y to the cooling tower 22 penetrate through a side wall of the circulation duct 38, pass through the inside of the circulation duct 38, and be coupled to the entrance of the heat exchange coil 28. With this configuration, part of the gas piping 26 is housed inside of the circulation duct 38, and hence heat exchange is efficiently performed between the exhaust outside air Y flowing through the circulation

duct 38 and the refrigerant gas flowing through the gas piping 26. Accordingly, it is possible to make larger an amount of heat which is absorbed by the exhaust outside air Y from the heat exchange coil 28, and hence the exhaust outside air Y having a temperature higher than that of the exhaust outside air Y exhausted from the exhaust port 30B can be
5 mixed with the taken-in outside air X.

In addition, a damper apparatus 40 is provided in the middle of the circulation duct 38, and the mixing amount (including the case where the mixing amount is zero) of the exhaust outside air Y to be mixed with the taken-in outside air X is adjusted by adjusting the opening degree (including the case where the opening degree is zero) of the
10 damper apparatus 40.

Further, the cooling tower 22 is provided with the controller 46 which controls the air amount of the exhaust outside air Y flowing through the circulation duct 38 by means of the damper apparatus 40 so that the condensation temperature of the refrigerant gas condensed by the heat exchange coil 28 becomes a predetermined temperature.
15 Here, the predetermined temperature may be set to, for example, a condensation temperature necessary to allow the refrigerant to stably circulate between the evaporators 20X and 20Y and the cooling tower 22 in the cooling system of the present invention.

Then, the controller 46 controls the opening degree of the damper apparatus 40 on the basis of the measurement temperature of the refrigerant liquid temperature sensor
20 44 provided at the exit of the heat exchange coil 28 so that the measurement temperature of the refrigerant liquid temperature sensor 44 becomes the predetermined temperature.

Description is given of an action of the second embodiment of the present invention having the configuration as described above.

It should be noted that, as described above, there are three types of outside air,
25 that is, the taken-in outside air X, the exhaust outside air Y, and the blown outside air Z, and these are selectively used as follows. That is, the taken-in outside air X refers to outside air itself which is taken in from the take-in port 30A. The blown outside air Z refers to outside air which is blown by the blower fan 36 to the heat exchange coil 28, and involves both of the taken-in outside air X alone and outside air in which the taken-
30 in outside air X and the exhaust outside air Y are mixed with each other. The exhaust outside air Y refers to outside air having an increased temperature after the blown outside

air Z has come into contact with the heat exchange coil 28 and heat has been exchanged therebetween.

Before the operation start of the cooling system 10, the opening degree of the damper apparatus 40 is set to zero (closed state), and the operation is started in this state.

5 That is, the refrigerant gas which returns from the evaporators 20X and 20Y to the cooling tower 22 through the gas piping 26 is cooled and condensed by the taken-in outside air X taken in from the take-in port 30A by the blower fan 36 and the water sprinkled by the sprinkler 34, while flowing through the heat exchange coil 28 inside of the cooling tower 22. As a result, the refrigerant gas is liquefied into the refrigerant
10 liquid, and flows through the liquid piping 24 to be supplied to the evaporators 20X and 20Y. On the other hand, the blown outside air Z which has come into contact with the heat exchange coil 28 absorbs heat from the refrigerant gas to have an increased temperature, and becomes the exhaust outside air Y to be exhausted from the exhaust port 30B.

15 In addition, the temperature of the refrigerant liquid liquefied by the heat exchange coil 28 is measured by the refrigerant liquid temperature sensor 44 provided at the exit of the heat exchange coil 28, and the measurement temperature is sequentially transmitted to the controller 46. In the case where the measurement temperature of the refrigerant liquid is lower than the predetermined temperature, the controller 46 opens
20 the damper apparatus 40, and circulates part of the exhaust outside air Y having an increased temperature to the vicinity of the take-in port 30A via the circulation duct 38, to thereby mix this exhaust outside air Y with the taken-in outside air X. Further, the controller 46 controls the air amount of the exhaust outside air Y flowing through the circulation duct 38 by means of the opening degree control of the damper apparatus 40 so
25 that the measurement temperature measured by the refrigerant liquid temperature sensor 44 becomes the predetermined temperature.

Then, if the measurement temperature of the refrigerant liquid temperature sensor 44 fluctuates with respect to the predetermined temperature, the controller 46 controls the damper apparatus 40 of the circulation duct 38 formed in the cooling tower
30 22, to thereby adjust the temperature of the blown outside air to be blown to the heat exchange coil 28 so that the measurement temperature of the refrigerant liquid temperature sensor 44 becomes the predetermined temperature.

In this way, in parallel with the valve control of the evaporators 20X and 20Y, the condensation temperature of the cooling tower 22 is controlled so as not to fluctuate, whereby the fluctuations in evaporation pressure of the evaporators 20X and 20Y can be suppressed. That is, when the fluctuations in temperature of the circulation duct type
5 cooling tower 22 are eliminated, it is possible to stably maintain the pressure on the high pressure side in the natural circulation of the refrigerant, so that the natural circulation of the refrigerant can be made stable.

As a result, it is possible to stably maintain the natural circulation of the refrigerant and to prevent dew condensation from being caused on the surfaces of the
10 evaporators, even when the flow rate of the refrigerant of the evaporators 20X and 20Y is valve-controlled in the cooling system having the refrigerant natural circulation system.

[Third Embodiment of the Present Invention]

Fig. 4 is a conceptual diagram illustrating an overall configuration of a third
15 embodiment of the cooling system 10 for the electronic device, and illustrates the case where the cooling tower 22 according to each of the first and second embodiments is replaced with a cold water type condenser 48 as the apparatus which condenses the refrigerant gas.

It should be noted that elements common to those of the first and second
20 embodiments are denoted by the same reference symbols, and description thereof is omitted.

As illustrated in Fig. 4, the heat exchange coil 28 coupled to the gas piping 26 and the liquid piping 24 and a cold water supply coil 50 coupled to a cold water supply
25 apparatus (not shown) are provided inside of a cold water type condenser main body 49 (casing). Then, the refrigerant gas flowing through the heat exchange coil 28 and cold water flowing through the cold water supply coil 50 exchange heat with each other, so that the refrigerant gas is cooled and condensed to be liquefied into the refrigerant liquid.

In the case where the cooling system of the refrigerant natural circulation system is applied to server cooling in a data center, the air temperatures at exits of the
30 evaporators 20X and 20Y which cool exhaust from the servers 14 are set to 22°C to 28°C which is a general set temperature of the server room in many cases, and the evaporation temperature of the refrigerant inside of the evaporators 20X and 20Y requires approximately 18°C to 24°C.

In the refrigerant natural circulation system, the temperature of the heat exchange coil 28 inside of the cooling tower 22 serving as the condenser needs to have a temperature lower by approximately 2°C to 6°C than the temperatures of the evaporators 20X and 20Y, and hence the condensation temperature of the refrigerant inside of the heat exchange coil 28 serving as the condenser requires approximately 12°C to 18°C.

On the other hand, in the cold water type condenser main body 49, normally, cold water having a temperature of approximately 7°C to 12°C is produced by heat source equipment which produces cold water, and is caused to circulate inside of the cold water supply coil 50, whereby the refrigerant is condensed. Here, cold water which is produced by a so-called free cooling system, in which low-temperature outside air in winter seasons and intermediate seasons is used for producing the cold water, is used as the cold water to be caused to circulate inside of the cold water supply coil 50, which makes it possible to realize an energy-saving operation which does not require the operation of the heat source equipment. In this case, the temperature of the outside air at which the cold water having a temperature necessary for condensation of the refrigerant can be efficiently produced is equal to or lower than 10°C in a general design.

In addition, the refrigerant liquid temperature sensor 44 which measures the condensation temperature of the refrigerant condensed by the cold water type condenser 48 is provided at the exit of the heat exchange coil 28, and a cold water amount adjusting valve 52 which adjusts the flow rate of the cold water flowing through the cold water supply coil 50 is provided at an exit of the cold water supply coil 50.

The refrigerant temperature measured by the refrigerant liquid temperature sensor 44 is sequentially inputted to the controller 46, and it is monitored whether or not the refrigerant temperature fluctuates with respect to the predetermined temperature. Further, the controller 46 controls the flow rate of the cold water to be supplied to the cold water type condenser 48 by means of the cold water amount adjusting valve 52 so that the measurement temperature of the refrigerant liquid temperature sensor 44 is maintained at the predetermined temperature without fluctuating so as to follow fluctuations in evaporation temperatures of the evaporators 20X and 20Y due to the valve control in the evaporators 20X and 20Y.

As a result, similarly in the case of the third embodiment of the present invention, it is possible to stably maintain the natural circulation of the refrigerant and to

prevent dew condensation from being caused on the surfaces of the evaporators, even when the flow rate of the refrigerant of the evaporators 20X and 20Y is valve-controlled in the cooling system having the refrigerant natural circulation system.

5 It should be noted that, in the first embodiment to the third embodiment, the temperature sensor is placed at the exit of the heat exchange coil 28 in the cooling tower 22 (including the circulation duct type) or the cold water type condenser 48. Alternatively, a pressure sensor (not shown) may be placed, and the controller 46 may perform such control that a measurement pressure of the pressure sensor is maintained at a predetermined pressure without fluctuating so as to follow fluctuations in evaporation
10 temperatures of the evaporators 20X and 20Y due to the valve control in the evaporators 20X and 20Y.

Here, the predetermined pressure may be set to, for example, a condensation pressure necessary to allow the refrigerant to naturally circulate in a stable manner.

WHAT IS CLAIMED IS:

1. A cooling method for an electronic device, comprising:
naturally circulating a refrigerant between:
an evaporator which vaporizes the refrigerant by heat exchange with exhaust
5 hot air from the electronic device, and cools the exhaust hot air; and
one of
(i) a cooling tower having a heat exchange coil and a blower for blowing
air on to the heat exchange coil to liquefy the vaporized refrigerant, and
(ii) a condenser having a cold water supply for providing cold water to
10 liquefy the vaporized refrigerant,
the cooling tower or condenser being placed at a position higher than the
evaporator;
valve-controlling a flow rate of the liquid refrigerant supplied to the evaporator
so that an air temperature after heat has been exchanged for cooling by the evaporator
15 becomes a temperature suited to an operating environment of the electronic device; and
controlling either a blowing amount of the blower in the cooling tower or the flow rate
of the cold water supply in the condenser to maintain one of a condensation temperature
and a condensation pressure of the gas refrigerant in the cooling tower or the condenser
respectively at a predetermined value, whereby one of the condensation temperature
20 and the condensation pressure do not fluctuate even when the flow rate of the liquid
refrigerant to be supplied to the evaporator is valve-controlled.
2. A cooling system for an electronic device, comprising:
an evaporator which vaporizes a refrigerant by heat exchange with exhaust hot
air from the electronic device, and cools the exhaust hot air; and
25 a cooling tower which is placed at a position higher than the evaporator, and
liquefies the vaporized refrigerant;
wherein the refrigerant is naturally circulated between the evaporator and the
cooling tower, and a flow rate of the liquid refrigerant supplied to the evaporator is
valve-controlled so that an air temperature after heat has been exchanged

for cooling by the evaporator becomes a temperature suited to an operating environment of the electronic device,

wherein:

the cooling tower comprises:

- 5 a cooling tower main body in which a take-in port and an exhaust port for outside air are formed;

 a heat exchange coil which is provided inside of the cooling tower main body, and includes:

- an entrance connected to gas piping through which the gas
10 refrigerant returning from the evaporator flows; and

 an exit connected to liquid piping through which the liquid refrigerant supplied to the evaporator flows;

a sprinkler which sprinkles water to the heat exchange coil;
a blower which takes in the outside air from the take-in port to blow the taken-in outside air to the heat exchange coil, and exhausts the air from the exhaust port;

a blowing amount adjustment device which adjusts a blowing amount of the
5 blower;

either a refrigerant liquid temperature sensor which measures a temperature of the liquid refrigerant at the exit of the heat exchange coil, or a refrigerant liquid pressure sensor which measures a pressure of the liquid refrigerant at the exit of the heat exchange coil; and

a controller which controls the blowing amount adjustment device on a basis of
10 the temperature measured by the refrigerant liquid temperature sensor or the pressure measured by the refrigerant liquid pressure sensor; and

the controller controls the blowing amount of the blower by means of the blowing amount adjustment device so that either the temperature measured by the refrigerant liquid temperature sensor is maintained at a predetermined temperature without fluctuating so as
15 to follow fluctuations in evaporation temperature of the evaporator due to valve control in the evaporator or the pressure measured by the refrigerant liquid pressure sensor is maintained at a predetermined pressure without fluctuating so as to follow the fluctuations in evaporation temperature of the evaporator due to the valve control in the evaporator.

3. A cooling system for an electronic device, comprising:

20 an evaporator which vaporizes a refrigerant by heat exchange with exhaust hot air from the electronic device, and cools the exhaust hot air; and

a cooling tower which is placed at a position higher than the evaporator, and liquefies the vaporized refrigerant;

wherein the refrigerant is naturally circulated between the evaporator and the
25 cooling tower, and a flow rate of the liquid refrigerant supplied to the evaporator is valve-controlled so that an air temperature after heat has been exchanged for cooling by

the evaporator becomes a temperature suited to an operating environment of the electronic device,
wherein:

the cooling tower comprises:

5 a cooling tower main body in which a take-in port and an exhaust port for outside air are formed;

a heat exchange coil which is provided inside of the cooling tower main body, and includes:

10 an entrance connected to gas piping through which the gas refrigerant returning from the evaporator flows; and

an exit connected to liquid piping through which the liquid refrigerant supplied to the evaporator flows;

a sprinkler which sprinkles water to the heat exchange coil;

15 a blower which takes in the outside air from the take-in port to blow the taken-in outside air to the heat exchange coil, and exhausts the air from the exhaust port;

either a refrigerant liquid temperature sensor which measures a temperature of the liquid refrigerant at the exit of the heat exchange coil or a refrigerant liquid pressure sensor which measures a pressure of the liquid refrigerant at the exit of the heat
20 exchange coil;

a circulation duct which returns part of the exhaust outside air exhausted from the exhaust port to a vicinity of the take-in port, and mixes the part of the exhaust outside air with the taken-in outside air from the take-in port;

25 a circulation air amount adjustment device which adjusts an air amount of the exhaust outside air flowing through the circulation duct; and

a controller which controls the circulation air amount adjustment device on a basis of the temperature measured by the refrigerant liquid temperature sensor or the pressure measured by the refrigerant liquid pressure sensor; and

30 the controller controls the circulation air amount of the exhaust outside air flowing through the circulation duct by means of the circulation air amount adjustment device so that either the temperature measured by the refrigerant liquid temperature sensor is maintained at a predetermined temperature without fluctuating so as to follow

fluctuations in evaporation temperature of the evaporator due to valve control in the evaporator or the pressure measured by the refrigerant liquid pressure sensor is maintained at a predetermined pressure without fluctuating so as to follow the fluctuations in evaporation temperature of the evaporator due to the valve control in the

5 evaporator.

4. A cooling system for an electronic device, comprising:
an evaporator which vaporizes a refrigerant by heat exchange with exhaust hot
air from the electronic device, and cools the exhaust hot air; and

a cold water type condenser which is placed at a position higher than the
5 evaporator, and liquefies the vaporized refrigerant;

wherein the refrigerant is naturally circulated between the evaporator and the
cold water type condenser, and a flow rate of the liquid refrigerant supplied to the
evaporator is valve-controlled so that an air temperature after heat has been exchanged
for cooling by the evaporator becomes a temperature suited to an operating

10 environment of the electronic device,
wherein

the cold water type condenser includes:

an entrance connected to gas piping through which the gas
refrigerant returning from the evaporator flows; and

15 an exit connected to liquid piping through which the liquid
refrigerant supplied to the evaporator flows, and is a condenser which obtains cold
energy for condensing the gas refrigerant into the liquid refrigerant by using cold water
which is supplied to the cold water type condenser via cold water supply piping; and

the cold water type condenser comprises:

20 a cold water amount adjustment device which is provided to the
cold water supply piping, and adjusts a flow rate of the cold water to be supplied to the
cold water type condenser;

either a refrigerant liquid temperature sensor which measures a
temperature of the liquid refrigerant at the exit of the cold water type condenser

25 or a refrigerant liquid pressure sensor which measures a pressure of the liquid
refrigerant at the exit of the cold water type condenser; and

a controller which controls the cold water amount adjustment device on a
basis of the temperature measured by the refrigerant liquid temperature sensor or the
pressure measured by the refrigerant liquid pressure sensor; and

30

the controller controls the flow rate of the cold water to be supplied to the cold water type condenser by means of the cold water amount adjustment device so that either the temperature measured by the refrigerant liquid temperature sensor is maintained at a predetermined temperature without fluctuating so as to follow fluctuations in

- 5 evaporation temperature of the evaporator due to valve control in the evaporator or the pressure measured by the refrigerant liquid pressure sensor is maintained at a predetermined pressure without fluctuating so as to follow the fluctuations in evaporation temperature of the evaporator due to the valve control in the evaporator.

5. The cooling system for the electronic device according to claim 4, wherein the
10 water supplied to the cold water type condenser is cooled by using outside air when a temperature of the outside air is equal to or lower than 10°C.