In the present invention, it is preferred that the deviation information detecting means further comprises refrigerant temperature detecting means for detecting a temperature of the refrigerant to be supplied to the cooling coil, and that the fan controlling means reduces or stops the rotational frequency of the fan if the supplied air temperature is equal to or higher than the upper limit of the specification temperature range of the electronic equipment, and if the flow regulating valve has the approximate maximum opening degree, and if the refrigerant temperature is ~~equal to or lower~~higher than a design temperature for securing the maximum cooling capacity.

Since there is further provided the refrigerant temperature detecting means in addition to the supplied air temperature detecting means and the valve opening degree detecting means, it is possible to more precisely monitor the deterioration of the cooling capacity of the evaporator. Specifically, although the temperature of the supplied air from the evaporator is equal to or higher than the upper limit of the specification temperature range, and the valve opening degree is the approximate maximum opening degree, the condenser is deemed to operate normally for securing the maximum cooling capacity if the refrigerant temperature is equal to or lower than the design temperature. Hence, the lowering of the cooling capacity of the evaporator is considered as a temporal variation due to disturbance or the like; thus, it may rather cause a wrong control if the rotational frequency of the fans is reduced or stopped in response to such disturbance or the like before the evaporator achieves the maximum cooling capacity.

The temperature of the refrigerant is an index to indicate whether or not the cooling system of the natural circulation type operates normally, and the refrigerant temperature detecting means enables monitoring of the entire cooling system of the natural circulation type.

In the present invention, it is preferred that the deviation information detecting means further comprises refrigerant pressure detecting means for detecting pressure of the refrigerant to be supplied to the cooling coil, and that the fan controlling means reduces or stops the rotational frequency of the fan if the supplied air temperature is equal to or higher than the upper limit of the specification temperature range of the electronic equipment, and if the flow regulating valve has the approximate maximum opening degree, and if the refrigerant pressure is equal to or higher than a design pressure for securing the maximum cooling capacity.

the flow rate of the refrigerant flowing in the cooling coil 18, thereby adjusting the temperature of the supplied air supplied from the evaporator 15 to be 25°C, for example. Hence, there is a response lag (time lag) from the adjustment of the valve opening degree until the temperature of the supplied air starts to change. For example, even if the cooling capacity of the evaporator 15 is normal, a temporal increase in temperature of the warm air exhausted from the server 14 causes increase in cooling load of the evaporator 15, the temperature of the supplied air of this evaporator 15 temporarily becomes increased, and exceeds the upper limit of the specification temperature range due to the response lag. In such a situation, if the rotational frequency of the fans 15C of this evaporator 15 is reduced or stopped, the normal operation of this evaporator 15 may be misrecognized as the abnormal operation, so that the rotational frequency of the fans is controlled to be reduced.

(Second embodiment of the apparatus for operation in abnormal state)

As shown in Figure 5, the deviation information detecting means 50 further includes refrigerant temperature detecting means 56 for detecting the temperature of the refrigerant to be supplied to the cooling coil 18 in addition to the plurality of supplied air temperature detecting means 25 and the valve opening degree detecting means 54 of the first embodiment. The fan controlling means 52 is configured to reduce or stop the rotational frequency of the fans 15C if the supplied air temperature is equal to or higher than the specification temperature range of the servers 14, the flow regulating valve 20 has the approximate maximum opening degree, and the refrigerant temperature is ~~equal to or lower~~higher than the design temperature for securing the maximum cooling capacity. The liquid refrigerant temperature sensor 44 for detecting the temperature of the liquid refrigerant is disposed at the exit of the heat exchange coil 28 of the cooling tower 22, as described above, and the refrigerant temperature detecting means 56 is preferably disposed at the entry of each evaporator 15 because some variation (change) in the refrigerant temperature occurs in the fluid pipe 24 between the cooling tower 22 to the evaporator 15.

In the second embodiment of the apparatus for an operation in an abnormal state, since there is further provided the refrigerant temperature detecting means 56 in addition to the plurality of supplied air temperature detecting means 25 and the valve opening degree detecting means 54, it is possible to more precisely monitor the deterioration of

{CLAIMS}

1. An apparatus for operating a cooling system in an abnormal state, wherein the cooling system including:

a plurality of evaporators that suck warm air exhausted from a plurality of electronic equipment installed in an equipment room with fans, cool the warm air through heat exchange with a refrigerant flowing in a cooling coil, and supply cool air into the equipment room; and

a condenser disposed at a position higher than the plurality of evaporators, the condenser which cools the refrigerant circulated naturally between the condenser and each evaporator,

the cooling system which adjusts a supplied air temperature of air supplied from each evaporator by adjusting an opening degree of each flow regulating valve that regulates a flow rate of the refrigerant flowing in the cooling coil,

wherein

the apparatus comprising:

deviation information detecting means for sequentially detecting deviation information between an maximum cooling capacity and a current cooling capacity in operation for each of the plurality of evaporators; and

fan controlling means for reducing or stopping a rotational frequency of a fan for an evaporator which has deviation information exceeding a predefined abnormal determining threshold value among the plurality of evaporators,

wherein the deviation information detecting means includes: supplied air temperature detecting means for detecting the supplied air temperature; and valve opening degree detecting means for detecting the opening degree of each flow regulating valve, and

the fan controlling means reduces or stops the rotational frequency of the fan if the supplied air temperature is equal to or higher than an upper limit of a specification temperature range of the electronic equipment, and if the flow regulating valve has an approximate maximum opening degree.

2. The apparatus for operating a cooling system in an abnormal state according to claim 1, wherein

the fan controlling means reduces the rotational frequency of the fan in accordance with a cooling capacity lowering rate of the evaporator based on the deviation information, and stops the fan if the cooling capacity lowering rate exceeds a threshold value.

~~3. The apparatus for operating a cooling system in an abnormal state according to claim 1 or claim 2, wherein~~

~~the deviation information detecting means includes: supplied air temperature detecting means for detecting the supplied air temperature; and valve opening degree detecting means for detecting the opening degree of each flow regulating valve, and~~

~~the fan controlling means reduces or stops the rotational frequency of the fan if the supplied air temperature is equal to or higher than an upper limit of a specification temperature range of the electronic equipment, and if the flow regulating valve has an approximate maximum opening degree.~~

~~4~~3. The apparatus for operating a cooling system in an abnormal state according to claim ~~3~~1 or claim 2, wherein

the deviation information detecting means further comprises refrigerant temperature detecting means for detecting a temperature of the refrigerant to be supplied to the cooling coil, and

the fan controlling means reduces or stops the rotational frequency of the fan if the supplied air temperature is equal to or higher than the upper limit of the specification temperature range of the electronic equipment, and if the flow regulating valve has the approximate maximum opening degree, and if the refrigerant temperature is ~~equal to or lower~~ higher than a design temperature for securing the maximum cooling capacity.

~~5~~4. The apparatus for operating a cooling system in an abnormal state according to claim 1 or claim 2~~3~~, wherein

the deviation information detecting means further comprises refrigerant pressure detecting means for detecting pressure of the refrigerant to be supplied to the cooling coil, and

the fan controlling means reduces or stops the rotational frequency of the fan if the supplied air temperature is equal to or higher than the upper limit of the specification temperature range of the electronic equipment, and if the flow regulating valve has the approximate maximum opening degree, and if the refrigerant pressure is equal to or higher than a design pressure for securing the maximum cooling capacity.

~~6. The apparatus for operating a cooling system in an abnormal state according to claim 3, wherein~~

~~the deviation information detecting means further comprises intake-air temperature-detecting means for detecting an intake-air temperature of the warm air sucked into the evaporators, and~~

~~the fan controlling means reduces or stops the rotational frequency of the fan if the supplied air temperature is equal to or higher than the upper limit of the specification temperature range of the electronic equipment, if the flow regulating valve has the approximate maximum opening degree, and if a temperature difference between the intake-air temperature and the supplied air temperature is equal to or larger than a design temperature difference for securing the maximum cooling capacity.~~

~~7~~5. The apparatus for operating a cooling system in an abnormal state according to any one of claim 1 to claim ~~6~~4, wherein

the electronic equipment is housed in racks in a stacked state, and each of the racks has suction ports formed at a front face thereof, and exhaust ports formed at a rear face thereof, and the evaporator is disposed between the racks, and

the intake ports of the evaporators and the exhaust ports of the racks face an identical space to form a warm space, and outlet ports of the evaporators and suction ports of the racks face another identical space to form a cooling space.