technique described in the Patent Document 1 (Patent National Publication of translated version NO. 2007-5141212) is disclosed. The technique disclosed in the Patent Document 1 includes, in a vicinity of the evaporator, a flow-rate regulating valve for regulating a flow rate of the refrigerant. This technique regulates the flow rate of the refrigerant in response to variation of the load, appropriately keeping the flow rate of the refrigerant to flow into the evaporator.

However, in the technique disclosed in the Patent Document 1, when the circulation flow rate of the refrigerant is decreased during partial load operation, the refrigerant pressure in the system is lowered to lower the evaporation temperature of the refrigerant in the evaporator, occasionally excessively cooling an object for being cooled (air).

Embodiments of t~~T~~he invention seek to provide~~is directed to~~ a cooling system and a method for controlling the cooling system, which may appropriately cool an object to be cooled even under a partial load operation.

SUMMARY OF THE INVENTION

An aspect of the invention provides a cooling system comprising~~and a method for controlling the cooling system including~~: one or more evaporators, each of the evaporators for evaporating a refrigerant and cooling an object to be cooled by heat exchange between the refrigerant and the object to be cooled; a refrigerant-supply-flow-rate regulator for regulating a flow rate of the refrigerant to be supplied to each of the evaporators; a post-cooling temperature measurement device for measuring a temperature of the object that is cooled by each of the evaporators through heat exchange with the refrigerant; a condenser for condensing a~~the~~ refrigerant~~,~~ evaporated by the evaporator~~s,~~ by cooling the evaporated refrigerant through heat exchange between the

evaporated refrigerant and a chilled water; ~~and~~ a refrigerant-temperature measurement device for measuring a temperature of the refrigerant condensed by the condenser; and a chilled-water-flow-rate regulator for regulating a flow rate of the chilled water to be supplied to the condenser, the. ~~The~~ refrigerant condensed by the condenser beingis pressurized to be supplied to all of the evaporators, the. ~~The~~ chilled-water-flow-rate regulator configured to regulates a flow rate of the chilled water, to be supplied to the condenser in such a way that, ~~for~~ a temperature of the condensed refrigerant is equal~~to come~~ to a predetermined target refrigerant-liquid temperature, and the. ~~The~~ refrigerant-supply-flow-rate regulator configured to regulates the flow rate of the refrigerant, to be supplied to each of the evaporators in such a way that, ~~for~~ a temperature of the object cooled is equal~~to come~~ to a predetermined target cooling temperature for each of the evaporators, the cooling system further comprising: a refrigerant pump for pressurizing the refrigerant condensed by the condenser to be supplied to the evaporators; a pressure-difference measurement device for measuring a pressure difference of the condensed refrigerant between a suction side and a discharge side of the refrigerant pump; and a refrigerant pump controller configured to regulate a rotation frequency of the refrigerant pump in such a way that the pressure difference calculated based on a measurement value of the pressure difference measurement device is equal to a differential-pressure setting value.

Another aspect of the invention provides a method for controlling a cooling system, comprising: providing one or more evaporators; evaporating, by each of the evaporators, a refrigerant to cool an object to be cooled by heat exchange between the refrigerant and the object to be cooled; regulating, by a refrigerant-supply-flow-rate regulator, a flow rate of the

refrigerant to be supplied to each of the evaporators; measuring, by a post-cooling-temperature measurement device, a temperature of the object that is cooled by each of the evaporators through heat exchange with the refrigerant; condensing, by a condenser, a refrigerant, evaporated by the evaporators, by cooling the evaporated refrigerant through heat exchange between the evaporated refrigerant and a chilled water; measuring, by a refrigerant temperature measurement, a temperature of the refrigerant condensed by the condenser; regulating, by a chilled-water-flow-rate regulator, a flow rate of the chilled water to be supplied to the condenser; pressurizing, by a refrigerant pump, the refrigerant condensed by the condenser to be supplied to all of the evaporators; regulating, by the chilled-water-flow-rate regulator, a flow rate of the chilled water to be supplied to the condenser in such a way that a temperature of the condensed refrigerant is equal to a predetermined target refrigerant-liquid temperature; regulating, by the refrigerant-supply flow-rate regulator, a flow rate of the refrigerant for each of the evaporators in such a way that a temperature of the object cooled is equal to a predetermined target cooling temperature for each of the evaporators; measuring, by a pressure-difference measurement device, a pressure difference of the condensed refrigerant between a suction side and a discharge side of the refrigerant pump; and regulating, by a refrigerant pump controller, a rotation frequency of the refrigerant pump in such a way that the pressure difference calculated based on a measurement value of the pressure difference measurement device is equal to a differential-pressure setting value.

Another aspect of the invention provides a cooling system comprising: an evaporator for evaporating a refrigerant by heat exchange

between the refrigerant and an object for being cooled; a refrigerant-supply-flow-rate regulator for regulating a flow rate of the refrigerant to be supplied to the evaporator; a post-cooling temperature measurement device for measuring a temperature of the object cooled by the evaporator; a condenser for condensing the refrigerant evaporated by the evaporator by cooling the evaporated refrigerant through heat exchange between the evaporated refrigerant and a chilled fluid; a refrigerant temperature measurement device for measuring a temperature of the refrigerant condensed by the condenser; and a chilled-fluid-flow-rate regulator for regulating a flow rate of the chilled fluid to be supplied to the condenser, the refrigerant condensed by the condenser being pressurized to be supplied to the evaporator, the chilled-fluid-flow-rate regulator configured to regulate a flow rate of the fluid to be supplied to the condenser in such a way that a temperature of the condensed refrigerant is equal to a predetermined target refrigerant-liquid temperature, and the refrigerant-supply-flow-rate regulator configured to regulate the flow rate of the refrigerant to be supplied to the evaporator in such a way that a temperature of the object cooled is equal to a predetermined target cooling temperature, the cooling system further comprising: a refrigerant pump for pressurizing the refrigerant condensed by the condenser to be supplied to the evaporator; a pressure-difference measurement device for measuring a pressure difference of the condensed refrigerant between a suction side and a discharge side of the refrigerant pump; and a refrigerant pump controller configured to regulate a rotation frequency of the refrigerant pump in such a way that the pressure difference calculated based on a measurement value of the pressure difference measurement device is equal to a differential-pressure setting value.

According to embodiments of the invention, the cooling system and the method for controlling the cooling system are provided, which may appropriately cool the object to be cooled even under a partial load operation. The cooling system and the method for controlling the cooling system are provided, which may prevent excessive cooling during the partial load operation and may enhance energy saving in response to a load.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

Fig. 1 is a diagram illustrating a configuration example of a cooling system according to the present embodiment;

Fig. 2 is a diagram illustrating a configuration of a data center with a dew-point thermometer; and

Fig. 3A is a diagram illustrating a configuration with a differential pressure gauge; and

Fig. 3B is a diagram illustrating a configuration including a