CLAIMS

[Claim 1] An operation control system for a cold generation apparatus including,

cold-water piping through which cold water is supplied to an external load apparatus,

a plurality of heat-pump type refrigerators which are arranged in series along the cold-water piping, and each have an evaporator and a condenser for cooling the cold water,

a cold-water pump which supplies the cold water returned from the external load apparatus, to the external load apparatus through the refrigerators so that the cold water is cooled in the evaporator in each of the refrigerators,

cooling-water pumps which are respectively arranged in correspondence with the refrigerators for supplying cooling water to the condenser in the refrigerators through cooling-water piping, and

cooling towers which are respectively arranged for the refrigerators, and respectively have cooling-tower fans for cooling the cooling water with outside air;

the operation control system comprising:

an acquisition means which acquires a wet-bulb temperature of the outside air taken into the cooling towers by the cooling-tower fans, a refrigeration load ratio as a ratio of an actual refrigeration load to a sum of preset values of refrigeration performance of the refrigerators, and a cold-water flow ratio as a ratio of an actual flow rate of the cold-water to a rated flow rate of the cold water;

a simulator which performs a simulation for determining an optimum value of a cooling-water flow ratio as a flow ratio between the cooling-water pumps corresponding to the refrigerators, an optimum value of an air flow ratio as a ratio between flow rates in the cooling-tower fans in the cooling towers, and an optimum value of a load sharing ratio as a ratio in which the actual refrigeration load is shared by the refrigerators, by calculating a coefficient of performance of the entire cold generation apparatus on the basis of arbitrary load sharing ratios inputted as a variable, under a condition determined by the wet-bulb temperature, the refrigeration load ratio, and the cold-water flow ratio which are acquired by the acquisition means, where the optimum value of the cooling-water flow ratio, the optimum value of the air flow ratio, and the optimum value of the load sharing ratio maximize a coefficient of performance of the cold generation apparatus; and

a control means which controls the cold-water pump of the refrigerators on the basis of the cold-water flow ratio, controls temperatures of the cold water at outlets of the refrigerators on the basis of the optimum value of the load sharing ratio, and controls the cooling-water pumps and the cooling-tower fans in the cooling towers on

the cold-water piping, and each have an evaporator and a condenser for cooling the cold water,

a cold-water pump which supplies the cold water returned from the external load apparatus, to the external load apparatus through the refrigerators so that the cold water is cooled in the evaporator in each of the refrigerators,

at least a cooling tower which is arranged for the plurality of refrigerators, and has a cooling-tower fan for cooling cooling water with outside air, and

cooling-water pumps which are respectively arranged in correspondence with the refrigerators for distributing the cooling water cooled in the cooling tower, to the plurality of refrigerators through cooling-water piping, so that the cooling water cooled in the cooling tower is supplied to the condenser in each of the refrigerators,

the operation control system comprising:

an acquisition means which acquires a wet-bulb temperature of the outside air taken into the cooling tower by the cooling-tower fan, a refrigeration load ratio as a ratio of an actual refrigeration load to a sum of preset values of refrigeration performance of the refrigerators, and a cold-water flow ratio as a ratio of an actual flow rate of the cold-water to a rated flow rate of the cold water;

a simulator which performs a simulation for determining an optimum value of a cooling-water flow ratio as a flow ratio between the cooling-water pumps corresponding to the refrigerators, an optimum value of an air flow rate in the cooling-tower fan in the cooling tower, and an optimum value of a load sharing ratio as a ratio in which the actual refrigeration load is shared by the refrigerators, by calculating a coefficient of performance of the entire cold generation apparatus on the basis of arbitrary load sharing ratios inputted as a variable, under a condition determined by the wet-bulb temperature, the refrigeration load ratio, and the cold-water flow ratio which are acquired by the acquisition means, where the optimum value of the cooling-water flow ratio, the optimum value of the air flow rate, and the optimum value of the load sharing ratio maximize a coefficient of performance of the cold generation apparatus; and

a control means which controls the cold-water pump on the basis of the cold-water flow ratio, controls temperatures of the cold water at outlets of the refrigerators on the basis of the optimum value of the load sharing ratio, and controls the cooling-water pumps and the cooling-tower fan in the cooling tower on the basis of the optimum value of the cooling-water flow ratio and the optimum value of the air flow rate.

[Claim 6] An operation control system for a cold generation apparatus including,

cold-water piping through which cold water is supplied to an external load

apparatus,

a plurality of heat-pump type refrigerators which are arranged in series along the cold-water piping, and each have an evaporator and a condenser for cooling the cold water,

a cold-water pump which supplies the cold water returned from the external load apparatus, to the external load apparatus through the refrigerators so that the cold water is cooled in the evaporator in each of the refrigerators,

at least a cooling tower which is arranged for the plurality of refrigerators, and has a cooling-tower fan for cooling cooling water with outside air, and

a cooling-water pump which is arranged for supplying the cooling water cooled in the cooling tower, to the plurality of refrigerators in succession from a high-temperature side to a low-temperature side through cooling-water piping, so that the cooling water cooled in the cooling tower is supplied to the condenser in each of the refrigerators,

the operation control system comprising:

an acquisition means which acquires a wet-bulb temperature of the outside air taken into the cooling tower by the cooling-tower fan, a refrigeration load ratio as a ratio of an actual refrigeration load to a sum of preset values of refrigeration performance of the refrigerators, and a cold-water flow ratio as a ratio of an actual flow rate of the cold-water to a rated flow rate of the cold water;

a simulator which performs a simulation for determining an optimum value of a cooling-water flow rate in the cooling-water pump, an optimum value of an air flow rate in the cooling-tower fan in the cooling tower, and an optimum value of a load sharing ratio as a ratio in which the actual refrigeration load is shared by the refrigerators, by calculating a coefficient of performance of the entire cold generation apparatus on the basis of arbitrary load sharing ratios inputted as a variable, under a condition determined by the wet-bulb temperature, the refrigeration load ratio, and the cold-water flow ratio which are acquired by the acquisition means, where the optimum value of the cooling-water flow rate, the optimum value of the air flow rate, and the optimum value of the load sharing ratio maximize a coefficient of performance of the cold generation apparatus; and

a control means which controls the cold-water pump on the basis of the cold-water flow ratio, controls temperatures of the cold water at outlets of the refrigerators on the basis of the optimum value of the load sharing ratio, and controls the cooling-water pump and the cooling-tower fan in the cooling tower on the basis of the optimum value of the cooling-water flow rate and the optimum value of the air flow rate.