

**SYSTEM AND METHOD OF PRESSURE DISTRIBUTION AND PRESSURE
REGULATION FOR HEATING AND AIR-CONDITIONING UNITS, AND A
VERY HIGH-RISE BUILDING UTILIZING THE SAME**

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Technical Field

The present invention relates to heating and air conditioning piping units equipped for a very high-rise building, and more particularly to a system and method of a multi-stage pressure distribution and pressure regulation for heating and air conditioning piping units, and a very high-rise building utilizing the same, wherein head pressure which is critical in heating and air conditioning piping units of the very high-rise building can be stably and correctly controlled.

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Background Art

Recently, owing to rapid development of architecture, there are a very large number of more than fifty-storied high-rise buildings of which heights are over 200m. Further, there are a large number of more than one hundred-storied very high-rise buildings of which heights are over 400m throughout the world.

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In such a high-rise building, water pressure within piping units of thermal equipment, such as a refrigerator, a boiler and a heat exchanger, is directly associated with the building. Generally, in case of an about twenty-storied building of which height is about 70m, even when the thermal equipment is installed only in a basement floor of the building, there is no substantial difficulty in providing thermo-fluid supplied from the thermal equipment to upper stories of the building. However, in case of a building of which height is over 70m, since pressure of the thermo-fluid becomes a critical factor, the thermal equipment should be distributively installed in intermediate stories or the topmost story of the building. Thus, as the height of a building becomes higher, the number of intermediate stories (equipment stories) for installing the thermal equipment therein increases in proportion to the building height.

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Accordingly, a facilities system for use in the very high-rise building should be

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properly designed in consideration of the characteristics of the very high-rise building, unlike that employed in a general building. In the very high-rise building, it is necessary to maintain a high pressure acting on a water piping units of air conditioning facilities within an appropriate pressure range depending on the building height.

5 Since there is a growing tendency for buildings to become higher, control of a head pressure in heating and air conditioning piping units has been significantly required in view of their construction environments and functions upon design of very high-rise buildings.

10 Technology for providing a method and system for effectively controlling air conditioning water in an air conditioning water piping system of such a very high-rise building is disclosed in Korean Patent No. 245,587, which was filed in the name of and then issued to the present inventor.

15 The present invention is directed to a multi-stage pressure distribution and regulation system for heating and air conditioning piping units, which can be stably applied even to an very high-rise building where a high head pressure acts under severe conditions by improving the above technology; a pressure control method of the same; and an very high-rise building utilizing the same.

Disclosure of the Invention

20 It is an object of the present invention to stably maintain inner pressure throughout heating and air conditioning piping units at a constant value in a head pressure control system of heating and air conditioning piping units in a very high-rise building.

25 It is another object of the present invention to control pressure fluctuation due to hunting and offset phenomena of valves generated during operation of the system, water hammer action generated upon start and stop of pumps, and pressure fluctuation derived from negative pressure creation due to cold water falling.

30 After plotting a pressure diagram of heating and air conditioning system, when examining pressure for safe use of equipment, fluctuation in thermo-fluid flow and pressure, control conditions, pump characteristics, control of the number of equipment for energy saving, and devices to be applied to pressure control of the system, the above

objects can be achieved by applying technology having the following characteristics.

Excessive water pressure and pressure reduction control

1. Problems related to water pressure within a supply piping portion and the constitution of a supply and circulation pump system

One of critical factors of various problems occurring in a water piping system in a very high-rise building is excessive pressure. Since head pressure is proportional to height in the natural world, an excessive pressure load acting on the water piping system in the very high-rise building causes serious problems in safe and normal operations of equipment, and also incurs additional expenses of maintenance thereof from an economical viewpoint. When pressure within the piping system is generally over 10kg/cm^2 , a steel pipe for pressure service (SPPS) should be used in consideration of safety. At this time, since auxiliary equipment such as a refrigerator, a boiler, a circulation pump, an air handling unit (AHU) and a fan coil unit (FCU) should be constituted in accordance with the high pressure, then these lead to increase the costs.

If a high pressure is not specifically required for operation of a certain equipment or system, it is irrational that the equipment or system is constructed such that pressure therein exceeds the maximum pressure at a discharging port thereof. It is preferred that the maximum pressure be limited, if possible.

Heating and air conditioning piping units according to the present invention is constructed by vertically zoning a very high-rise building into multi-stage areas on a height basis so that head pressure can be controlled at an appropriate pressure within a setting limit. Thermo-fluid circulation is carried out such that thermo-fluid can be pressurized and supplied by booster pumps of booster pumping systems constructed in a multi-stage manner. Upon stop of the pump, by preventing the upstream side pressure from acting on the downstream side by means of a check valve, excessive water pressure exerted on the system can be regulated at each stage. At this time, it is advantageous that an appropriate pressure range for water pressure control is set to be vertically zoned in the range of about 7 to 25kg/cm^2 in consideration of economical efficiency and stability.

2. Problems related to water pressure within a return piping portion and the

constitution of a pressure regulating system

The water pressure acting on the supply piping portion can be firmly kept safe by means of the check valve function of pump control valves and installation of check valves on the downstream sides of the booster pumps. However, control of water pressure acting
5 on the return side piping portion requires a high degree of engineering, and application of knowledge and technology concerning fluid mechanics, kinematics of machinery, thermo-fluid engineering and construction equipment are also required.

Since there is downward flow in the return side piping portion, head pressure within the system is controlled by employing a pressure reducing and sustaining device
10 that is a pressure control device for reducing the water pressure within the piping system to an appropriate pressure. Such device functions to cut off a main device when the upstream side pressure becomes lower than a predetermined pressure and to prevent backflow by cutting off the main device when the downstream side pressure becomes higher than the predetermined pressure. This pressure maintaining function allows pressure within the
15 system to be always stably maintained within a range of design.

In order to accomplish the above objects of the present invention, there is provided a multi-stage pressure distribution and pressure regulation system for heating and air conditioning units, comprising: one or more heating and cooling loads for areas vertically zoned depending on head pressure; a heat source supply system for supplying thermo-fluid
20 to the respective heating and cooling loads for the vertically zoned areas; one or more booster pumping systems which are provided between the heat source supply system and the respective heating and cooling loads and each of which includes booster pumps for transferring the thermo-fluid from the heat source supply system to the respective heating and cooling loads and pump control valves for maintaining a predetermined head pressure;
25 and one or more pressure regulating systems which are installed between output side return lines of the respective heating and cooling loads and the heat source supply system and each of which includes at least one pressure reducing and sustaining device for reducing the pressure of the thermo-fluid outputted from each heating and cooling load and maintaining it at the predetermined head pressure, wherein the head pressure acting in
30 proportion to the heights of stories of a building is distributed in a multi-stage manner

within a head pressure range for safe use.

Brief Description of the Drawings

5 The above and other objects and features of the present invention will become apparent from the following description of a preferred embodiment given in conjunction with the accompanying drawings, in which:

FIG. 1 is a systematic diagram of heating and air conditioning piping units of an embodiment according to the present invention;

10 FIG. 2 is a conceptual view of a system for controlling the system of the present invention;

FIG. 3 is a block diagram showing thermo-fluid circulation within heating and air conditioning piping units of the present invention;

15 FIG. 4 is a block diagram showing thermo-fluid circulation within heating and air conditioning piping units of the present invention in a case where a district heat source supply system is employed as a heat supply means; and

FIG. 5 is a schematic view showing the constitution of a pressure reducing and sustaining device provided for a pressure regulating system according to the present invention.

20 Best Mode for Carrying Out the Invention

Hereinafter, a preferred embodiment of the present invention will be explained in detail with reference to the accompanying drawings.

25 Although the present invention can be embodied by dividing an entire heating and cooling load into those for a plurality of zoned areas depending on head pressure according to the heights of stories of a building, a preferred embodiment of the present invention to be described below will be explained with heating and air conditioning piping units in the building in which the entire heating and cooling load is divided into those for first, second and third stages of the zoned areas depending on the head pressure according to the heights of stories of the building.

30 The heights of respective stages of the zoned areas can be arbitrarily adjusted

depending on piping material, building conditions and the like.

Referring to FIG. 1, a multi-stage pressure distribution and pressure regulation system according to the present invention comprises a heating and cooling load 400 consisting of a first-stage heating and cooling load 410, a second-stage heating and cooling
5 load 420, and a third-stage heating and cooling load 430; a booster pumping system 300; and a pressure regulating system 600. The multi-stage pressure distribution and pressure regulation system is connected with a heat source supply system 100 through piping units for controlling air conditioning water.

Heating and air conditioning piping units according to the present invention may
10 employ steel pipes, copper pipes, stainless steel pipes or the like.

The heating and cooling load 400 consists of an air handling unit (AHU), a fan coil unit (FCU), a convector and the like.

The heat source supply system 100 comprises a number of thermal equipment such as a refrigerator R, a boiler B, a water cooling/heating device RB; a first circulation pump
15 PP1 for circulating and driving thermo-fluid; a pump control valve PCV1 interlocked with the first circulation pump PP1; and a pressure relieving and sustaining valve RSV1.

Although the heat source supply system 100 consists of general thermal equipment such as a refrigerator R, a boiler B, a water cooling/heating device RB equipped within a building, a district heat source supply system, such as a combined heat and power plant, for
20 supplying thermo-fluid from the exterior of the building may be used.

Referring to FIG. 4, in a case where the district heat source supply system is used as the heat source supply system 100, the piping system is constructed such that a machine room receives the thermo-fluid from the district heat source supply system and transmit it to the booster pumping system, and that the thermo-fluid returned and collected via the
25 heating and cooling loads is transmitted back to the district heat supply system.

The booster pumping system 300 and the pressure regulating system 600 are intended to perform pressure control at each stage by constructing them to be vertically zoned in a multi-stage manner depending on the head pressure of the building, so that pressure control can be stably carried out within the entire system.

30 For example, when a pressure control range of the first-stage booster pumping

system is maintained at 7 to 25kg/cm² in consideration of safety and economical efficiency, since the story height per one story in the very high-rise building is generally 4.0 to 4.5m, the head pressure generated when each area zoned in the building is composed of twenty stories would be in the order of 8 to 10kg/cm². Accordingly, the booster pumping system
5 300 is constructed such that booster pumps PP2 should be installed at respective areas to circulate and supply the thermo-fluid, thereby controlling the head pressure in a pressure range for safe use.

The booster pumping system 300 includes booster pumps PP2 and pump control valves PCV2 connected to the booster pumps PP2 in series. The booster pumping system
10 300 has a function of preventing a surging phenomenon upon start and stop of the booster pumps PP2, and a function of instantly closing the valve to prevent thermo-fluid backflow upon stop of electricity supply, in order to stably optimize control of the system by minimizing pressure fluctuation upon control of the number of pumps to be operated.

In addition, the booster pumping system 300 further includes pressure relieving
15 and sustaining valves RSV2 connected to the booster pumps PP2 and pump control valves PCV2 in parallel to maintain pressure, which is changed when 2-way valves V2 of the heating and cooling load 400 are opened and closed, at a predetermined pressure irrespective of an inlet side potential or flow rate changes required for the system.

In addition, it is preferred that a check valve (not shown) is further installed on a
20 lower end of each booster pump PP2 of the booster pumping system 300. The check valve constructed as such prevents pressure on an upstream side with respect to the booster pump from acting on the downstream side thereof upon stop of the booster pump so that excessive water pressure cannot act on the system.

A surge tank device unit 500 is installed on the topmost portion of a return piping
25 system, functions to adjust pressure fluctuation factors, which are generated when pressure control devices are opened or closed at different timing by means of a pressure relief valve RV or a check valve, prevents the surge action when the control valves are rapidly closed, functions as a water supply tank, and relieves pressure in the system by opening the pressure relief valve RV when rapid pressure expansion is generated.

30 That is, the booster pumping system 300 is vertically zoned in a multi-stage

manner by setting up water pressure control ranges in consideration of characteristics, conditions, stability and the like within head pressure for safe use at each stage, and the thermo-fluid is pressurized and supplied by a booster pumping system of each zoned area. Upon stop of the pumps, as described above, the mechanical check valves of the booster
5 pumps are closed so that the upstream side pressure does not act on the downstream side of the pumps.

If a carbon steel pipe for pressure service is used as a pipe for supply piping of a circulation supply piping line, the height of each of the vertically zoned areas can be increased. That is, the height of each vertically zoned area may be increased such that its
10 head pressure is larger than the head pressure of 7 to 25kg/cm² within the pressure range for safe use of the piping line and the pumps, and then, the number of and installation space for machine facilities such as a booster pump can be reduced. In addition, the head pressure within the piping system for the heating and cooling load at each zoned area is caused to be maintained at pressure for safe use of equipment (5 to 10kg/cm²).

15 Next, since there is downward flow in a water return piping, the pressure regulating system prevents negative pressure creation due to water falling and controls reduction of the high head pressure.

The characteristics of the head pressure control device for reducing the head pressure in the system to an appropriate pressure performs the pressure reduction function,
20 and a backflow prevention function that the main valve is caused to be closed when the upstream side pressure becomes lower than a predetermined pressure as well as when the downstream side pressure becomes higher than a predetermined pressure.

That is, the pressure regulating system should perform a pressure maintaining function that thermo-fluid pressure in the system is caused to be always stably maintained
25 within the design range. The pressure regulating system for meeting the requirements is constructed as follows.

The pressure regulating system 600 includes pressure reducing and sustaining devices PRSD. Each pressure reducing and sustaining device PRSD reduces a high pressure of an inlet side thereof (upstream side) to a low pressure of an outlet side thereof
30 (downstream side), and accurately maintains a predetermined outlet pressure irrespective

of a change in the inlet side pressure or a flow rate. The valve is closed when the outlet side pressure becomes higher than the predetermined pressure as well as when the inlet side pressure becomes lower than the predetermined pressure.

Since the pressure regulating system constructed as such is vertically zoned in a multi-stage manner in consideration of the pressure control range and characteristics and constructed to include a first stage or more stages so as to reduce the pressure of thermo-fluid, the occurrence of cavitation can be avoided. The control range of the head pressure in the pressure regulating system is 7 to 25kg/cm² in the same way as the booster pumping system. This range is desirable in view of stability and economical efficiency.

Since the heat source supply system 100, the first-stage booster pumping system 310 and the first-stage pressure regulating system 610 may be installed on the basement floor of building to constitute a machine room 200, installation space thereof can be reduced.

Since an air- or nitrogen-pressurized diaphragm type closed expansion tank ET is installed in the machine room 200 to absorb and regulate pressure fluctuation occurring upon start and stop of the pumps or due to hunting and offset phenomena of the pressure reducing and sustaining valves, the predetermined pressure in the system can be always stably maintained.

Reference numeral M denoted within the machine room 200 in the figures designates a flow meter for measuring a flow rate of the returned thermo-fluid. The flow meter M is provided with a flow detector 220, and signals generated from the detection of the flow meter M are inputted into a system control panel 210.

Hereinafter, main functions and characteristics of each component of the present invention constructed as such will be summarized.

1 Pressure reducing and sustaining device

Each pressure reducing and sustaining device PRSD performs two independent functions: the function of reducing a high pressure of the inlet side thereof (upstream side) to a low pressure of the outlet side thereof, and the function of correctly maintaining the predetermined outlet side pressure irrespective of a change in the inlet side pressure or the flow rate. That is, the high pressure of the inlet side thereof (upstream side) is reduced to

the low pressure of the outlet side thereof, and the predetermined outlet side pressure is accurately maintained irrespective of the change in the inlet side pressure or the flow rate.

Specifically, referring to FIG. 5, a first pressure sensor SS1 and a second pressure sensor SS2, which are pressure sensing units, and a first service valve GV1 and a second service valve GV2 are positioned at both sides of the pressure reducing and sustaining valve PRSV. Reference numeral ST designates a filter.

The pressure reducing and sustaining device constructed as such maintains the inlet side pressure at the predetermined pressure while always maintaining the outlet side pressure, which is a reference pressure, at the predetermined pressure.

That is, when the inlet side pressure becomes lower, the lowered pressure is sensed by the first pressure sensor SS1, and the pressure reducing and sustaining valve PRSV is automatically closed through pilot control. Then, the inlet side pressure is raised until a certain pressure is reached and maintained. If the outlet side pressure becomes higher due to added pressure or returned pressure, this is sensed by the second pressure sensor SS2. Then, the pressure reducing and sustaining valve PRSV is closed to prevent backflow.

In constructing the pressure reducing and sustaining device according to the present invention, it is desirable that the pressure reducing and sustaining valves be arranged to be connected with each other in parallel as described below.

When various changes in the flow rate are required, if one valve is selected for a large flow rate, this valve should meet both small and large flow rate while reducing the pressure to a desired pressure. When a very small flow rate is required, a valve seat should be opened only in a little amount, and then, immediately closed. However, if this process is repeated, a chattering phenomenon as well as excessive wear of an operating portion thereof are generated. This becomes a cause of noise generation. This problem can be solved by installing two valves, i.e., a large-diameter valve and a small-diameter valve, in parallel. An additional valve may be separately installed as a spare part to enhance stability.

□ Pressure relieving and sustaining valves

The pressure relieving and sustaining valves RSV1, RSV2 serve to maintain the predetermined inlet side pressure at a constant value irrespective of a change in the inlet

side potential or the flow rate required by the system, and function to alleviate a load by bypassing a portion of the pressure so that only constant pressure can be supplied.

□ Pump control valves

5 The pump control valves PCV1, PCV2 function to eliminate the surging phenomenon within the piping system generated upon start and stop of the pump, and are installed in the discharge side piping of the booster pump PP2 and the first circulation pump PP1 to control discharge pressure.

10 When the pump starts in a state where the valves are closed, electricity is supplied from a power source to an electronic control valve for pilot, and then, the valves are slowly opened. Then, the thermo-fluid in the piping is caused to be gradually raised to a suction lift of the pump.

When a stop signal is transmitted to the pump, the electricity supplied from the power source to the electronic control valve for pilot is cut off. Then, the valves are slowly closed, and thus, the flow rate is gradually reduced. Thus, when the valves are closed, a
15 limit switch for electrically interlocking the pump with the valves is operated to cut off the electricity to the pump. As a result, the pump stops. If the electricity is suddenly cut off (power failure), thermo-fluid flow stops at the moment that a check valve contained in the pump is closed. The check valve is closed irrespective of a position of a solenoid or diaphragm in order to prevent backflow.

20 □ Booster pumps

The booster pumps PP2 are installed to be connected with each other in series in a multi-stage manner, if necessary, in order to supply the thermo-fluid in the supply piping to a higher position, and the booster pump at each stage is constructed by connecting two or more pumps having rated capacity in parallel so as to control the number of pumps to be
25 operated by the system control panel depending on values measured by the flow meter. Accordingly, since the booster pumps can be controlled in response to various changes in the flow rate, energy consumption can be reduced. The vertical height (pressure range) of each zoned area is determined in consideration of pressure resistance strength and characteristics of the piping and equipment and the like.

30 Operation control of the booster pump may be made by configuring a sequence

such that energy consumption can be reduced by control of the number of pumps to be operated and variable flow rate control (control of the number of rotations), or by stopping the pumps in response to the pressure in the system and controlling the number of pumps to be operated depending on the load.

5 □ Expansion tank

The expansion tank ET is provided for a water return header of the heat source supply system to absorb, relieve and regulate expansion pressure. In the present invention, it is preferred to use an air- or nitrogen-pressurized closed tank, and auxiliary equipment such as an air compressor, a relief valve, a supplementary water line and an alarm device is
10 provided thereto.

Upon operation of the system, when the pressure in the water return header becomes higher than the predetermined pressure, the expansion tank always maintains the pressure in the system at a constant value by absorbing and regulating this pressure.

 □ surge tank

15 The surge tank prevents the surging phenomenon due to rapid changes in the flow rate or velocity upon operation of the system, and opens the pressure relief valve RV or safety valve to drop the pressure in response to rapid pressure changes. A check valve CV functions to prevent backflow, and also functions as a supplementary water tank.

Thermo-fluid circulation process in the multi-stage pressure distribution system of
20 heating and air conditioning piping units according to the present invention constructed as such will be explained in detail.

First, the pressure in the machine room 200, which is a reference pressure in the present invention, should be always maintained at a constant value. Thus, upon operation of the system under the condition that the pressure is maintained at a constant value, the
25 system control panel 210 constructed as shown in FIG. 2 is operated so that the first circulation pump PP1, the booster pumps PP2 at each stage and thermal equipment R, B, RB are sequentially operated.

The thermo-fluid flow will be explained in detail with reference to FIGS. 1 and 3.

In order to supply the thermo-fluid to be used in the first-stage heating and cooling
30 load 410, the second-stage heating and cooling load 420 and the third-stage heating and

cooling load 430, the system control panel 210 is operated so that the first circulation pump PP1 of the heat source supply system 100 and respective booster pumps PP2 of the booster pumping system 300 can be driven.

5 The first circulation pump PP1 of the heat source supply system 100 is driven so that the thermo-fluid can be transferred to the booster pumping system 300 via the thermal equipment R, RB, B.

The respective booster pumps PP2 of the first-stage booster pumping system 310, the second-stage booster pumping system 320 and the third-stage booster pumping system 330 are operated so that the thermo-fluid can be transferred to the respective heating and cooling loads 410, 420, 430 via the pump control valves PCV2.

As for, the thermo-fluid supplied to the first-stage heating and cooling load 410, the thermo-fluid outputted from the heat source supply system 100 is directly transferred to the load 410 via the first-stage booster pumping system 310.

As for the thermo-fluid supplied to the second-stage heating and cooling load 420, 15 the thermo-fluid is distributed at an appropriate pressure by the first-stage booster pumping system 310 is transferred to the load 420 via the second-stage booster pumping system 320.

Likewise, as for the thermo-fluid supplied to the third-stage heating and cooling load 430, the thermo-fluid is distributed at an appropriate pressure from the first- and second-stage booster pumping systems 310, 320 is transferred to the load 430 via the third-stage booster pumping system 330.

The number of booster pumps PP2 to be operated at each stage is controlled depending on the load by the system control panel 210, and changes in the flow rate and pressure generated upon stop of the pumps are controlled by the control function of the sequential pump control valves PCV2 to ensure silent operation of the system.

Next, when the 2-way valve V2 provided for the heating and cooling load 400 is closed due to a change in the load, the pressure in the water supply piping is raised. At this time, the raised pressure is controlled by the control function of the booster pumping system 300. The pressure relieving and sustaining valves RSV2 serves as emergency and complementary devices. In addition, upon generation of unusual pressure, the pressure 30

relief valve RV or safety valve of the surge tank ST is operated at the topmost portion of the piping system for the respective stages.

The pressure of the thermo-fluid which has passed through the heating and cooling load 400 is controlled to be reduced via the multi-stage pressure regulating system 600 which is installed at areas vertically zoned according to the heights of stories of the building. Thus, the thermo-fluid repeatedly circulates while maintaining the pressure in the machine room 200 at a constant value.

The head pressure in the respective stages of the pressure regulating system 600 is set in the order of the predetermined pressure range (7 to 25kg/cm²) at the vertically zoned areas as described above in consideration of economical efficiency and safety. The operation pressure can be set up to a value higher than the head pressure generated upon stop of the pump by 2 to 3kg/cm². Further, the pressure fluctuation due to the hunting and offset phenomena of the pressure reducing and sustaining valves PRSV is absorbed and regulated by the expansion tank ET provided for the water return header.

Upon stop of the pump, the pump control valve is slowly closed, and thus, the flow rate is reduced and the pressure drops. When the pressure in the system continues to drop and becomes lower than the predetermined pressure of the water return side pressure sustaining valve, the valve is automatically closed to maintain a hydrostatic head pressure. When the valve is completely closed, a limit switch is operated to stop the booster pumps.

Although the present invention has been described with respect to heating and air conditioning piping units of the preferred embodiment in which the entire heating and cooling load is divided into the first-, second- and third-stage heating and cooling load for the vertically zoned areas, this is not intended to limit the present invention but provided for illustrative purposes only. Therefore, it will be understood by those skilled in the art that various other modifications and equivalents can be made thereto without departing from the scope and spirit of the present invention. The scope of the invention is defined only by the appended claims.

Industrial Applicability

As described above, according to the present invention, by vertically zoning

heating and air conditioning piping units of the very high-rise building in the multi-stage manner so that the head pressure can be controlled at an appropriate pressure, the following advantages can be obtained.

5 First, the entire heating and cooling load is divided into those for the vertically zoned area depending on the head pressure generated according to the heights of stories of the building, so that the head pressure at each area can be controlled within a predetermined range for safe use. Thus, the present invention can be applied to all buildings irrespective of the building heights.

10 That is, since pressure generated from the action of the thermo-fluid flowing within heating and air conditioning piping units in the building can be maintained at a constant value even in case of any pressure loads so that the system can be stably maintained even in case of large pressure fluctuation, the present invention can be technically applied to any buildings having an infinite height.

15 Second, according to the present invention, heavy thermal equipment such as a refrigerator, a heat exchanger and a boiler, which has been installed in intermediate stories or the rooftop of the building in the prior art, can be operated in a state where it is installed in the basement floor of the building.

20 Therefore, since load acting on the building can be reduced, a lightweight building structure can be achieved and the safety of the building can be enhanced. In addition, danger such as noise, vibration and a fire can be minimized in the building.

Third, according to the present invention, since the thermo-fluid is transferred directly to the heating and cooling load from the basement floor of the building through the piping system, so that heat loss can be minimized and thus heat transfer efficiency can be maximized. Accordingly, an energy saving effect can be obtained.

25 Fourth, since in addition to economic profit creation due to reduction in construction expenses, large space occupied by a thermal equipment room in the conventional system can be available for another use, usage efficiency of the space of the building can be enhanced.

30 Fifth, according to the present invention, since the thermal equipment can be centralized and managed in the basement floor of the building, there are advantages in that

efficient operation and management of the air conditioning facilities is allowed, in that maintenance of the thermal equipment and system becomes easier, and in that the air conditioning facilities can be operated even small manpower, and thus, management expenses can be reduced.

What is claimed is:

1. A multi-stage pressure distribution and pressure regulation system for heating and air conditioning units, comprising:
 - 5 one or more heating and cooling loads for areas vertically zoned depending on head pressure;
a heat source supply system for supplying thermo-fluid to the respective heating and cooling loads for the vertically zoned areas;
one or more booster pumping systems which are provided between the heat source supply system and the respective heating and cooling loads and each of which includes
10 booster pumps for transferring the thermo-fluid from the heat source supply system to the respective heating and cooling loads and pump control valves for maintaining a predetermined head pressure; and
one or more pressure regulating systems which are installed between output side
15 return lines of the respective heating and cooling loads and the heat source supply system and each of which includes at least one pressure reducing and sustaining device for reducing the pressure of the thermo-fluid outputted from each heating and cooling load and sustaining it at the predetermined head pressure,
wherein the head pressure acting in proportion to the heights of stories of a
20 building is distributed in a multi-stage manner within a head pressure range for safe use.
2. The system as claimed in claim 1, wherein each of the booster pumping systems further includes a pressure relieving and sustaining valve connected to the booster pumps and the pump control valves in parallel the pressure of the thermo-fluid so that only a
25 predetermined pressure can be exerted on the booster pumps and pump control valves.
3. The system as claimed in claim 1, wherein a lower end of each booster pump of each of the booster pumping systems is provided with a check valve for preventing pressure on an upstream side with respect to the booster pump from acting on the
30 downstream side thereof upon stop of the booster pump.

4. The system as claimed in claim 1, wherein the pressure reducing and sustaining device includes a pressure reducing and sustaining valve, pressure sensor units provided on inlet and outlet sides of the pressure reducing and sustaining valve for sensing the pressure of the thermo-fluid and for allowing control of maintenance of a constant pressure, and a service valve.
5. The system as claimed in claim 4, wherein the pressure reducing and sustaining valve further includes an additional small-diameter pressure reducing and sustaining valve for bypassing the thermo-fluid.
6. The system as claimed in claim 1, wherein a surge tank is installed at the top of a circulation line to communicate therewith, and a pressure relief valve or safety valve and a check valve is installed in the surge tank to communicate therewith, so that the pressure relief valve or safety valve can prevent abrupt pressure fluctuation within the piping system while the check valve can prevent backflow.
7. The system as claimed in claim 1, wherein a water return header of the heat source supply system further includes an expansion tank for absorbing, relieving and regulating expansion pressure, so that pressure fluctuation occurring upon start and stop of the pumps or due to hunting and offset phenomena of the pressure reducing and sustaining valve can be absorbed and regulated.
8. The system as claimed in claim 7, wherein the expansion tank is an air- or nitrogen-pressurized closed tank.
9. The system as claimed in claim 1, wherein the heat source supply system is an external district heat supply system for supplying the thermo-fluid to the building.
10. An very high-rise building utilizing a multi-stage pressure distribution and

regulation system for heating and air conditioning units, comprising:

one or more heating and cooling loads for areas vertically zoned depending on head pressure according to the heights of stories of a building;

5 a heat source supply system for supplying thermo-fluid to the respective heating and cooling loads for the vertically zoned areas;

one or more booster pumping systems which are provided between the heat source supply system and the respective heating and cooling loads and each of which includes booster pumps for transferring the thermo-fluid from the heat source supply system to the respective heating and cooling loads and pump control valves for maintaining a
10 predetermined head pressure; and

one or more pressure regulating systems which are installed between output side return lines of the respective heating and cooling loads and the heat source supply system and each of which includes at least one pressure reducing and sustaining device for reducing the pressure of the thermo-fluid outputted from each heating and cooling load and
15 sustaining it at the predetermined head pressure,

wherein the head pressure acting in proportion to the heights of stories of the building is distributed and reduced in a multi-stage manner within a head pressure range for safe use.

20 11. The very high-rise building as claimed in claim 10, wherein each of the booster pumping systems further includes a pressure relieving and sustaining valves connected to the booster pumps and the pump control valves in parallel in order to control the pressure of the thermo-fluid so that only a predetermined pressure can be exerted on the booster pumps and the pump control valves.

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12. The very high-rise building as claimed in claim 10, wherein the pressure reducing and sustaining device includes a pressure reducing and sustaining valve, pressure sensor units provided on inlet and outlet sides of the pressure reducing and sustaining valve for sensing the pressure of the thermo-fluid and for allowing control of maintenance of a
30 constant pressure, and a service valve.

13. The very high-rise building as claimed in claim 10, wherein the heat source supply system is an external district heat supply system for supplying the thermo-fluid to the building.

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14. A pressure control method of a multi-stage pressure distribution and pressure regulation system for heating and air conditioning units, comprising:

a first step of supplying thermo-fluid from a heat source supply system to a plurality of heating and cooling loads for areas vertically zoned depending on head
10 pressure while distributing the pressure of the thermo-fluid in a multi-stage manner, by using at least one booster pumping system including booster pumps and pump control valves; and

a second step of returning the thermo-fluid outputted from the plurality of heating and cooling loads to the heat source supply system while reducing the pressure of the
15 thermo-fluid in the multi-stage manner, by using at least one pressure regulating system including a pressure reducing and sustaining device for sustaining a predetermined head pressure.

ABSTRACT

The present invention relates to a multi-stage pressure distribution and pressure regulation system for heating and air conditioning piping units, a pressure control method of the same, and a very high-rise building utilizing the same, wherein head pressure that is critical in heating and air conditioning piping units of an very high-rise building can be stably and correctly controlled. According to the present invention, there is provided a multi-stage pressure distribution and pressure regulation system for heating and air conditioning piping units, comprising: one or more heating and cooling loads 400 for areas vertically zoned depending on head pressure; a heat source supply system 100 for supplying thermo-fluid to the respective heating and cooling loads 400 for the vertically zoned areas; one or more booster pumping systems 300 which are provided between the heat source supply system 100 and the respective heating and cooling loads 410, 420, 430 and each of which includes booster pumps PP2 for transferring the thermo-fluid from the heat source supply system 100 to the respective heating and cooling loads 400 and pump control valves PCV2 for maintaining a predetermined head pressure; and one or more pressure regulating systems 600 which are installed between output side return lines of the respective heating and cooling loads 410, 420, 430 and the heat source supply system 100 and each of which includes at least one pressure reducing and sustaining device PRSD for reducing the pressure of the thermo-fluid outputted from each heating and cooling load 400 and sustaining it at the predetermined head pressure, wherein the head pressure acting in proportion to the heights of stories of a building is distributed in a multi-stage manner within a head pressure range for safe use. Therefore, high head pressure in heating and air conditioning piping units of the very high-rise building can be accurately and stably controlled, and building space can be efficiently available since there is no need for intermediate stories for installing thermal equipment therein contrary to the prior art. Further, there are advantages in that a lightweight building structure and a saving of construction expenses can be achieved and in that energy consumption can be reduced.