A heating installation includes a heat pump, heating fluid piping passing through a condenser of the heat pump to exchange heat between refrigerant and heating fluid, first and second objects heated by the heating fluid to first and second set temperatures, a valve switchable between first and second positions to supply heating fluid to the first and second objects, sensors detecting first and second actual temperatures at the first and second objects, and a control. The heat pump also has an evaporator, a compressor and an expansion device. The control in a demand dependent mode, is configured to determine a first demand based on the first set and actual temperatures and a second demand based on the second set and actual temperatures, and is configured to switch the valve to the first and second positions based on comparison of the first and second demands. A method for controlling a heating installation heats the first or second object based on such a comparison.
HEATING INSTALLATION AND METHOD FOR CONTROLLING THE HEATING INSTALLATION

CROSS-REFERENCE TO RELATED APPLICATIONS


TECHNICAL FIELD

[0002] The present invention relates to a heating installation and a method for controlling the heating installation. It is, however, to be understood that the present invention may also be incorporated in combined heating and cooling installations and is then implemented for controlling the installation in the heating mode. More particularly, the present invention relates to a heating installation comprising a heat pump, particularly an air-source heat pump, having an outdoor evaporator, a compressor, a condenser and an expansion means connected by a refrigerant piping in a cycle; a heating fluid piping passing through the condenser for exchanging a heat between the refrigerant and the heating fluid and at least a first and a second object to be heated by the heating fluid to a first set temperature and a second set temperature.

BACKGROUND ART

[0003] In existing systems such a heating installation is controlled based on a set priority. That is, a user manually inputs which of the first and second object is to be served first, if both the first and the second object have a heat demand, i.e. require supply of heating fluid. Hence and independently from the amount of heat which is demanded by the priority object, the priority object is served, whereas the other object is set on hold until the demand of the priority object has been satisfied.

[0004] In case the priority is set to the domestic hot water production, there is a possibility that the indoor temperature is dropping below the level of comfort. In case the priority is set to the space room heating, there may occur discomfort in the domestic hot water production if an insufficient hot water production takes place.

SUMMARY

[0005] Hence, it is the object of the present invention to provide a heating installation and a method for controlling a heating installation as described in the introductory part which enables both to prevent severe temperature drops in e.g. rooms to be heated and provide sufficient heating to e.g. hot water in a hot water container at the same time being as efficient as possible.

[0006] This object is solved by a heating installation as defined in claim 1 and a method for controlling the heating installation as defined in claim 9.

[0007] Aspects of the present invention are named in the dependent claims.

[0008] The principle idea of the present invention is to provide the heating installation with an adaptive control which controls the supply of heating fluid to a first and second object to be heated based on a comparison of the heating demand of the first and second object. Hence, the present invention considers both heating demands of the objects to be heated compares the demands and based on the comparison decides which of the first and second object is to be served first, i.e. supplied with heating fluid.

[0009] The heating installation of the present invention comprises a heat pump having an evaporator, a compressor, a condenser and an expansion means connected by a refrigerant piping in a cycle. It is to be understood that the heat pump in a combined heating and cooling installation may also be operated in a cooling mode, that is reversed compared to the heating mode. In the cooling mode, the evaporator will then serve the condenser and the condenser will serve as the evaporator of the heat pump. Furthermore, the heating installation of the present invention comprises a heating fluid piping passing through the condenser for exchanging heat between the refrigerant and the heating fluid as well as at least a first and a second object to be heated by the heating fluid to a first set temperature and a second set temperature, respectively. In addition, in order to selectively supply heating fluid to heat the first object or the second object, the heating installation of the present invention comprises a valve which is at least switchable between a first position for supplying heating fluid to heat the first object and a second position for supplying heat to heat the second object. In addition, at least two sensors are provided for detecting the first and the second actual temperature at the first and the second object, respectively. The control of the heating installation of the present invention is configured to, in a demand dependent mode, determine a first demand based on at least the first set temperature and the first actual temperature and a second demand based on at least the second set temperature and the second actual temperature and based on the first and second demand switches the valve to the first and the second position to either serve the first object or the second object, hence, satisfying the first or the second demand (heating demand). It is to be understood that the first demand is determined based on at least the first set temperature and the first actual temperature but other parameters may also be considered in determining the demands, such as time and temperature concurrent. If these parameters other than the said temperatures are sufficiently significant, the demand may also be determined based on these parameters only. Further, the first demand and the second demand may be determined based on at least the difference between the set temperature and the actual temperature.

[0010] In a preferred embodiment, the control is configured to switch the valve to the first position if the first demand is higher than the second demand and to switch the valve to the second position if the second demand is higher than the first demand. Self-evident the control is configured to switch the valve to the first position, if there is no second demand and to switch the valve into the second position, if there is no first demand. Nevertheless, even if there are a first demand and a second demand and according to this preferred embodiment, the control switches the valve so as to serve the higher demand.

[0011] As previously indicated, it is considered preferred that the first object is at least one heat emitter which is arranged in a room to be heated, wherein the heat emitter on an upstream side thereof is connected to the heating fluid piping via said valve. According to one preferred embodiment, the heat emitter comprises a floor heating loops or may entirely consist of a floor heating loops. However, also a
combination of radiators and floor heating loops may form the heat emitter of the present invention.

In this embodiment it is preferred that the first actual temperature is the actual flow temperature to the heat emitter, i.e. the flow temperature of the heating fluid to the heat emitter and the first set temperature is the desired flow temperature to the heat emitter, which may be required to obtain the desired room temperature.

Moreover and as also previously indicated, the second object is water contained in a hot water container. According to one embodiment a portion of a pipe, the upstream side of which is connected to the heating fluid piping via a said valve, is connected to a heat exchanger for transferring the heat from the heating fluid to the water. According to another embodiment, the portion of the pipe forms the heat exchanger and passes, e.g., in the form of a coil, through the interior of the hot water container, thereby transferring the heat from the heating fluid to the water.

In this embodiment, it is preferred that the second actual temperature is the actual water temperature of the water contained in the hot water container and to be heated and the second set temperature is the desired temperature of said water.

Further and to order to enable the user to select between the preferred demand mode and a priority mode the control has an input device for selecting the mode, wherein in the priority mode a priority is manually set with respect to the first or the second object. The input device may also comprise an input element, such as a bottom, for selecting a boosting mode, in which an additional heater in the hot water container is manually activated to quickly heat up the water in the container if required.

Furthermore and as previously mentioned, the present invention also provides a method for controlling a heating installation as described above. The control method comprises the steps of calculating a first demand based on at least the first set temperature and the first actual temperature and a second demand based on at least the second set temperature and the second actual temperature, comparing the first and second demand and heating either the first object or the second object based on the comparison, that is to either supply heating fluid to the first object or to the second object.

The embodiments of the method of the present invention correspond to the preferred embodiments of the heating installation described above so that in order to avoid repetitions reference is made to the dependent claims and the above description only.

BRIEF DESCRIPTION OF DRAWINGS

Additional features and advantages of the present invention will become apparent from the detailed description of a preferred embodiment with reference to the accompanying drawings in which:

FIG. 1 is a perspective view of a room heating and cooling installation in which the present invention may be implemented;

FIG. 2 is a system diagram for schematically explaining the components of the installation shown in FIG. 1;

DETAILED DESCRIPTION OF EMBODIMENT(S)

The present application will be described in the following as being implemented in an installation which is capable of heating and cooling a predetermined space (room) and heating water in a hot water container, the water via piping being used for sanitary purposes like the taps, the shower, etc. (see FIG. 1). Yet it is to be understood that the present invention may also be implemented in other installations than the one shown in FIGS. 1 and 2, where appropriate.

The installation shown in FIG. 1 consists of three major components, an outdoor unit, an indoor unit and a hot water container. The outdoor unit is connected to a piping which connects the outdoor unit to the indoor unit. The outdoor unit comprises an inlet/outlet and an outlet/inlet for a refrigerant piping. The indoor unit comprises an inlet/outlet and an outlet/inlet for the refrigerant piping. In addition, the indoor unit has an outlet and an inlet for the fluid to be circulated in the fluid circuit (depending on the mode the fluid is heating or cooling fluid). The fluid may be water or a brine solution. The piping downstream of the outlet is connected via a valve to a piping and a piping. The piping passes through the interior of the hot water container in form of a coil (see FIG. 1) and leaves the hot water container via a piping connected to a piping leading to the inlet. The piping downstream of the valve leads to a heat emitter and/or underfloor heating loops and then is led to the indoor unit via the piping and the inlet.

As will be appreciated, the connections to the outdoor unit and the connections to the indoor unit may respectively be reversed depending on the mode in which the system is operated, i.e. the heating mode or the cooling mode.

As shown in FIG. 2 the outdoor unit comprises an evaporator and/or condenser, a four-way valve, a compressor and an expansion device, which is may be an electric valve or a capillary. The indoor unit comprises a condenser/evaporator. These components form a heat pump. Hence, the evaporator/condenser, the compressor and the expansion device are connected in this order in a cycle or loop by means of a refrigerant piping. A refrigerant is circulated by means of the compressor in the refrigerant piping. In the heating mode the refrigerant circulates clockwise in FIG. 2. Hence, the refrigerant leaving the condenser and having a first temperature upstream of the expansion device (means) are connected in this order in a cycle or loop by means of a refrigerant piping. A refrigerant is circulated by means of the compressor in the refrigerant piping. In the heating mode the refrigerant circulates clockwise in FIG. 2. Hence, the refrigerant leaving the condenser and having a first temperature upstream of the expansion device (means) is pressure being reduced. Afterwards, the refrigerant passes the evaporator and is evaporated having a second temperature downstream of the evaporator higher than the first temperature. After leaving the evaporator, the refrigerant passes through the compressor, the pressure being increased. Finally, the refrigerant is again condensed to the first temperature in the condenser, wherein the heat from the refrigerant is transferred to the water or brine solution (fluid) in the piping connected to the indoor unit via the connections and outlet.

In the cooling mode, this process is reversed, wherein the component then serves as condenser and the component as evaporator. The refrigerant then circulates counter-clockwise in FIG. 2.

The indoor unit further comprises a pump and a backup heater. The pump serves for circulating the fluid (heating or cooling fluid) in the fluid circuit. The purpose of the backup heater is to cope with situations in which the heat pump described above is not capable to satisfy the entire heating demand (at very low
temperatures, e.g. below -10 degrees Celsius). This backup heater 26 in some cases may also be omitted.

[0027] In the heating mode the fluid (heating fluid) enters the indoor unit 20 through the inlet 22, passes the condenser 25, wherein heat is transferred from the refrigerant to the fluid, then flows through the backup heater 26 in which the fluid may be additionally heated if necessary and subsequently passes the pump 27 which circulates the fluid in the fluid circuit. Afterwards and by controlling the valve 32 the fluid is either supplied to the floor heating loops 40 and the heat emitter 41 (see FIG. 1) or alternatively to the hot water container/piping (31, 34). In the latter case, the fluid may enter the hot water container 30 by means of the piping 31 passing the heating coil inside the hot water container 30 thereby transferring the heat from the fluid to the water contained in the hot water container 30 and subsequently being refeeded to the circuit by the pipings 34 and 36 finally being reintroduced into the indoor unit via the inlet 22. Similar, the fluid may also be supplied to the floor heating loops 40 as a heat emitter or the radiator 41 shown in FIG. 1 and subsequently be reintroduced in to the indoor unit via the inlet 22. In case the temperature of the fluid is not sufficient to heat the water in the hot water container an additional (booster) heater 33 may be provided in the hot water container.

[0028] As previously mentioned, the circulation of the fluid in the cooling mode is the same but the cycle of the heat pump (flow direction of the refrigerant) is reversed.

[0029] Moreover, the system comprises a temperature sensor 60 which detects the temperature of the heating fluid leaving the indoor unit which, in the following, is considered as the actual flow temperature of the heating fluid. An additional temperature sensor 63 is provided to detect the temperature of the hot water in the hot water container 30.

[0030] In the following, the control of the embodiment of the present invention is explained.

[0031] An input device (not shown) which in general will be arranged in or on the indoor unit is used to input a desired flow temperature (first set temperature) of the heating fluid to the heat emitters 40, 41 and the desired water temperature in the hot water container 30 (second set temperature).

[0032] Alternatively, the flow temperature may also be adapted automatically based on the outdoor temperature (ambient temperature) and/or the room temperature in the room to be heated. That is, if the outdoor temperature decreases the flow temperature is increased and vice versa and/or if the low temperature is too high for the room to be heated resulting in a high cycling ratio between supply and nonsupply of heating fluid to the heat emitter the flow temperature is decreased and vice versa.

[0033] In operation, the control via the sensors 60, 63 detects the flow temperature of the heating fluid leaving the indoor unit

[0034] as a first actual temperature and the temperature of the hot water in the hot water container 30 as a second actual temperature.

[0035] Based on the first set and second set temperature and the first and second actual temperature the control determines a first demand of the heat emitters 40, 41 and a second demand of the hot water container 30. This calculation or determination may include the difference between the first set and the first actual temperature and the difference between the second set and actual temperature. Also other parameters such as may influence the result of the first and the second demand. These parameters may be selected from the group of field settings which can be selected by the installer.

[0036] If only the heat emitters 40, 41 or the hot water container 30 demand heat, i.e. that the heating fluid is supplied to either the heat emitters 40, 41 or the hot water container 30, this demand is satisfied. If both the heat emitters 40, 41 and the hot water container 30 demand heat, the control compares the first and the second demand and depending on which demand is higher serves the heat emitters 40, 41 or the hot water container 30. I.e. if the first demand is higher, the valve 32 switches to the first position supplying heating fluid to the heat emitters 40, 41 via piping 35. In case the second demand is higher than the first demand, the valve 32 switches to the second position supplying heating fluid via piping 31 to the hot water container 30 passing the heating coil inside the hot water container 30 being refed via piping 32 and 36 to the indoor unit, whereby the hot water in the hot water container 30 is heated by transfer of heat from the heating fluid flowing through the heating coil to the water in the container.

[0037] If a user selects a priority mode via the input device (not shown) of the described heating installation, the control changes from the above described demand dependent mode to a priority mode, wherein the user has to set a priority, either for heating the rooms, i.e. supplying heating fluid to the heat emitters 40, 41 or the hot water in the hot water container 30, i.e. supplying heating fluid to the hot water container 30. In addition, the system may comprise a button to select a “boosting mode” which enables to activate the additional heater 33 in the hot water container 30 to quickly heat up the water in the hot water container to quickly obtain the desired temperature (second set temperature). This additional heater 33 may also be activated by means of the control in the demand dependent mode if the first demand is higher than the second demand and the heating fluid is supplied to the heat emitters 40, 41 rather than to the hot water container 30 so as to concurrently obtain the desired water temperature in the water container 30 if the actual temperature measured by the sensor 63 drops below a predetermined value lower than the desired temperature of the hot water in the container (second set temperature).

[0038] Although the present invention has been described with respect to a combined heating and cooling installation, the present invention may also be applied to a heating installation without the cooling capability. In addition, the present invention has been described with respect to heat emitters 40, 41 and a hot water container 30 as first and second object. It is, however, to be understood that the present invention may also be implemented to heat other objects than the above described.

1. A heating installation comprising:
   a heat pump having an evaporator, a compressor, a condenser and an expansion device connected by a refrigerant piping in a cycle;
   a heating fluid piping passing through the condenser to exchange heat between a refrigerant and a heating fluid;
   a first and second objects arranged to be heated by the heating fluid to first and second set temperatures, respectively,
a valve switchable between at least
a first position in which the heating fluid is supplied to
heat the first object and
a second position in which the heating fluid is supplied to
heat the second object;
at least two sensors arranged and configured to detect first
and second actual temperatures at the first and second
objects, respectively, and
a control, in a demand dependent mode,
configured to determine
a first demand based on at least the first set temperature
and the first actual temperature and
a second demand based on at least the second set temperature and the second actual temperature, and
configured to switch the valve to the first position and the
second position based on a comparison of the first and
second demand.

2. The heating installation as set forth in claim 1, wherein
the control is further configured
to switch the valve to the first position if the first demand
is higher than second demand and
to switch the valve to the second position if the second
demand is higher than first demand.

3. The heating installation as set forth in claim 1, wherein
the first object includes at least one heat emitter arranged in
a room to be heated, the heat emitter having an upstream
side thereof connected to the heating fluid piping via the
valve.

4. The heating installation as set forth in claim 3, wherein
the heat emitter includes floor heating loops.

5. The heating installation as set forth in claim 3, wherein
the first actual temperature is an actual flow temperature to
the heat emitter and the first set temperature is a desired
flow temperature to the heat emitter.

6. The heating installation as set forth in claim 1, wherein
the second object includes water contained in a hot water
container, and
a portion of a pipe is connected to a heat exchanger con-
figured and arranged to transfer the heat to the water or
forms the heat exchanger passing through the interior of
the hot water container, the portion of the pipe having an
upstream side connected to the heating fluid piping via
the valve.

7. The heating installation as set forth in claim 6, wherein
the second actual temperature is an actual water tempera-
ture of the water contained in the hot water container,
and the second set temperature is a desired temperature
of the water.

8. The heating installation as set forth in claim 1, wherein
the control has an input device arranged and configured to
select between the demand dependent mode and a pri-
ority mode in which a priority is manually set with
respect to the first object or the second object.

9. A method for controlling a heating installation, which
includes:
a heat pump having an evaporator, a compressor, a con-
denser and an expansion device connected by a refriger-
ating piping in a cycle;
a heating fluid piping passing through the condenser to
exchange heat between a refrigerant and a heating fluid;
first and second objects arranged to be heated by heat of
the heating fluid to first and second set temperatures, respec-
tively, the method comprising:
detecting first and second actual temperatures of the first
and second objects, respectively;
calculating
a first demand based on at least the first set temperature
and the first actual temperature and
a second demand based on at least the second set tem-
perature and the second actual temperature;
comparing the first and second demands; and
heating either the first object or the second object based on
the comparison.

10. The method as set forth in claim 9, wherein
the first object is heated when the first demand is higher
than second demand, and the second object is heated
when the second demand is higher than first demand.

11. The method as set forth in claim 9, wherein
the first object includes a heat emitter arranged in a room to
be heated, and
the first actual temperature is an actual flow temperature to
the heat emitter in the room and the first set temperature
is a desired flow temperature to the heat emitter.

12. The method as set forth in claim 9, wherein
the second object includes water contained in a hot water
container, and
the second actual temperature is an actual water tempera-
ture of the water contained in the hot water container,
and to be heated and the second set temperature is a
desired temperature of the water.

13. The method as set forth in claim 10, wherein
the first object includes a heat emitter arranged in a room to
be heated, and
the first actual temperature is an actual flow temperature to
the heat emitter in the room and the first set temperature
is a desired flow temperature to the heat emitter.

14. The method as set forth in any one of claims 10, wherein
the second object includes water contained in a hot water
container, and
the second actual temperature is an actual water tempera-
ture of the water contained in the hot water container,
and the second set temperature is a desired temperature
of the water.

15. The method as set forth in any one of claims 11, wherein
the second object includes water contained in a hot water
container, and
the second actual temperature is an actual water tempera-
ture of the water contained in the hot water container,
and the second set temperature is a desired temperature
of the water.

16. The heating installation as set forth in claim 2, wherein
the first object includes at least one heat emitter arranged in
a room to be heated, the heat emitter having an upstream
side thereof connected to the heating fluid piping via the
valve.

17. The heating installation as set forth in claim 2, wherein
the second object includes water contained in a hot water
container, and
a portion of a pipe is connected to a heat exchanger con-
figured and arranged to transfer the heat to the water or
forms the heat exchanger passing through the interior of
the hot water container, the portion of the pipe having an
upstream side connected to the heating fluid piping via
the valve.
18. The heating installation as set forth in claim 2, wherein the control has an input device arranged and configured to select between the demand dependent mode and a priority mode in which a priority is manually set with respect to the first object or the second object.

19. The heating installation as set forth in claim 3, wherein the second object includes water contained in a hot water container, and a portion of a pipe is connected to a heat exchanger configured and arranged to transfer the heat to the water or forms the heat exchanger passing through the interior of the hot water container, the portion of the pipe having an upstream side connected to the heating fluid piping via the valve.

20. The heating installation as set forth in claim 3, wherein the control has an input device arranged and configured to select between the demand dependent mode and a priority mode in which a priority is manually set with respect to the first object or the second object.

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