

Heating system with optimized recovery of waste water heat

The present invention relates to a heating system with recovery of waste water heat, of the type comprising a heat pump, a waste water holding vat comprising a casing, defining an internal space for holding the waste water, and a heat exchanger to recover
5 calories in the holding vat and use them in the heat pump.

FR-A-2 885 406 describes a heating system with recovery of waste water heat comprising a waste water holding vat ensuring a vertical heat stratification of the waste water and a heat pump whereof the evaporator is incorporated into the holding vat, and receives waste water coming from the hottest part of the waste water from the holding vat.

10 Nevertheless, the volume of the holding vat is substantial.

One aim of the invention is to provide a heating system with recovery of waste water heat having a small bulk, while offering a high energy output.

To that end, the invention relates to a heating system of the aforementioned type, characterized in that the holding vat comprises at least one baffle extending in the holding
15 space and dividing the holding vat into a plurality of compartments and defining, with the casing, a waste water flow path that bypasses the baffles and passes into the compartments, the heat exchanger being positioned so as to recover calories in at least two compartments.

According to specific embodiments, the heating system according to the invention
20 includes one or several of the following features, considered alone or according to all technically possible combinations:

- the waste water flow path passes into each compartment, successively;
- at least one baffle comprises a free edge delimiting, with the casing, a waste water flow passage;
- 25 - the holding vat comprises at least one first baffle and at least one second baffle arranged head to tail;
- at least one baffle is horizontal or vertical;
- the exchanger is formed in at least one baffle including an internal coolant flow conduit;
- 30 - the internal conduit forms a circuit comprising several parallel segments with opposing flow directions;
- the system comprises at least two baffles provided with internal conduits serially connected to form the exchanger;
- the heat pump comprises an evaporator and a condenser connected by a
35 primary circuit for the flow of a refrigerant, and a secondary circuit for the flow of a coolant, connecting the exchanger to the evaporator.

The invention also relates to a heating installation comprising a waste water source, a heating system with recovery of waste water heat, and a heating application such as a central heating circuit or a domestic hot water circuit, the heating application being supplied with calories by the heating system, characterized in that the heating system is as defined above, the waste water source being connected to an inlet of the holding vat.

The invention will be better understood upon reading the following description, provided solely as an example, and done in reference to the appended drawings, in which:

- 10 - Figure 1 is a diagram showing a heating installation comprising a heating system with recovery of waste water heat, according to the invention;
- Figure 2 is a lateral vertical cross-sectional view of a waste water holding vat and a heat exchanger of the heating system of Figure 1;
- Figure 3 is a partial lateral view of the holding vat of Figure 2, in which an
15 insulating layer of the vat has not been shown;
- Figure 4 is a vertical cross-sectional diagrammatic view along line IV-IV of Figure 2;
- Figure 5 is a view similar to Figure 1 of a holding vat of a heating system according to a second embodiment of the invention;
- 20 - Figure 6 is a diagrammatic view illustrating a heat exchanger formed by several baffles inside the holding vat of Figure 5;
- Figure 7 is a cross-sectional view of one of the baffles of Figure 6;
- Figure 8 is a view similar to Figures 2 and 5 of a holding vat of a heating system according to a third embodiment of the invention, the holding vat being provided with a
25 decanting tank; and
- Figure 9 is a diagrammatic view of an exchanger formed by a horizontal baffle inside the holding vat of Figure 8.

Figure 1 illustrates an individual heating installation 2 comprising a heating system 4 with recovery of waste water heat and a heating application 6 supplied with heat by the heating system 4.

The heating application 6 is for example a radiator circuit, for domestic hot water, a heated floor, or a hot air system.

The heating installation 2 also includes one or several sources 8 of lukewarm waste water, receiving waste water for example from a shower, a washing machine, a
35 dishwasher, or a tub.

The heating system 4 comprises a holding vat 10 for holding waste water, supplied by the source 8 and a heat pump 12 using the heat provided by the waste water from the vat 10.

5 The heating installation 2 also comprises a central control unit 7 controlling the heat pump 12 and the final application 6.

The heat pump 12 traditionally comprises an evaporator 14, a compressor 16, a condenser 18 and a pressure regulator 20 serially connected by a primary refrigerant circuit 22.

10 The holding vat 10 includes an internal exchanger 26 and an external exchanger 28 connected in parallel to the evaporator 14 by a secondary flow circuit 30 for the flow of a coolant.

The secondary circuit 30 comprises a pump 30A ensuring the flow of the coolant, a bypass conduit 30B of the exchangers 26 and 28, and a three-way control valve 30C selectively ensuring the closing of the by-pass conduit 30B or the exchangers 26 and 28.

15 The secondary circuit 30 also comprises a control and regulation unit 30D controlling the three-way control valve 30C and the pump 30A, and a temperature sensor 30E for the coolant flowing in the secondary circuit 30. The control and regulation unit 30D receives a temperature measurement signal provided by the temperature sensor 30E, and is connected to the central unit 7.

20 The secondary circuit 30 is also connected to an expansion tank 30F.

The waste water holding vat 10 will now be described in more detail, in reference to figures 2 to 4.

25 The vat 10 empties by overflowing: the water enters the vat 10 and emerges from it by overflowing through an outlet when the level of the water in the vat reaches that of the outlet.

The vat 10 comprises a casing 34 delimiting an inner space 36 for holding waste water, a waste water inlet 38 into the holding space 36, and a waste water outlet 40 from the holding space 36.

30 The casing 34 comprises a cylindrical wall 41 with a horizontal axis, and two vertical walls 42 closing the cylindrical wall 41 at its respective ends. The holding space 36 is delimited by the inner surface of the walls 41 and 42.

The holding space 36 has a length between 1 m and 4 m, preferably between 1.4 m and 2.5 m, and a diameter between 0.4 m and 2 m, preferably between 0.4 m and 1 m. The dimensions are chosen as a function of the final application 6.

The waste water inlet 38 and the waste water outlet 40 are respectively formed in the opposite vertical walls 42, each via an opening passing through the wall 42 and emerging in the holding space 36.

5 The inlet 38 and the outlet 40 are situated in an upper part of the holding vat 10, at a same height.

The height of the outlet 40 in the holding space 36 defines the maximum waste water level in the holding space 36 after which the waste water overflows from the holding space 36 via the outlet 40.

10 The vat 10 comprises a plurality of bypass baffles 44 extending inside the holding space 36. The baffles 44 are arranged so as to modify the direct path of the water between the inlet 38 and the outlet 40, by imposing a winding path bypassing the baffles 44.

The vat 10 comprises several baffles 44 regularly distributed along the axis of the vat 10.

15 The baffles 44 divide the holding space of the vat 10 into a plurality of compartments 46.

Each baffle 44 in fact forms two compartments 46 on either side. In the illustrated example, the vat has three baffles 44 defining four compartments 46.

20 Each baffle 44 is generally plate-shaped, more precisely in the shape of a truncated disc. They each delimit a continuous surface.

Each baffle 44 comprises a junction edge 48 with the casing 34, with a shape complementary to the casing 34, and a free edge 50 defining a flow passage 52 with the casing 34. The edge 50 is horizontal.

The flow passages 52 are situated at a level lower than the waste water outlet 40.

25 The baffles 44 are parallel to each other and are arranged head-to-tail in an alternating manner. The baffles 44 are vertical. The flow passages 52 are alternatively formed in the bottom and in the upper portion of the holding space 36.

30 In the illustrated example, one of the baffles 44 extends protruding upwards from the bottom of the casing 34 while two other baffles 44 are arranged on either side and extend protruding downwards from the top of the casing 34.

The baffles 44 delimit, with the casing 34, a waste water flow path from the inlet 38 towards and up to the outlet 40. The flow path passes successively into each compartment 46. It comprises several changes of direction of the waste water flow, to bypass the baffles 44.

35 These changes of direction are, in the illustrated example, between 90° and 180°.

The volume of the vat 10 is more than 20 times the passage section per unit of length of the inlet and outlet conduits, preferably greater than or equal to 40 times.

In the illustrated example, this ratio is 45.

5 The travel time of the waste water along the flow path is therefore equivalent to the flow time of the waste water in a conduit with a passage section identical to the inlet 38 and the outlet 40, and the length of which is 45 times greater.

The heat exchangers 26 and 28 are arranged to recover calories in the holding vat 10. The exchangers 26 and 28 are connected in parallel to the secondary circuit 30 and each have a manual control valve 58 for regulating the flow.

10 The internal exchanger 26 comprises a plurality of conduits 60 extending inside the holding space 36.

Each conduit 60 successively passes through each of the compartments 46. The internal exchanger 26 is thus able to recover calories in each of the compartments defined by the baffles 44.

15 The conduits 60 are connected in parallel. They are also arranged parallel to each other.

Each conduit 60 comprises two vertical sections 62 and a horizontal section 64 connecting the two vertical sections 62 at their lower ends. Each conduit 60 thus forms a U.

20 The horizontal section 64 extends into the bottom of the vat 10, over substantially the entire length of the vat 10. The horizontal section 64 extends into the flow passages 52 defined by the upper baffles 44 and passes through the lower baffle 44.

The external exchanger 28 comprises a helical conduit 66 extending in a helix around the casing 34, over substantially the entire length of the casing 34.

25 The external exchanger 28 is arranged in an insulating layer 68 surrounding the external casing 34. The insulating layer 68 prevents heat losses from the vat 10.

The holding vat 10 also includes two access panels 72 arranged in the vertical walls 42 of the outer casing 34, respectively.

30 The diameter of the access panels 72 is substantial, in the vicinity of half of the diameter of the vat 10, for easy cleaning.

Lastly, the holding vat 10 is provided with a temperature sensor 73 and a water level sensor 74 connected to the central control unit.

The operation of the invention will now be described.

The starting up of the heating installation 2 is done using the central control unit 7.

35 The central control unit 7 sends a start-up signal to the final application 6, the heat pump 12, and the control and regulation unit 30D of the secondary circuit 30.

The control and regulation unit 30D controls the pump 30A and the three-way control valve 30C as a function of the control signals supplied by the central unit 7 and/or the temperature value provided by the temperature sensor 30E.

Alternatively, the control and regulation unit 30D also controls the control valves 58
5 for regulating the flow of the exchangers 26 and 28.

The flow of the coolant in the exchangers 26 and 28 heats the coolant. The coolant passes through the evaporator 14 while transferring heat to the refrigerant. The latter cools in the condenser 18 while supplying heat for the final application 6.

For safety and energy savings reasons, the central control unit 7 stops the
10 installation if the temperature value supplied by the temperature sensor 73 of the vat 10 is too low and/or if the water level sensor 74 detects an excessively low water level in the vat 10.

With the invention, the baffles 44 impose a flow path on the waste water in several compartments 46, successively, from which the exchangers 26 and 28 recover the heat.
15 The waste water arriving through the inlet is forced to pass into each compartment 46, which ensures a significant recovery of the heat from that waste water by the exchangers 26 and 28. The energy output of the installation 2 is high. The volume necessary for the holding vat 10 is low.

The length of the flow time of the waste water around the baffles 44 ensures
20 optimal recovery of their heat by the exchangers 26 and 28.

The baffles 44 prevent a vertical heat stratification of the waste water in which the hottest water would be found in the upper portion of the vat 10, which would lead to an excessively fast flow of the hottest water.

Moreover, the baffles 44 do not cause a risk of obstructing the vat 10.

25 The arrangement of the exchangers 26 and 28 ensures a significant surface area of the heat exchanger with the waste water present in the holding vat 10.

The emptying of the vat 10 by overflowing limits the risk of obstruction of the vat 10. Indeed, the presence of a control valve 10 at the outlet 40 is pointless. The vat is reliable.

30 Moreover, the risk of obstruction of the outlet 40 by an aggregate of particles is very low.

The use of a secondary flow circuit 30 for a coolant connecting the exchangers 26 and 28 to the evaporator 14 makes it possible to adapt the holding vat 10 to preexisting heat pumps 12.

35 Moreover, the heat pump 12 is removable without intervention on the holding vat 10, which facilitates the assembly and maintenance operations of the installation 2.

Alternatively, the heating installation 2 is that of a building.

Figures 5 to 7 illustrate a heating system 4 according to a second embodiment of the invention whereof the only differences relative to the first embodiment will be described below. In Figures 5 to 7, the elements similar to the first embodiment are
5 designated using identical reference numbers.

The heating system 4 according to the second embodiment is essentially different due to the holding vat 10. The internal exchanger 26 and the external exchanger 28 have been replaced by a single exchanger 76 formed by the baffles 44 of the vat 10.

Indeed, as illustrated in Figures 6 and 7, each baffle 44 delimits an internal conduit
10 78 for the flow of a coolant.

The internal conduit 78 itself comprises baffles making it possible to impose a long path and a long flow time on the coolant in the internal conduit 78, favoring heat exchanges.

The inlet of each conduit 78 of each baffle 44 is connected to the outlet of the
15 adjacent baffle 44. The baffles 44 are thus serially connected to form the exchanger 76.

The baffles 44 are fastened in openings 79 formed in the cylindrical wall 41 of the casing 34, and connected to each other outside the casing 34.

Moreover, the number of baffles 44 has been increased. The number of baffles 44 is henceforth such that the passage section of the flow path of the waste water between
20 the baffles 44 is substantially constant in the vat 10.

The exchange surface of the exchanger 76 is very substantial.

Figures 8 and 9 illustrate a heating system 4 according to a third embodiment of the invention, in which the only differences relative to the second embodiment of the invention will be described below. Identical reference elements designate similar
25 elements.

The heating system 4 according to the third embodiment essentially differs from the heating system 4 according to the second embodiment in that the vat 10 comprises horizontal baffles imposing a winding path on the bottom of the vat 10 towards the outlet 40 at the top of the vat 10 and in that the vat 10 includes a tank 82 for decanting the waste
30 water.

The horizontal baffles 44 have a contour complementary to the casing 34. They thus have a general rectangular contour, which facilitates their production.

Certain horizontal baffles 44 have an internal conduit 78 and form the exchanger 76.
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In the illustrated example, only every other horizontal baffle 44 forms the exchanger 76, the other horizontal baffles 44 not having a coolant flow conduit and being

arranged so as to alternate with the baffles 44 forming the exchanger 76. This reduces the bulk of the vat 10 as well as the cost of the exchanger 76. Nevertheless, alternatively, each horizontal baffle 44 forms the exchanger 76.

Moreover, as illustrated in figure 9, the baffles 44 include a through orifice 80
5 forming a waste water flow passage 52.

The decanting tank 82 is arranged in the bottom of the vat 10. It is arranged on the waste water inlet 38 side.

The decanting tank 82 converges downwards, more precisely is downwardly conical. The reservoir 82 has, at its lower end, an outlet gate 84.

10 The vat 14 includes a vertical inlet baffle 86 forcing the waste water entering the vat 10 to descend towards the bottom towards the tank 82, before coming back up towards the outlet 40 while following the path defined by the horizontal baffles 44.

The operation of the decanting tank 82 is simple. To clean the vat 10, one need only open the outlet gate 84. The particles accumulated in the tank 82 are then
15 discharged.

The decanting tank 82 facilitates maintenance operations.

The arrangements of the tank 82 and the baffles 86 and 44 improve the guiding of the particles present in the waste water towards the tank 82. These arrangements also limit particles rising back up.

CLAIMS

1.- A heating system (4) with recovery of waste water heat, of the type comprising:

- a heat pump (12);

5 - a waste water holding vat (10) comprising a casing (34) defining an internal space (36) for holding the waste water; and

- a heat exchanger (26, 28; 76) to recover calories in the holding vat (10) and use them in the heat pump (12);

10 characterized in that the holding vat (10) comprises at least one baffle (44) extending in the holding space (36) and dividing the holding vat (10) into a plurality of compartments (46) and defining, with the casing (34), a waste water flow path that bypasses the baffles (44) and passes into the compartments (46), the heat exchanger (26, 28; 76) being positioned so as to recover calories in at least two compartments (46).

15 2.- The heating system (4) according to claim 1, wherein the passage section of the waste water flow path between the baffles is substantially constant.

3.- The heating system (4) according to any one of the preceding claims, wherein the waste water flow path passes into each compartment (46), successively.

20 4.- The heating system (4) according to claim 1 or 2, wherein at least one baffle (44) comprises a free edge (50) delimiting, with the casing (34), a waste water flow passage (52).

25 5.- The heating system (4) according to any one of the preceding claims, wherein the holding vat (10) comprises at least one first baffle (44) and at least one second baffle (44) arranged head to tail.

30 6.- The heating system (4) according to any one of the preceding claims, wherein at least one baffle (44) is horizontal or vertical.

7.- The heating system (4) according to any one of the preceding claims, wherein the exchanger (76) is formed in at least one baffle (44) including an internal coolant flow conduit (78).

35 8.- The heating system (4) according to claim 7, wherein the internal conduit (78) forms a circuit comprising several parallel segments with opposing flow directions.

9.- The heating system (4) according to claim 7 or 8, comprising at least two baffles (44) provided with internal conduits (78) serially connected to form the exchanger (76).

5 10.- The heating system (4) according to any one of the preceding claims, wherein the heat pump (12) comprises an evaporator (14) and a condenser (18) connected by a primary circuit (22) for the flow of a refrigerant, and a secondary circuit (30) for the flow of a coolant, connecting the exchanger (26, 28; 76) to the evaporator (14).

10 11.- A heating installation (2) comprising a waste water source (8), a heating system (4) with recovery of waste water heat, and a heating application (6) such as a central heating circuit or a domestic hot water circuit, the heating application (6) being supplied with calories by the heating system (4), characterized in that the heating system (4) is according to any one of the preceding claims, the waste water source (8) being
15 connected to an inlet (38) of the holding vat (10).