Heating system with two symmetrically constructed intermediate storage means.
Figure 1: Conventional heating system for service water heating with heat pump, prior art

Figure 2: Heating system with two symmetrically constructed intermediate storage means
Figure 3: Heating system with two symmetrically constructed intermediate storage means, illustration of optimized line routing.

Figure 4: Heating system with two symmetrically constructed intermediate storage means and with heat exchanger WT for heat transmission to a drinking water circuit.
SYMMETRICAL INTERMEDIATE STORAGE MEANS FOR HEAT PUMPS WITH CYCLICAL DRAINAGE INTO A MAIN SYSTEM

PRIOR ART

[0001] Heat pumps are at the present time sometimes connected [1, 2, 3] to a buffer store. Depending on the set-up, heating water or (by means of a heat exchanger) service water can be extracted from the buffer store. Heat pumps at the present time operate predominantly with a temperature spread of approximately 5 to 10 K. Within this spread, the buffer store is brought to a desired setpoint temperature. It is clear that the overall buffer store, at the end of a charge phase of the heat pump, is brought to a high average temperature. The store is fully heated [4].

[0002] FIG. 1 shows the set-up of a conventional heating installation with a heat pump for service water heating [5]. The heat pump discharges heat to the service water store by means of the heat transfer medium and in a heat exchanger which is located here in the service water store. In this case, the entire store is heated up cyclically to the level of use. Hot service water can be extracted in the upper region of the store. In the event of extraction, cold water flows in in the lower region of the store. If the heat pump is in operation simultaneously with tapping or if the water store is partially unloaded, cold water enters the heat pump and is introduced, only slightly heated, into the upper hot region of the buffer store. The progressive stratification in the water store is in this case destroyed during the further charging operation. In this case, exergy is nullified, and the system work coefficient falls.

[0003] Recently, intermediate storage means have been proposed which allow a relatively mix-free charging operation of the store [6, 7]. These systems have solved the following problems:

[0004] 1. In the introduction of layering into a service water store, the heated water regions are not intermixed with the colder water layers. Exergy nullification occurs to a greatly reduced extent.

[0005] 2. The heating operation, that is to say until heat storage medium at a useful temperature level is available again in the upper part of the buffer store after tapping, is very short.

[0006] 3. Normally cold heat transfer medium is located in the lower part of the buffer store. When the buffer store is in bivalent operation in conjunction with other energy generation installations, such as condensing boilers or a solar installation, this state has a positive effect upon the system efficiencies of said subsystems.

[0007] 4. The buffer store can be operated at a low mean temperature without loss of comfort, this leading to low heat losses due to the heat insulation of the buffer store. The system work coefficient can rise overall by 20% to 30%.

[0008] The disadvantage of the systems shown is that, in some of the systems, colder water is located above warmer water in the intermediate storage means for short times, and this state may lead to unwanted and exergy-nullifying, hence disadvantageous intermixing of the cold and warm water. Systems shown in [5] and [6], in which intermixing does not occur, have a complicated set-up and require a multiplication of valves.

Problems to be Solved

[0009] The object of the invention is to provide a system of a heat pump and intermediate storage means, the system having a simple set-up and warmer heat transfer medium always being located above colder heat transfer medium in the intermediate storage means.

Cyclical Intermediate Storage Means with a Symmetrical Set-Up

[0010] To solve said problem areas, the use of two intermediate storage means in installations with heat pumps or refrigerating machines is proposed, the intermediate storage means receiving heat transfer medium, mostly water. The heat transfer medium is pumped alternately from intermediate storage means 1 and 2 into the remaining system, for example a buffer store. During this pumping operation, cold water is pumped out of the remaining system into the intermediate storage means.

[0011] While the one store discharges the heat transfer medium to the remaining system, the contents of the other store are heated by the heat pump. The temperature spread in the heat pump circuit is in this case very low and the volume flow is very high in comparison with the temperature rise and volume flow of the remaining system. These boundary values are advantageous for the efficiency of both subsystems.

[0012] The intermediate storage means are arranged such that they make it possible to control the temperature of the heat transfer medium located in the intermediate storage means and can discharge this heat transfer medium into the remaining system after temperature control. Discharge to the remaining system, for example into a service water store, thus takes place, as required, alternately from intermediate storage means 1 and 2. It may be pointed out expressly here that temperature control also means cooling, that is to say the invention also applies to the case of cold generation, in which case the position of the loading and unloading connection pieces in the event of cooling must be in an interchanged arrangement, that is to say loading by the refrigerating machine is arranged at the bottom and unloading into the remaining system is arranged at the top. In this way it is ensured that, at any time, colder heat transfer medium is located beneath warmer heat transfer medium and temperature stratification remains stable in the intermediate storage means.

Operation of the Systems with Two Symmetrical Intermediate Storage Means

[0013] If the entire temperature-controlled water is brought from the intermediate storage means 1 into the remaining system, the valves are switched again such that the intermediate storage means 1 can be temperature-controlled once again by the heat pump. Care must be taken to ensure that the store involved are designed such that loading, storage (advantageously with stratification) and unloading which are as mix-free as possible are possible. For example, baffle plates may be used in order to prevent turbulence and intermixing.

[0014] During the unloading of the intermediate storage means into the remaining system, heat transfer liquid with the desired temperature and, in comparison with conventional systems without intermediate storage means, with a markedly reduced mean volume flow is transferred. The result of a high temperature and low volume flow is that:

[0015] 1. stratification in the main store, present if appropriate, is maintained during the operation of the system

[0016] 2. hot heat transfer medium is available even after a short time

[0017] 3. further energy-generating installations in the system, such as, for example, condensing boilers or solar
installations, can operate with higher efficiency, since cold heat transfer medium is located in the lower region of the main store,

4. the thermal losses of the main store are reduced,

5. the work coefficient of the system rises by 20% to 30%.

To make clear the position and function of the intermediate storage means and of a following system, FIG. 2 illustrates a heating system with a heat pump and two symmetrical intermediate storage means for service water heating. Nonreturn valves prevent intermixing of the two circuits. Controllers and further necessary components are not depicted in the figures. In systems with heating tie-up (not depicted), depending on requirements, the intermediate storage means either is heated up to the desired service water temperature and then pumped into the service water store or the intermediate storage means is heated up to the desired room heating temperature and then pumped into the heating buffer store. For this purpose, a regulating unit determines the demand for service water heating and room heating and controls the corresponding valves.

FIG. 3 shows a set-up in which the arrangement of the pipe lines is optimized. In this set-up, hot water which is located in the pipe lines from the heat pump to the intermediate storage means is pumped into the service water store, not mixed with cold water, as in FIG. 2. Exergy nullification is lowered even further as a result of this arrangement.

The proposed intermediate storage means may be integrated directly into the heat pump in new installations. However, retrofit kits for old installations are also commercially available. Advantageous forms of construction of the intermediate storage means, valve regulations and other structural aspects have already been described in [6] and [7]. The regulation of the valve changeover arises logically from the functioning of the system.

literature


[0024] 6) Löffler, Michael: Speicher für Wärmepumpen mit zyklischer Entleerung in ein Hauptsystem [Store for heat pumps with cyclical drainage into a main system], KI 2008


description of the claims and figures

claim 1 describes the basic use of two symmetrically arranged intermediate storage means in conjunction with a heat pump for controlling the temperature of a heat transfer medium and for conveying the temperature-controlled heat transfer medium into a remaining system which in most cases is a heating installation.

claim 2 contains a temperature control system with a heat pump and two intermediate storage means, the temperature-controlled medium being pumped into a buffer store after temperature control, the buffer store advantageously allowing temperature stratification.

claim 3 relates to a system with a heat pump and intermediate storage means, the heated heat transfer medium being pumped after heating from an intermediate storage means into a service water store, heating store or combined store. This system serves for supplying heat to buildings and, if appropriate, for supplying hot service water.

claim 4 relates to the throughflow direction in the intermediate storage means. The flow passes through the intermediate storage means from the top downward during the loading of these and from the bottom upward during unloading. This takes place conversely in the case of operation with a refrigerating machine, that is to say from the bottom upward during the loading of the intermediate storage means with cold heat transfer liquid and from the top downward during unloading to the remaining system.

claim 5 shows the set-up of a conventional heating system for service water heating with the heat pump. The heat pump heats the heat transfer medium. The heat transfer medium discharges the heat to the service water by means of a heat exchanger which is located here in the service water store. In this case, the entire store is heated up to the level of use. Hot water can be extracted in the upper region of the store. In the event of extraction, cold water flows in in the lower region of the store.

claim 6 shows the set-up of a heating system according to the invention with the heat pump and two intermediate storage means. In a first stroke, V1 and V3 are opened and V2 and V4 are closed. The intermediate storage means I is loaded via the heat pump with a high volume flow and a low spread. At the same time, the intermediate storage means 2 is unloaded into the main store with a low volume flow, cold water flowing from the main store back into the intermediate storage means 2 via a nonreturn valve R2. In the second stroke, V2 and V4 are opened and V1 and V3 are closed. The role of the intermediate storage means is thereby interchanged: intermediate storage means 1 is then unloaded and the intermediate storage means 2 is loaded.

claim 7 shows basically the same set-up as in FIG. 2, the pipe routing being optimized. Hot water which is located between the heat pump and intermediate storage means is pumped into the buffer store during the changeover of valves in FIG. 3. In FIG. 2, the hot water is, by contrast, intermixed with cold water, this corresponding to exergy nullification, albeit low.

claim 8 shows the set-up of a system for service water heating with a heat exchanger WT. The heated water from the intermediate storage means discharges its heat to the drinking water via a heat exchanger WT. In the set-up, a further water pump P3 is required on account of the drinking water circuit. The heat exchanger WT operates with very high efficiency on account of the low volume flow.

1. A set-up of a temperature control system with a heat pump or refrigerating machine, with a first intermediate storage means, a second intermediate storage means, valves and a control and with a remaining system which is supplied with
temperature-controlled heat transfer liquid, characterized in that the two intermediate storage means can be connected by means of the valves selectively and alternately to the heat pump or the refrigerating machine or else to the remaining system.

2. The functioning of a temperature control system with the set-up as claimed in claim 1, characterized in that the heat pump/refrigerating machine, in a first stroke, beams the heat transfer medium in the intermediate storage means 1 to a desired temperature level, while the intermediate storage means 2 discharges already heated/COOLED heat transfer medium to a remaining system, and the heat pump/refrigerating machine, in a second stroke, brings the heat transfer medium in the intermediate storage means 2 to a desired temperature level, while the intermediate storage means 1 discharges already heated/COOLED heat transfer medium to a remaining system, this then being followed again by stroke 1 in the case of a heating/cooling demand.

3. The functioning of a temperature control system with a heat pump as claimed in claim 1, characterized in that the remaining system contains a heating installation with a store, into which temperature-controlled heat transfer medium is pumped from the intermediate storage means, the buffer store of the remaining system preferably allowing stratified heat storage.

4. The set-up of a temperature control system with a heat pump as claimed in claim 1, characterized in that the overall system comprises an installation for service water heating and/or room heating.

5. The functioning of a temperature control system with a heat pump as claimed in claim 1, characterized in that the flow passes through intermediate storage means in opposite directions during loading and unloading, the loading of the intermediate storage machines in the case of heat pumps taking place from the top downward and in the case of refrigerating machines taking place from the bottom upward.

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