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(54) **Eljárás és készülék igény szerinti hőellátásra egy fűtőberendezésben**

METHOD AND DEVICE FOR DEMAND-DRIVEN HEAT PROVISION IN A HEATING SYSTEM

The invention relates to a method for demand-driven heat provision in a heating system, to which a pre-specified thermal power is provided in accordance with an external reference variable, wherein the thermal power provided additionally depends on the heat requirement of the heating system, by the dependence on the external reference variable being such as to take into account correction values. The invention further relates to a corresponding device, which is in particular designed for carrying out this method.

A demand-driven heat provision can in particular be used in heating systems with a thermostatic, electronic and/or manual single-room temperature control system for adapting the supply temperature and/or the mass flow of the heat-transfer medium used for heating, in order to create a heating system, which is optimally adapted to the total heat requirement of a building. In heating systems of this type, the heat for heating is typically generated or provided centrally and transferred in a decentralized manner, particularly on a room-by-room basis. Water is conventionally used in as heat-transfer medium. The power adaptation of the central heating supply takes place by means of a change of the supply temperature and/or the mass flow of the heat-transfer medium.

In currently operated heating systems for the heat supply of buildings, the desired value of the supply temperature of the heat-transfer medium also termed heating agent, is overwhelmingly managed in accordance with the external temperature on the basis of a stationary, linear or non-linear heating travel curve. Examples for such heating travel curves are illustrated in Fig. 1.

If, in addition to the external temperature as external reference variable, no further reference variables are taken into account for specifying the supply temperature, this heating control generally leads to a significant difference between the currently provided thermal power and the actual, current building thermal requirement. The consequence is typically system or supply temperatures, which are too high or too low, that is to say not adapted to the requirement, which results, for the widespread case in practice of excessive system temperatures as a consequence of heating travel curves that have been set to be too high, both in unnecessary heat distribution losses and overheating states of the rooms, which entail a clear and unnecessary increased energy consumption. By contrast, system or supply temperatures, which are too low, lead to unsatisfactory heating states of the rooms, that is to say to undesired discomfort.

This disadvantage can be substantially overcome by a demand-orientated correction of the supply temperature or the supply temperature desired value and/or the heating mass flow or the heating volumetric flow. An example for a method and a device for the adaptation of the thermal power in heating systems is explained in detail in WO 03/052536 A2. Provision is made there to obtain a heating-circuit or building-supply state from certain information of the individual heating elements as control variable for a control system upstream of the actual heating control system, which control variable predetermines a desired value and/or correction value for the actual heating control system.

DE 35 37 104 A1 also describes an adaptive heating system.

This and other known methods for correcting the supply temperature pursue the aim of a timely correction of the supply temperature by means of a control system, which reacts directly to detected control deviations. This presumes high-performance information transmission technologies and entails the risk of unstable control systems as a consequence of too large a feedback amplification.

It is therefore the object of the present invention to suggest a possibility for heat-demand-driven correction of the thermal power in heating systems, which can be handled easily and prevents instabilities as a consequence of feedback amplifications, which are too large, in a control system.

This object is achieved with the features of Claims 1 and 12. In the method already explained at the beginning, it is suggested in particular that the correction values are determined in accordance with the external reference variable from a correction curve, which takes account of an average thermal requirement of the heating system. The core idea of the invention therefore lies in transferring from a feed-back control system, which reacts directly to a control deviation for a demand-driven adaptation of the thermal power by means of influence on the supply temperature and/or the heating mass flow of the heating system, to a control, which takes correction values for an external reference variable from a correction curve. This correction curve contains average correction values and therefore takes account of a typical average heat requirement of the actual heating system. The external temperature or a measured value correlated with the external temperature can for example be used as external reference variable, wherein certain correction values are assigned by means of the correction curve to a countable number of reference points in the external reference variable. By means of the transition according to the invention from a rapidly reacting feedback control system to a control with a correction curve adapted to the heating system and the user behaviour, it is possible to dispense with the complex and expensive communication-capable electronic individual room temperature control systems and the correspondingly complicated communication infrastructure, which is required in the known methods for managing the heating supply temperature or the thermal power.

The dispensing with strong control fluctuations in the heating control system to this end contributes to the control system becoming better and more stable as a whole and the regulation of the individual room temperature is also improved. Owing to the heat provision adapted to the demand, the heat output, which is pre-specified by the pipe system and cannot be regulated, is also minimized. Furthermore, the mass flow of the heat-transfer medium is better distributed in the system as a whole, because the valves of the individual heating elements are brought from a almost closed to a medium opening state, which is optimal in terms of control technology. This offers a high possibility for control for the respective individual rooms.

In a simple configuration of the system, the correction values can simply be added to the control values of the heating control system or control in the form of correction control values. Alternatively, correction values read off the correction curves could also be transmitted to the heating control, which determines a corrected control variable therefrom, particularly for the heat generator or - in the case of a district heating system - heat-transfer system. Furthermore, it is possible to calculate and/or save the correction curves directly in the heating control or control system, so that the control value calculation takes place directly in the heating control or control system.

In a simple realisation of the method according to the invention, a logical circuit according to the invention for the adaptation of the demand-driven heat provision and/or a thermal power control system, particularly therefore a control consisting of these elements, can also be integrated into a boiler control system.

According to a further feature of the method according to the invention, provision is made for the correction curve to be a non-stationary, adaptive correction curve that is adapted after specified time periods. The underlying concept consists in detecting the deviations from an optimal thermal power adaptation during a pre-specified time period and, after the end of this time period, analysing, in order to adapt the correction curve. This has the consequence that although the control takes place during this time period using the non-optimally adapted correction curve, the correction curve is adapted subsequently to this time period, so that for the future provision of the thermal power, an improved thermal power adaptation takes place. The adaptation of the correction curve is therefore an iterative process and can in particular be used continuously, in that an adaptation takes place once per day for example. The pre-specified time period would therefore be one day in this case.

The adaptation of the correction curve can take place according to the invention in that, over a pre-specifiable time period, the current heat requirement of the heating system is used as a control variable of a control system, which determines the difference between the current heat requirement and the thermal power or between the current desired value and the actual value of a supply state as control deviation and outputs a current correction value as correction or control variable. The adaptation of the correction curve can to this end take place in particular whilst averaging the current correction values during the pre-specified time period. Therefore, during the pre-specified time period for adapting the correction curve, the control deviations between the current heat demand and the current, actual thermal power (or in terms of control technology: between the desired value and the actual value of the overall supply state) are constantly detected and supplied to a control system, which outputs a current correction value as correction variable, using which a current control variable for the thermal power generation of the heating system could be determined, in order to adapt the thermal power generated to the actual heat requirement. In contrast with a conventional control system, this current control value is not forwarded to the heating control, however, rather only saved internally or within a correction-curve adaptation module and averaged over the pre-specified time period. A correction of the correction curve used can then take place on the basis of this average value, in the simplest case by means of a parallel displacement of the correction curve.

According to a preferred configuration of this adaptation of the correction curve, it is provided however, that an averaging of the external reference variable also takes place over the pre-specified time period, so that the correction curve can in particular be adapted in the region, in which the external reference variable lay during the detection of the control deviations.

To this end, an adaptation of the correction curve weighted with the external reference variable can particularly preferably take place, wherein the adaptation has the largest absolute value around the average value of the reference variable and falls at a greater distance from this average value. The averaging both of the reference variable and the current correction values is not limited to an arithmetic averaging in this case, rather can for example also take place by means of a filtering of these variables or the like.

In order to avoid fluctuations of the correction curve, which are too large, an adaptation of the correction curve can be limited to a pre-specified value range, even if a current and/or averaged correction value lies outside of this value range. By this limitation of the for example daily correction value adaptation to a parametrizable region with a minimum and/or maximum correction value, by which the correction curve is adapted, a particularly high system stability can be achieved.

According to a particularly preferred configuration of the method according to the invention, it is suggested that a plurality of correction curves are provided for various time periods. Thus, it is sensible in particular to provide various correction curves for various times of day, such as morning, midday, afternoon, evening and/or night, and also different types of day, particularly work days and Sunday or a holiday, as the heat requirement may be different depending on the respective user behaviour in these time periods, even if an external reference variable (for example external temperature) is identical.

The suggested method can be implemented particularly easily, in that the correction curve is defined by the provision of correction values at reference points of the external reference value which are fixedly pre-specified or determined in a variable manner in accordance with the gradient of the correction curve. As long as the external reference variable then lies between two reference points, a sensible correction value can be determined by suitable interpolation methods. If the reference variable lies outside of the value range covered by the reference points, it is possible to extrapolate.

In a sensible use for the heating control, the external reference variable is the external temperature or a measured value dependent on the external temperature, for example the resistance of a temperature sensor.

Accordingly, the correction value can correspond to a change of the supply temperature and/or the mass flow of the heating system, which is supplied to the heating directly as a correction value or converted as a control variable for the control of the heat generator or heat-transfer system.

Furthermore, the invention relates to a device for the demand-driven heat provision, in particular designed for carrying out the previously described method with all of the features thereof, in a heating system, with a logic circuit for specifying correction values which take into account the heat requirement of the heating system, wherein the logic circuit comprises a correction module with a memory for storing one or a plurality of correction curve(s), an input for entering at least one external reference variable and an output for outputting a correction value. In order to achieve a high stability in the thermal power adaptation and to prevent large control fluctuations in the heating control system, it is provided according to the invention that a correction module with an input for entering the current heat requirement of the heating system is provided, which is designed to determine a current correction value from the current heat requirement, and that the correction curve adaptation module is designed to determine the correction value from a correction curve in accordance with the external reference variable and to adapt the correction curve. As a result, a direct access of the current correction value to the heating control system, which may if appropriate lead to high control fluctuations, is avoided. Instead, the current correction value is used, in order to correct the correction curves, which then pre-specify the correction value acting on the heating control system.

Preferably, to adapt a correction curve, the external reference variable and a current correction variable are averaged over a pre-specified time period and the correction curve is correspondingly adapted. In addition to the external reference variable, which is called upon directly for determining the control variable, further inputs for reference variables can be provided, which enable a selection of various correction curves. Such further reference variables can for example be the time of day and the type of day, so that various correction curves can be used for various time-of-day intervals (morning, midday, evening, night, etc.) and various types of day (work day, Sunday and holiday, etc.) and correspondingly adapted.

The correction module can in this case realise all of the features related to the previously described method. In particular, to determine current correction values from the current heat requirement of the heating system, a control system can be provided, the control result of which is not called upon directly as control variable for the heat generator or transmitted, however, but rather is only used for the adaptation of the correction curve.

Further features, advantages and use possibilities of the invention also result from the following description of an exemplary embodiment and the drawing. All described and/or pictorially illustrated features form the subject of the present invention per se or in any desired combination, even independently of their summarisation in the claims or back references thereof.

In the figures:

Fig. 1 shows typical heating travel curves of a heating control;

Fig. 2 shows a signal flow plan for the demand-driven heat provision according to a first embodiment of the present invention;

Fig. 3 shows a signal flow plan for the demand-driven heat provision according to a second embodiment of the present invention;

Fig. 4 shows a first correction curve according to the present invention;

Fig. 5 shows a second correction curve according to the present invention; and

Fig. 6 shows a comparison of two correction curves before and after a current adaptation.

Fig. 1 shows typical heating travel curves, which pre-specify the desired value of the heat-transfer-medium supply temperature in accordance with the external temperature as external reference variable, which desired value of the heat-transfer-medium supply temperature is transmitted to a heat generator or heat-transfer system as an input variable of the heating power control system. It is to be expected that the desired value of the heat-transfer-medium supply temperature is highest at low external temperatures and is continuously reduced with increasing external temperature. This applies both for linear and non-linear heating travel curves (heating curves), for which various examples are illustrated in Fig. 1.

In the signal flow plan for a heating control or control system 1 shown in Fig. 2, the heating travel curve used is implemented in the thermal power control system 7, which pre-specifies the actuating variable U_{HZG} for a heat generator or transfer system 8 using the external temperature ϑ_A and if appropriate taking account of a mass flow $\dot{m}$ and/or a supply temperature ϑ_{HVL} of the heat-transfer medium. The heat generator or heat-transfer system 8 supplies the heating system 2 with a satisfactory heating power $\dot{Q}_{TH}$, so that in the heating system 2, a suitable mass flow $\dot{m}$ of the heat-transfer medium or heating agent with the desired supply temperature ϑ_{HVL} can be output to the heating elements of connected room temperature control systems 3. After outputting the required heat quantity, the heat-transfer medium returns back to the heating system 2 with a return temperature ϑ_{HRL}.

The room temperature control systems 3 set the desired temperature in the respective rooms by regulating the travel positions of control valves of the heating elements for example. These individual room control systems 3 in this case take account for example of the external temperature ϑ_A and the solar thermal power $\dot{Q}_S$ and internal thermal power $\dot{Q}_I$, which are to be termed heat yields. The input variables, on the basis of which the room temperature control systems 3 control the temperature in the rooms to be heated, are not decisive for the present invention however. Therefore, the present invention is suitable for any type of connected room temperature control systems 3, which can also alternatively or additionally depend on other input variables.

Each room temperature control system 3 transmits information I for determining the heat requirement to a module for heat requirement or thermal power analysis 4, which determines an instantaneous or averaged heat requirement DQ therefrom. To this end, the information I, as described in WO 03/052536 A2, can be the travel positions or valve positions of the individual heating elements of the room temperature control systems, from which a heating-circuit or building supply state is determined for the heat requirement. Alternatively, as described in DE 10 2004 049 112 A1, a supply state can also be determined from at least two heating surface temperature values and/or a volumetric flow value $\dot{m}$. However, the invention is not limited to the previously mentioned methods for determining a heat requirement, rather it can basically be used in all heating systems, in which a heat requirement can be determined from measured values determined in rooms to be heated by the heating system 2. Thus, the heating-circuit-supply and/or heating-circuit-return temperature ϑ_{HVL} or ϑ_{HRL} can for example be used as input variables of the module for heat-requirement or thermal-power analysis 4.

This heat requirement DQ determined for the building or a heating circuit in a certain situation is supplied to a module with a circuit 5 for supplying correction values, which together with the thermal-power control system 7 forms a control 6 for the pre-specification of the actuating variable U_{HZG}. In this case, further input variables, such as in particular the thermal requirement desired value DQ_S, the current supply temperature ϑ_{HVL} and/or the current mass flow $\dot{m}$, are taken into account by the control 6.

The interaction of the circuit 5 for the pre-specification of correction values, which makes up the core of the invention, with the thermal-power control system 7 in the context of the control 6 is clarified in the enlargement of Fig. 2 which is described in detail in the following.

A control deviation of the thermal requirement Δ_{DQ}, which is also termed thermal requirement for simplicity in the following, is determined in a difference module 9 from the instantaneous thermal requirement DQ determined by the module 4 for thermal-requirement analysis, and a pre-specified thermal-requirement desired value DQ_S. This control deviation Δ_{DQ} is supplied to a correction module 11, which determines a current correction value DXS_{AKT} therefrom. To this end, the correction module 11 has control and filter functions, which are suitably parametrized. In particular, the correction module can therefore be constructed in the form of a conventional control system, which determines a current correction value DXS_{AKT} from the current control deviation Δ_{DQ} of the current thermal requirement using conventional control algorithms, for example filtering and learning processes known from control technology, such as PT-1 filter, splines or else artificial intelligence in the form of neural networks.

This current correction value DXS_{AKT} is not supplied to the heating control system 7 however and therefore is not directly used for regulating or controlling the heating system 2. The intervention into the heating control system 7 takes place by means of the correction-curve adaptation module 10, which primarily determines a correction value DXS from a correction curve in accordance with the external temperature

ϑ_A, which is used as external reference variable. This correction value is output as desired correction value DXS and supplied to an adder 12, which adds the desired correction value DXS to a desired value XS determined from a stationary heating curve according to Fig. 1 by means of the thermal-power control system 7, so that the thermal power control system 7 as a whole uses the desired value XS_{KORR} = XS + DXS, in order to output the desired value U_{HZG} to the heat generator or heat-transfer system 8 using a suitable control algorithm.

The correction value DXS of the correction curve adaptation module 10 is therefore independent of the current control deviation Δ_{DQ} of the thermal requirement.

In order to adapt a correction curve stored in the correction curve adaptation module 10 (and called upon for determining the correction value DXS) according to the invention, the correction curve adaptation module 10 detects both the current correction value DXS_{AKT} output by the correction module 11 and the respectively current external temperature $\vartheta_{A,AKT}$ and averages the same over a pre-specified time period. The correction curve is then corrected on the basis of the external temperature $\vartheta_{A,AKT}$ averaged for this time period as reference variable and an average correction value DXS_{AKT}. This can also take place in the correction-curve adaptation module 10 using conventional control algorithms, filtering and learning processes known from control technology, such as PT-1 filter, splines, etc. or else artificial intelligence in the form of neural networks.

This corrected correction curve is then subsequently used for outputting the correction values DXS, which together with the desired value XS forms the corrected desired value XS_{KORR}, from which the control variable U_{HZG} for the heat generator 8 is calculated.

The special feature of the circuit 5 for pre-specification of correction values DXS therefore lies in the fact that the correction values DXS are determined from a stored correction curve in accordance with the external temperature ϑ_A, which is used as reference variable. Strictly speaking, this is a control, as control deviations Δ_{DQ} occurring in the system are not taken into account directly. These are only used in the adaptation of the correction curve in the correction curve adaptation module 10 and can be used in the future control of the heating system 2.

In this case, a plurality of correction curves are stored in the correction curve adaptation module 10 in accordance with the time of day T and the type of day D, which correction curves are corrected separately. To this end, the pre-specified time period, after which an adaptation of the correction curve is undertaken, can coincide with the provided time-of-day intervals T of the respective types of day D.

A variant of the circuit 5 for pre-specification of correction values DXS is illustrated in Fig. 3. The circuit 5 according to Fig. 3 differs from the previously described circuit 5 in Fig. 2 in that the correction module 11 and the correction-curve adaptation module 10 are combined to form a common module. This corresponds to a realisation, which often arises in practice, as the correction module 11 and the correction-curve adaptation module 10 are constructed in the form of a microcontroller, which realizes both the tasks of the correction module 11 and of the correction-curve adaptation module 10. Apart from that, the heating control 1 according to Fig. 3 corresponds to the heating control 1 described in Fig. 2, so that the same reference numbers have been used and a detailed description is dispensed with.

The method provided in the circuit 5 for pre-specification of correction values DXS is described in detail once more in the following.

Input values of the circuit 5 for pre-specification of correction values DXS, in which the method according to the invention is implemented and which is in particular a constituent of the device according to the invention, are temporally current or temporally averaged characteristic variables, from which the temporally current or the temporally averaged heat requirement of the building or heating circuit can be determined. These input values can be the external temperature ϑ_A or a correlated measured value (such as for example resistance values of sensors), the time of day T, the type of day D (for example work day, holiday), profile time periods (for example night, morning, afternoon, evening), supply states of heating surfaces and the desired values thereof, supply states of buildings, building parts or heating circuits and the desired values thereof, radiator powers $\dot{Q}_{HK}$ and the desired values thereof, radiator nominal powers at the normal operating point $\dot{Q}_{HK,Nenn}$, radiator powers at the current supply temperature and the nominal mass flow $\dot{Q}_{HK,dm\_Nenn}$, radiator powers at current supply temperature and for a completely opened radiator valve $\dot{Q}_{HK,Hub\_100s}$ and/or power ratios of radiators and the desired values thereof

$$\left(\dot{Q}_{HK} \big/ \dot{Q}_{HK,Nenn}, \; \dot{Q}_{HK} \big/ \dot{Q}_{HK,dm\_Nenn}, \; \dot{Q}_{HK} \big/ \dot{Q}_{HK,HUB\_100} \right).$$

It is the aim of the method to output correction values DXS for the correction of the supply temperature and/or the mass flow of a central heating system 2. These are taken from one or a plurality of correction curve(s) stored in the circuit 5 for the pre-specification of the correction values in accordance of the external reference variable (external temperature or the equivalent thereof). In this case, various correction curves are stored in dependence on the current type of day (work day, holiday) and the current time of day section (profile), in that correction values are stored at certain reference points of the external reference variable (external temperature). A correction control variable DXS is calculated from these in an inter- or extrapolating or else approximating manner and transmitted to the heating controller or determined by the same. The resulting, corrected actutating variable U_{HZG} is formed from the basic desired value XS of the thermal power control system 7 and the correction value DXS and also if appropriate taking account of the current actual values of the supply temperature and/or the mass flow in a determined control algorithm.

Examples for control curves used are illustrated in Figs 4 and 5, in which supply temperature correction values in arbitrary units are entered at various reference points of the external temperature. For comparison, in each case a correction curve before determining the correction values (all correction values are set to zero) and a correction curve with supply temperature correction values determined in accordance with the external temperature are illustrated.

The correction curves according to Fig. 4 and Fig. 5 differ in terms of profile (time of day), wherein the curve according to Fig. 4 compared to the curve according to Fig. 5 provides a stronger fall overall. The correction curve according to Fig. 4 is therefore suitable for a night profile, as a lower room temperature and therefore a lower thermal power is generally required at night. The correction curve according to Fig. 5

is by contrast suitable for a day profile. Basically, the correction curves can be pre-specified by profile and stored in the circuit.

However, it is provided according to the described embodiment that the correction curves are determined automatically in the circuit 5, wherein they are adapted iteratively according to the user behaviour. To this end, it is provided that current or temporally averaged correction values for the correction of supply temperature and/or mass flow of the heating system are determined on the basis of the determined deviation between desired and actual value of the characteristic variable (control deviation Δ_{DQ}) indicating the thermal requirement. The characteristic variables can, as already explained, be supply states of heating surfaces, supply states of buildings, building pars or heating circuits and the desired values thereof, radiator powers $\dot{Q}_{HK}$ and the desired values thereof, radiator nominal powers at the normal operating point $\dot{Q}_{HK,Nenn}$, radiator powers at the current supply temperature and the nominal mass flow $\dot{Q}_{HK,dm\_Nenn}$, radiator powers at the current supply temperature and for a completely opened radiator valve $\dot{Q}_{HK,Hub\_100}$, and/or power ratios of radiators and the desired values thereof

$$(\dot{Q}_{HK}/\dot{Q}_{HK,Nenn},\ \dot{Q}_{HK}/\dot{Q}_{HK,dm\_Nenn},\ \dot{Q}_{HK}/\dot{Q}_{HK,HUB\_100}).$$

The current correction values DXS_{AKT} for the correction of the supply temperature and/or the mass flow of the central heating system 2 are determined in accordance with methods of control technology that are known per se such that the control deviations of the characteristic variable are minimised or fall to almost zero. It is advantageous in the sense of high system stability in this case if the adaptation of the correction curve within a pre-specified time period, for example a daily correction value adaptation is limited to a maximum parametrizable range, so that an adaptation can in particular be changed only by a maximum value.

The control deviations of the characteristic variables and the current correction variables resulting therefrom for the correction of supply temperature and/or mass flow of the central heating system 2 are averaged or filtered during the pre-specified time periods, also termed learning phases. Likewise, the external temperature ϑ_A or a variable correlated with the external temperature are averaged or filtered during these learning phases. After the completion of each learning phase, for example the time period of a day profile time period, a set of correction reference values $DXS_{Node}(i)$ are trained or adapted in fixed or variable reference points (i) of the external temperature ϑ_A or a variable correlated with the external temperature (for example resistance values of an external temperature sensor) with the aid of the averaged values (correction values and external temperature). As a result, time-variant, adaptive correction curves DXS_{Node} (i), which are adapted automatically, particularly also to a changing user behaviour, result.

The learning of the correction values in the reference points takes place iteratively, taking account of past and instantaneous values. Known filtering and learning processes from control technology or else artificial intelligence can be used for this:

$$DXS_{Node}(i)_{new} = f\left(DXS_{Node}(i)_{old}, DXS_{AKT}, \vartheta_{A,AKT}, Filtertyp, Parameter\right) \text{ with:}$$

$DXS_{Node}(i)$	correction value at reference point i;
DXS_{AKT}	averaged or current correction value of the last learning phase;
$\vartheta_{A,\ AKT}$	external temperature (or equivalent) of the last learning phase.

This procedure can be drawn from the correction curves illustrated next to one another in Fig. 6.

Also advantageous is a weighted distribution of the correction value DXS_{AKT} from the current learning phase to the correction reference values $DXS_{Node}(i)$ on the basis of the external temperature or the external temperature equivalent $\vartheta_{A,\ AKT}$ in accordance with the following formula:

$$DXS_{Node}(i)_{new} = DXS_{Node}(i)_{old} + g(i) \cdot DXS_{AKT},$$

where

$$g(i) = \exp\left(-[d(i)/K]^2\right)$$
$$d(i) = \vartheta_{A\_Node}(i) - \vartheta_{A,AKT}$$

$\vartheta_{A\_Node}(i)$	external temperature or equivalent in the reference point i and
K	distribution constant.

Ideally, the learning phase or the pre-specified time periods are assigned to time-of-day sections, to which corresponds a significantly different user behaviour. Examples for this are the day sections night, morning, afternoon and evening. The correction curves can be stored as value pairs (correction value $DXS_{Node}(i)$, external temperature $\vartheta_A(i)$) in the memory of the circuit 5. The correction curves are assigned to the type of day (work day, holiday) and the time-of-day sections (night, morning, afternoon, evening), during which the same were trained. They mirror the type-of-day and time-of-day dependent and external-temperature dependent user behaviour and the heating system operation in a building.

The average of the learned correction curves over all reference points shows the average drop of the mass flow or the supply temperature compared to the base desired values, which result from the basic settings of the thermal power control system 7. The current correction values show the instantaneous drop of the mass flow or the supply temperature compared to the basic desired values. Both the average and the current correction values can be stored and used for evaluating the success of the method. Thus, for example a drop of the supply temperature by 1 Kelvin in Germany corresponds to approx. 2% saving in heating energy.

The adaptive correction curves are a property of the system 'building/user' and can also be used after switching off the correction logic or circuit 5, which adapts and trains these correction curves, for estimating an optimum desired value for the supply temperature and/or the mass flow.

Instabilities in the system for the demand-driven heating energy provision are prevented in that the present invention learns (trains) correction curves in small steps daily and in a profile-based manner. In addition, low requirements are placed on the data transmission performance of communication infrastructures within the building for transmitting the characteristic values and control variables as a consequence of daily and profile-based learning phases, as only one training step is lost in the event of failure of the communication.

The system suggested according to the invention can be flexibly integrated into a multiplicity of existing heating systems, as the system can be adapted on the basis of the automatic, iterative adaptation without the necessity of pre-specifications for the widest range of heating systems.

The learned correction curves illustrate the deviation of the set basic desired values from the energetic optimum for the supply temperature and/or for the heating mass flow for the technical personnel for building and house technology. The targeted, current and average energy saving compared to non-corrected basic desired values for the heating mass flow and/or the supply temperature can be calculated from the learned correction curves.

REFERENCE LIST

1	Heating control or control system
2	Heating system
3	Room temperature control system
4	Module for thermal-requirement or thermal-power analysis
5	Circuit for the pre-specification of correction values
6	Control
7	Thermal-power control system
8	Heat generator or heat-transfer system
9	Difference module
10	Correction curve adaptation module
11	Correction module
12	Addition module
D	Type of day
DQ	Heat requirement
DQ_S	Heat requirement desired value
DXS	Correction value, correction control variable
Δ_{DQ}	Control deviation of the thermal requirement
I	Information for determining the thermal requirement

$\dot{m}$ Mass flow

$\dot{Q}_{TH}$ Heating thermal power

T Time of day

ϑ_A External temperature

ϑ_{HVL} Supply temperature

ϑ_{HRL} Return temperature

U_{HZO} Actuating variable

XS Desired value

ELJÁRÁS ÉS KÉSZÜLÉK IGÉNY SZERINTI HŐELLÁTÁSRA EGY FŰTŐBERENDEZÉSBEN

SZABADALMI IGÉNYPONTOK

1. Eljárás igény szerinti hőellátásra egy fűtőberendezésben (2), amely számára egy külső vezérlő paraméter (ϑ_A) függvényében egy meghatározott hőteljesítményt (Q_{TH}) biztosítunk, ahol a biztosított hőteljesítmény (Q_{TH}) járulékosan a fűtőberendezés (2) hőigényétől (DQ) függ, ahol is a külső vezérlő paramétertől (ϑ_A) való függőségnél olyan korrekciós értékeket (DXS) veszünk figyelembe, amelyeket a külső vezérlő paramétertől (ϑ_A) függően egy a fűtőberendezés átlagos hőigényét figyelembe vevő korrekciós görbéből határozunk meg, amely egy instacioner, adaptív korrekciós görbe, amelyet előre meghatározott időszakaszok után kiigazítunk, **azzal jellemezve**, hogy a korrekciós görbe kiigazítását azáltal végezzük el, hogy egy előre meghatározott időszakaszon keresztül a fűtőberendezés aktuális hőigényét (DQ) használjuk fel egy szabályozás szabályozási jellemzőjeként (Δ_{DQ}), amely korrekciós jellemzőként egy aktuális korrekciós értéket (DXS_{AKT}) ad ki, ahol a korrekciós görbe kiigazítása az aktuális korrekciós értékeknek (DXS_{AKT}) az előre meghatározott időszakasz alatti átlagosítása mellett történik.

2. Az 1. igénypont szerinti eljárás, **azzal jellemezve**, hogy a korrekciós görbe kiigazításához a külső vezérlő paramétert (ϑ_A) átlagosítjuk.

3. Az 1. vagy 2. igénypont szerinti eljárás, **azzal jellemezve**, hogy a korrekciós görbének egy a külső vezérlő paraméterrel (ϑ_A) súlyozott kiigazítását végezzük.

4. Az előző igénypontok bármelyike szerinti eljárás, **azzal jellemezve**, hogy a korrekciós görbe kiigazítását egy előre meghatározott értéktartományra korlátozzuk.

5. Az előző igénypontok bármelyike szerinti eljárás, **azzal jellemezve**, hogy több korrekciós görbét irányozunk elő különböző időszakaszok számára.

6. Az előző igénypontok bármelyike szerinti eljárás, **azzal jellemezve**, hogy a korrekciós görbét a külső vezérlő paraméter ($\vartheta_A(i)$) értékeihez hozzárendelt referenciapontokon (i) érvényes korrekciós értékek

($DXS_{Node}(i)$) megadásával határozzuk meg.

7. A 6. igénypont szerinti eljárás, **azzal jellemezve**, hogy a külső vezérlő paraméternek ($\vartheta_A(i)$) nem a referenciapontokon (i) érvényes értékei számára a korrekciós értékek interpolációját vagy extrapolációját végezzük el.

8. Az előző igénypontok bármelyike szerinti eljárás, **azzal jellemezve**, hogy a külső vezérlő paraméter a külső hőmérséklet (ϑ_A) vagy egy a külső hőmérséklettől függő mérési mennyiség.

9. Az előző igénypontok bármelyike szerinti eljárás, **azzal jellemezve**, hogy a korrekciós értéket (DXS) a fűtőberendezés előremenő hőmérsékletének (ϑ_{HVL}) és/vagy tömegáramának ($\dot{m}$) változásából képezzük.

10. Készülék igény szerinti hőellátásra egy fűtőberendezésben (2), amely készülék egy logikai áramkörrel (5) rendelkezik korrekciós értékek (DXS) meghatározására, amelyek figyelembe veszik a fűtőberendezés (2) hőigényét (DQ), ahol a logikai áramkör (5) egy korrekciósgörbe-adaptáló modult (10) tartalmaz egy adattárolóval egy vagy több korrekciós görbe tárolására, a készülék rendelkezik továbbá egy bemenettel legalább egy külső vezérlő paraméter (ϑ_A) bevitelére, valamint egy kimenettel egy korrekciós érték (DXS) kiadására, ahol egy korrekciós modul (11) van elrendezve egy bemenettel a fűtőberendezés (2) aktuális hőigényének (Δ_{DQ}) bevitelére, amely egy aktuális korrekciós értéknek (DXS_{AKT}) az aktuális hő-igényből (Δ_{DQ}) való meghatározásához van kiképezve, és hogy a korrekciósgörbe-adaptáló modul (10) a korrekciós értéknek (DXS) egy korrekciós görbéből a külső vezérlő paraméter (ϑ_A) függvényében történő megállapításához, valamint a korrekciós görbe kiigazításához van kiképezve, **azzal jellemezve**, hogy a korrekciós modul (11) egy szabályozással rendelkezik az aktuális korrekciós értékek (DXS_{AKT}) meghatározásához a fűtőberendezés (2) aktuális hőigényéből (Δ_{DQ}), és a készülék az 1-9. igénypontok bármelyike szerinti eljárás megvalósítására van kiképezve.

11. A 10. igénypont szerinti készülék, **azzal jellemezve**, hogy a korrekciósgörbe-adaptáló modul (10) a vezérlő paraméter (ϑ_A) és az aktuális korrekciós érték (DXS_{AKT}) egy meghatározott időszakaszon keresztül történő átlagolására van kiképezve.

12. A 10. vagy 11. igénypont szerinti készülék, **azzal jellemezve**, hogy a logikai áramkör (5) és/vagy a hőteljesítmény-szabályozás (7) egy kazánszabályozásba van integrálva.

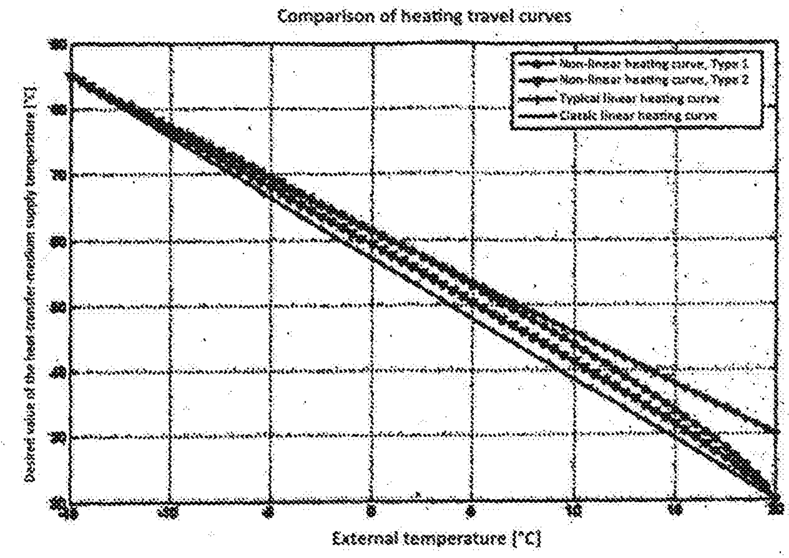
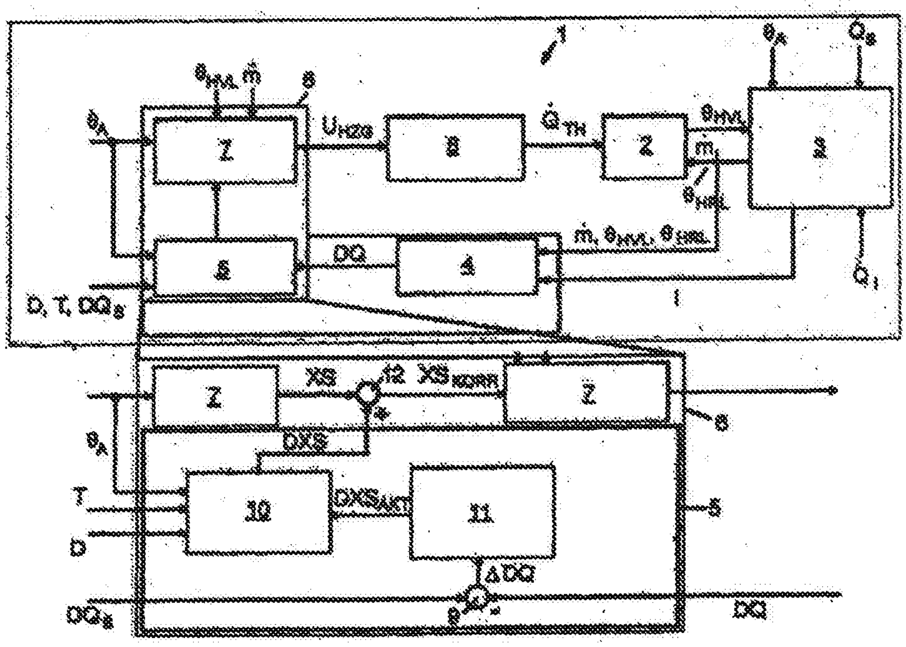

Comparison of heating travel curves
Non-linear heating curve, Type 1
Non-linear heating curve, Type 2
Typical linear heating curve
Classic linear heating curve
Desired value of the heat-transfer-medium supply temperature [°C]
External temperature [°C]

Fig. 1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12
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U_{HZG}
$\dot{Q}_{TH}$
DQ
XS
XS_{KORR}
DXS
DXS_{AKT}
ΔDQ
T
D
DQ_S
D, T, DQ_S
Q_S
Q_I

Fig. 2

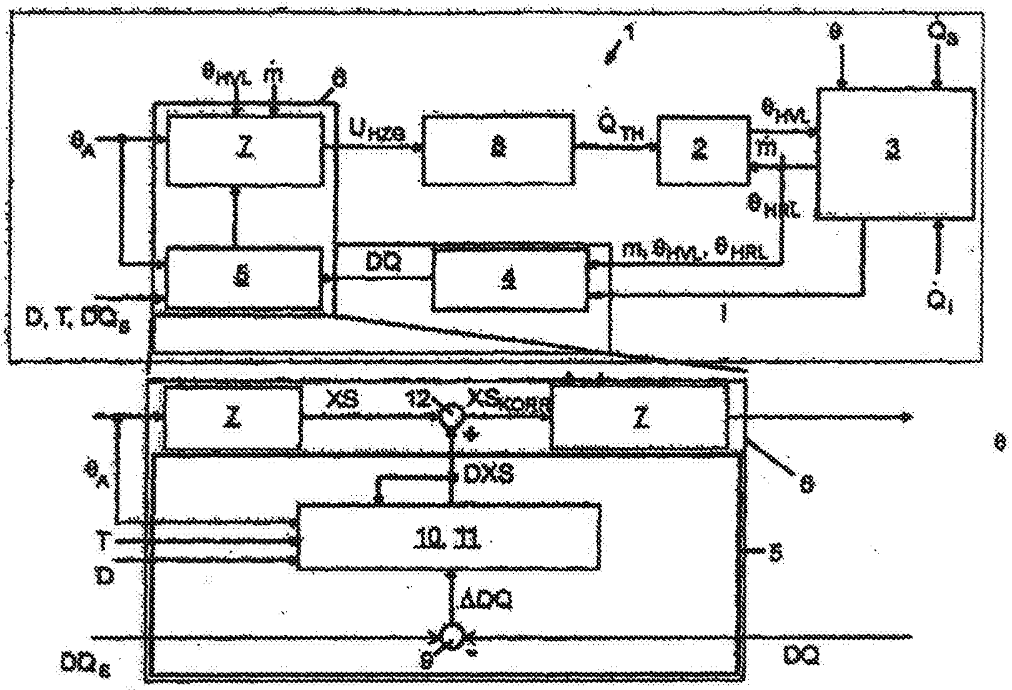
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Fig. 3

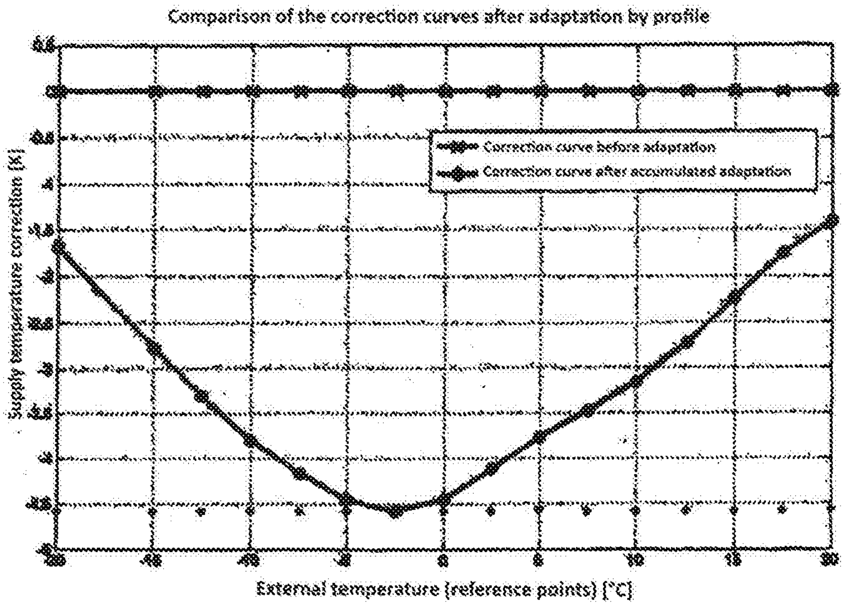
Comparison of the correction curves after adaptation by profile
Correction curve before adaptation
Correction curve after accumulated adaptation
Supply temperature correction [K]
External temperature (reference points) [°C]

Fig. 4

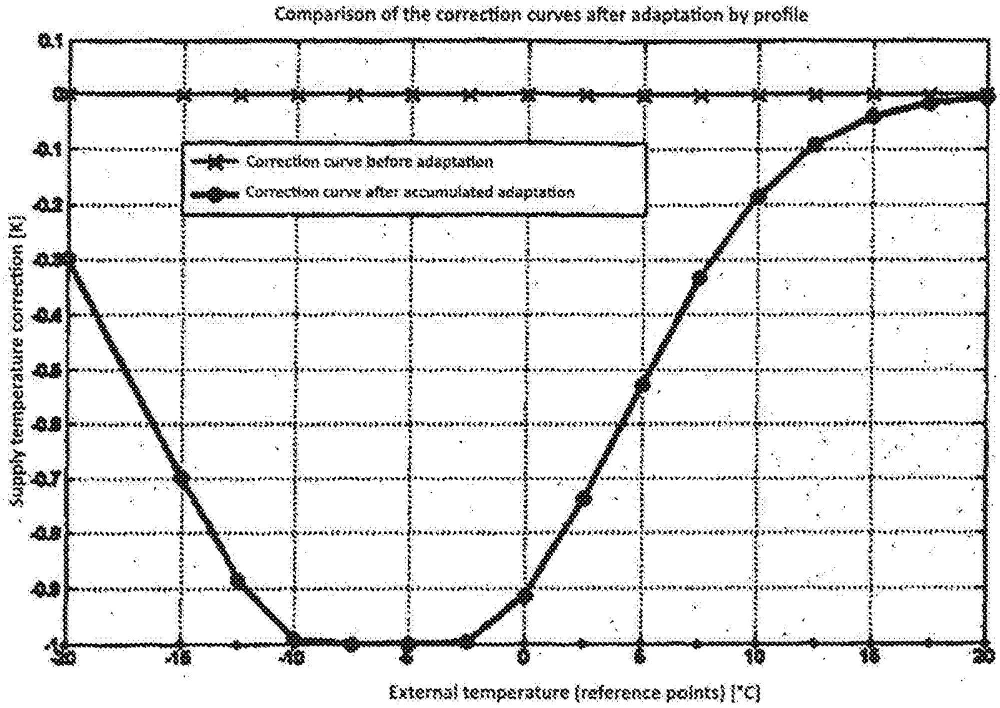
Comparison of the correction curves after adaptation by profile
Correction curve before adaptation
Correction curve after accumulated adaptation
Supply temperature correction [K]
External temperature (reference points) [°C]

Fig. 5

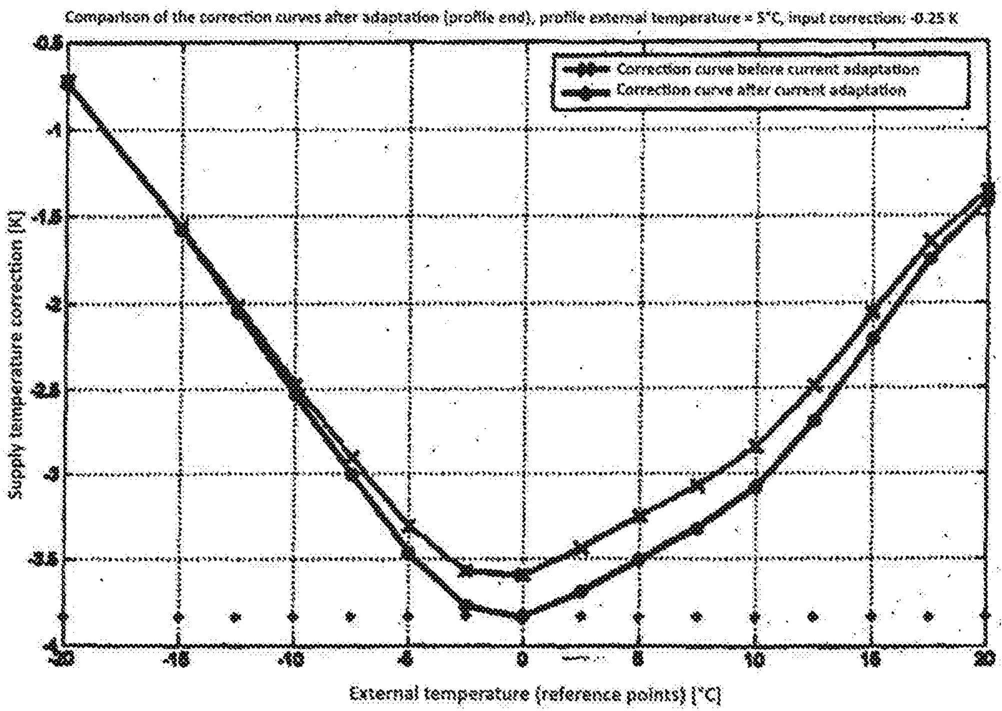
Comparison of the correction curves after adaptation (profile end), profile external temperature = 5°C, input correction: -0.25 K
Correction curve before current adaptation
Correction curve after current adaptation
Supply temperature correction [K]
External temperature (reference points) [°C]

Fig. 6