TEMPERATURE-CONTROL ARRANGEMENT, METHOD FOR THE INSTALLATION THEREOF AND METHOD FOR CONTROLLING THE TEMPERATURE OF A ROOM

DESCRIPTION

The invention relates to an arrangement (i.e., a device) for controlling the temperature of a room in a building, in particular for cooling a room in a building, with

- a wall (or building wall, respectively) or ceiling (or building ceiling, respectively) forming a supporting element,

- at least one calcium silicate panel arranged (at a distance) on the supporting element (e.g., on wall or ceiling), which has a rear side facing the supporting element and a front side facing away from the supporting element and therefore facing the room and

- at least one piping system, through which a (liquid) temperature-control medium, e.g., water, can flow and through which it flows during operation.

Such a (temperature-control) arrangement or (temperature-control) device, respectively, is used for cooling and alternatively also for heating a room in a building and therefore as wall or ceiling heating and/or cooling. The pipelines, through which the temperature-control medium (e.g., water) flows, are integrated in a quasi-concealed manner in the wall structure or ceiling structure. Mat-shaped piping systems, in particular (commercially available) capillary tube mats, are preferably used thereby as piping systems, in the case of which, e.g., the capillary tubes are arranged at a distance from one another in the register and

are provided either with main tubes arranged opposite each other or main tubes arranged on one side of the capillary tubes as supplies and discharges for the temperature-control medium. Capillary tube mats are preferably made of plastic.

In practice, temperature-control arrangements of this type are currently used especially for heating rooms, whereby a heating medium, e.g., warm water, flows through the piping system and the heat is released to the room via the wall or ceiling structure.

Alternatively, such piping systems or capillary tube mats, respectively, are also already used for cooling rooms, in that a cooling medium, e.g., cold water, flows through the capillary tubes. In practice, especially the cooling of a room to below the dew point and the condensate formation associated therewith, which leads to moisture in the wall or ceiling structure causes problems thereby. This can lead to mildew stains, mold formation and even to serious impairments of the building fabric. This is particularly problematic in regions with high temperatures and high humidity, in which there is generally a particularly high demand for cooling rooms in order to create a tolerable or pleasant climate, e.g., in living spaces, hospitals, social institutions or work spaces. The temperature-control arrangements, which are currently used in practice, based on capillary tube mats work, e.g., with gypsum plasterboard or capillary tube mats are integrated into conventional concrete ceilings. In order to avoid the problems resulting from the condensate formation at high temperatures and high humidity, dew point sensors are used, e.g., in practice, for the dew point monitoring, so that the cooling can be deactivated upon reaching the dew point so as not to endanger the building fabric.

In light of the foregoing, a system has already been proposed and used, in the case of which the capillary tube mats are arranged on a heat-insulating base panel made of hygroscopic

material, e.g., of calcium silicate. The surface of the base panel having the capillary tubes is covered with a layer, which is formed as loam rendering layer (see EP 3 146 271 B1). Due to its moisture-regulating properties and its relatively good heat conduction, loam rendering is particularly suitable for the layer covering the surface of the base panel with the capillary tubes. The loam rendering forms a permeable and thus steam-permeable coating and supports the base panel in absorbing moisture and in releasing moisture again. The base panel made of calcium silicate with its hygroscopic properties is also significant in the case of this system. The option of the cooling temperature falling below the dew point, so that the condensate created thereby is absorbed by the base panel (made of calcium silicate) and by the covering layer (loam rendering layer) and is released again when the cooling is deactivated, is thus already described in the EP 3 146 271 B1. This system has also proven itself in practice, but can be improved. The invention therefore relates in particular to the further development and improvement of applicant's system described in the EP 3 146 271 B1.

The DE 41 06 200 describes a temperature-control element formed as heating module, which has a heat-insulating base panel, which is formed as hard foam board, wooden board or fiberboard. A capillary tube mat is fixed, for example, by means of stapling, on the surface facing the room. The surface of the base panel and the capillary tube mat are covered by a filling layer made of a heat-conductive material with adhesive properties, whereby a cover panel, which is significantly thinner than the supporting panel, is adhered to the filling layer. This can be a cement-, lime- or gypsum-bound chipboard or fiberboard or a panel made of plasterboard.

Further systems are known, e.g., from the DE 197 20 863 A1 and the DE 10 2004 050 207 A1. The use for heating is generally the main focus.

A cooling element is described, e.g., in the DE 40 36 520 A1, which is equipped with a heat-insulating base panel, which has capillary tubes, through which a cooling medium is guided, wherein the base panel consists of a hygroscopic material.

The DE 10 2012 005 655 A1 describes the production of surface heating system or surface cooling system on on-site ground with a heat-insulating base panel and with capillary tubes, through which a cooling medium can be guided, wherein the base panel is made of calcium silicate and the base panel is provided with a loam rendering layer.

A room element for fastening to ceilings or walls is known from the DE 20 2006 000 201 U1. This room element is formed as laminar body and has a support shell as well as a functional layer, wherein the support shell comprises a building panel, which can consist of calcium silicate.

Moreover, an arrangement for air-conditioning rooms, which consists of prefabricated air conditioning panels and which can be configured in a layered manner in grid form underneath a ceiling, in front of a wall or above a floor in drywall construction is known from the DE 198 44 617 A1. Each air conditioning panel has a body made of mineral materials in the form of a hydrate mixture of different hydrate stages as well as mineralogical and/or metallic additives with dense structure, in which a fluid channel made of copper or a copper alloy is integrated.

Based on the known prior art, embodiments of the invention relate to an arrangement, which provides for a temperature-control, which is particularly energetically efficiently, of a room and which provides in particular for an economical cooling in environments with high temperatures and/or high relative humidity. In addition, the arrangement is to be constructed and capable of being mounted easily and economically.

Embodiments of the invention teach, in the case of a generic arrangement of the above-described type, that the piping system is formed as capillary tube mat and is arranged on the rear side of the calcium silicate panel between the supporting element and the calcium silicate panel. The calcium silicate panel therefore faces the room to be cooled or to be heated – with respect to the capillary tube mat.

According to a first aspect of the present invention, there is provided an arrangement for controlling the temperature of, in particular for cooling or heating, a room in a building, with a ceiling forming a supporting element, at least one calcium silicate panel arranged on the supporting element, which has a rear side facing the supporting element and a front side facing away from the supporting element and facing the room and at least one piping system, through which a temperature-control medium, e.g., water, can flow and is formed as capillary tube mat, wherein the capillary tube mat is arranged on the rear side of the calcium silicate panel between the supporting element and the calcium silicate panel, whereas the calcium silicate panel is fastened to the supporting element or to a substructure by interconnecting the capillary tube mat, which is loosely placed onto the panel.

According to a second aspect of the present invention, there is provided a method for the installation of the above temperature-control arrangement, wherein one or several calcium silicate panels are arranged to the supporting element by interconnecting at least one capillary tube mat, so that the capillary tube mat is arranged on the rear side of the calcium silicate panels between the supporting element and the calcium silicate panels and the calcium silicate panels face the room, whereas the calcium silicate panels are fastened to the supporting element or to a substructure by interconnecting the capillary tube mat, which is placed loosely onto the panel, and the piping system is fixed thereby.

According to a third aspect of the present invention, there is provided a method for controlling the temperature of a room, in particular for cooling or heating a room, by means of the above temperature-control arrangement, which is arranged in the region of at least a ceiling, wherein a temperature-control medium flows through the capillary tube mat and the temperature of the calcium silicate panel is controlled thereby.

The calcium silicate panel, which is a prefabricated, dimensionally stable and pressure-resistant building panel, which is manufactured on the basis of silicon dioxide and calcium oxide, is therefore an essential part of the invention. According to the invention, commercially available calcium silicate panels can be used, which are not used as base panel or supporting panel, respectively, on the side of the capillary tube mat facing the wall or the ceiling, respectively, but which are arranged on the side of the capillarity tube mat facing the room as cold transfer element or alternatively also as heat transfer element. As part of the cooling with the system, the cold supplied via the capillarity tube mats is transferred to the calcium silicate panel. The latter absorbs the cold, stores it within the panel and releases it from there to the room to be cooled (in that it extracts heat from the room). It is of particular importance that when falling below the dew point, the calcium silicate panel absorbs the condensate accumulating at the capillary tube mats and the panel and stores it in the calcium silicate panel, so that the panel does not only release the stored cold as “radiant cooling” but also as evaporation cooling to the room to be cooled. The high storage capacity of the calcium silicate is particularly

advantageous, which provides for a long-lasting and thus also time-shifted release of the cold including the radiant cooling resulting therefrom. These effects result in that the cooling effect is maintained even when the active cooling of the capillary tube mats is deactivated. The system therefore does not require a permanent or consistent active cooling, respectively, of the medium guided in the capillary tube mats. The cooling does not only act in the case of an activated cooling generator (e.g., heat pump) but also in phases with deactivated cooling generator. The system can thus be realized with significantly reduced energy expenditure and thus particularly energy-efficiently with also excellent cooling. The absorption of the accumulating condensate by means of the calcium silicate panel is particularly advantageous thereby. The absorbed condensate and the cooling energy contained in the temperature-control element thereby is released into the room in particular as evaporation cooling when the cooling is deactivated, e.g., at night. This, in turn, leads to a balanced and constant humidity content in the room, which is then passively cooled. At night, the passive cooling leads to a consistently pleasant and healthy room climate (without a bothersome draft, which occurs in the case of conventional air-conditioning systems).

The option of a constant, consistent cooling, namely even in the case of weather conditions with frequent or persistent falling below the dew point is a particular advantage because the accumulating condensate is absorbed completely by the calcium silicate panel. This does not only lead to an effective, energy-efficient cooling but also to the avoidance of moisture damages or the settling or build-up of germs, such as, e.g., mold. The formation of pathogens is also avoided because cooling takes place without any draft. The calcium silicate panel acts as active cooling medium, but simultaneously also as storage medium for a passive cooling in the case of a deactivated system. A pleasant and

healthy room climate is attained with this type of cooling, namely without bothersome draft.

On the one hand, the system protects the environment and, on the other hand, a healthy and pleasant room climate is created. The system is thus particularly well suited, for example, in hospitals or social or medical institutions.

According to the invention, the described, advantageous properties of the calcium silicate panel come into play in particular because the calcium silicate panel is not used as supporting panel for the capillary tube mats on walls or ceilings but as panel arranged on the room side, which ensures a flawless transfer of the energy from the capillary tube mats to the room. In the case of this arrangement according to the invention, it is advantageous in particular in the region of the ceiling of a room that the condensate created at the capillary tube mats during the cooling, i.e., the liquid, is absorbed directly and completely by the calcium silicate panel arranged therebelow due to gravity. However, this arrangement is also advantageous in the region of a wall for the described reasons.

The (prefabricated) calcium silicate panel has a thickness of, e.g., 1 cm to 4 cm. The thickness is preferably 1 cm to 3 cm. It preferably has a thickness of 2 cm to 3 cm. Commercially available calcium silicate panels can be used, which can be handled and assembled easily. The building material is a building material made of silicon dioxide, calcium oxide, water glass and cellulose, which is hardened in a process under water vapor and thus obtains the special properties for the invention. The calcium silicate panel does not swell in response to moisture absorption and in response to the moisture release, but it also does not diminish. The pH value is well above 8.0, so that there is no risk of settling or build-up of germs, e.g., mold and pathogens even in response to prolonged impregnation with

water. In addition, calcium silicate is extremely heat resistant and, according to the European Technical Assessment, has a fire-resistant qualification. It is environmentally friendly and can be disposed of without any problems.

The cooling of the system takes place via a (liquid) cooling medium, which is supplied by means of the capillary tube mat. The piping system is thus capillary tubes or capillary tube mats, respectively. Existing or commercially available systems, respectively, can be used in the case of these capillary tube mats. The capillary tube mat consists of a plurality of capillary tubes, which are arranged next to one another in parallel and which are made either as inlet or outlet with main tubes arranged opposite one another or in the case of which the main tubes for the inlet and outlet are guided next to one another on one side of the mat. The individual capillary tube mats (made of plastic) are thereby welded together as required, so that large surfaces, e.g., surfaces of up to 13m^2 can be realized, in particular for the cooling process. The capillary tube mats consist of plastic, e.g., of polyolefin, e.g., of polypropylene or on the basis of polypropylene. For example, polypropylene copolymers, e.g., polypropylene random copolymer (PP-R) can be used. Capillary tube mats have good properties for the transfer of heat or cold as well as a high strength. They can be produced in an environmentally friendly manner of recycled material.

According to the invention, the capillary tubes or capillary tube mats, respectively, are always arranged between the supporting element (wall or ceiling) on the one hand and the calcium silicate panel on the other hand. The calcium silicate panel is fastened directly or indirectly to the supporting element (wall/ceiling) or to a substructure fastened to the supporting element by interconnecting the capillary tube mat. The invention can thus also be realized

in the case of suspended ceilings, in the case of which a metallic substructure, e.g., is fastened to the ceiling. The calcium silicate panels are then assembled, e.g., to this (metallic) substructure. It is always advantageous when an insulating material, e.g., an insulating material layer or insulating material panel, is arranged between the capillary tube mat and the supporting element (e.g., wall or ceiling). A direct contact of the capillary tube mat with other (organic) building materials is thus prevented and cold losses or heat losses are avoided at the same time. An optimal and efficient energy transfer from the capillary tube mat to the calcium silicate panel arranged on the opposite side of the insulating material can be accomplished.

The system according to the invention is also characterized by a simple and economical assembly or installation, respectively. It is thus particularly preferably possible to fasten, e.g., to screw, the calcium silicate panel directly or indirectly to the supporting element, for example to the ceiling or also to a supporting structure of a suspended ceiling, by interconnecting the capillary tube mats. For this purpose, the calcium silicate panels can also be fastened to wall or ceiling or a corresponding substructure by interconnecting the capillary tube mats, which are loosely placed onto the panel. According to the invention, a fixation of the capillary tube mats to the calcium silicate panels can thus be forgone. A (permanent) fastening of the capillary tube mats to wall or ceiling is preferably also forgone. A simple pre-fixation of the capillary tube mats to the ceiling or the supporting structure can take place only for assembly purposes in that the capillary tube mats are initially pretensioned, e.g., on the ceiling and the tightness of the capillary tubes is optionally also tested. An assembly of the calcium silicate panels can take place subsequently, so that the capillary tube mats rest on the calcium silicate panels after the assembly (during operation) and are supported by them, without a stable (supporting) fixation of

the mats to the ceiling or the ceiling structure being required. The capillary tube mats thus rest (fully) on the calcium silicate panels, preferably due to their gravity, so that a flawless heat transfer or cold transfer, respectively, from the mats to the panels (and vice versa) is ensured. It is of particular interest thereby that the calcium silicate panels do not have to be formed or processed specifically for the combination with the capillary tube mats. In preferred embodiment, the grooves or slits, which are frequently used in the prior art, for the capillary tubes in the calcium silicate panels are in particular forgone. This leads to a simple and cost-efficient manufacture and assembly.

Usually, it is expedient to initially equip the entire or a larger region of the ceiling or of a wall with capillary tube mats and to functionally connect the individual mats to one another and to optionally also test them with regard to tightness. The cladding of the entire surface with the calcium silicate panels then takes place successively. It is advantageous thereby to bond the individual calcium silicate panels with a special calcium silicate adhesive in order to cover joints and to thus avoid a cold loss or condensate escape, respectively. The calcium silicate adhesive can furthermore also be used for filling joints and for connecting to other non-organic building elements, such as, e.g., concrete. It is particularly advantageous that the entire wall or ceiling can be covered and lined flawlessly because the calcium silicate panels can be cut to size easily and exactly and can thus be adapted to the geometry of the room.

According to the invention, it is of particular importance that the calcium silicate panel – with respect to the capillary tube mat and the entire setup – faces the room. This does not rule out, however, that the surface of the calcium silicate panel facing the room is provided with a

further layer. It is thus advantageous to provide the calcium silicate panels with a (permeable) plaster or with a (permeable) plaster layer, respectively, e.g., with a calcium silicate plaster on the room-side after the assembly to wall or ceiling. The thickness of the plaster layer can be, e.g., 1 mm to 3 mm. Alternatively or additionally, the calcium silicate panel or the plaster layer can be provided with a coat of paint. It is particularly advantageous to coat the previously applied plaster layer with a (permeable) paint, e.g., a permeable paint for living spaces, after the hardening.

Overall, the arrangement according to the invention provides for a particularly energy-efficient, environmentally friendly, climate-friendly and healthy temperature control and in particular cooling of a room. This applies in particular when the temperature control of the medium (e.g., of the water) takes place by means of a heat pump. The system distinguishes itself in particular in the case of the cooling of rooms in regions with long-lasting high temperatures and high humidity. In addition, the room climate is influenced in a particularly positive manner. The system ensures a flawless and particularly economical room air conditioning in homes and workplaces as well as in public buildings, hospitals and social institutions. The environmentally harmful and energy-intensive air conditioning units, which are currently used, in the form of traditional cooling air fans or split air conditioners can be replaced. In addition, the effects in the room air, e.g., dust particles, viruses and pathogens, which are harmful to health in the case of conventional systems, can be avoided. The draft, which is perceived as being unpleasant in the case of conventional air conditioners is also avoided. In connection with the use of heat pumps, it is possible to activate the heat pump, for example air-water heat pump, only in short intervals or in certain phases, respectively, e.g., at a ratio of 1:4, so that significantly less waste heat is generated and thus

contributes significantly less to a heat-up of the external air. The waste heat, which is permanently generated especially in metropolitan areas by means of the heat pumps and the heat build-up associated therewith can be avoided or reduced, respectively.

According to a further proposal of the invention, the arrangement for controlling the temperature of a room can optionally have a moistening device for (actively) moistening the calcium silicate panel(s), wherein a moistening medium, e.g., water, can be applied or is applied, respectively, to the calcium silicate panel(s) by means of the moistening device and can thus actively and additionally be moistened with water. For this purpose, the moistening device can comprise one or several dispensing devices, e.g., nozzles, spray devices, splashing devices or dripping devices, which are arranged, e.g., above the calcium silicate panel(s) (and, e.g., above the capillary tube mat), so that water can be applied, e.g., from the top, to the calcium silicate panel(s). The moistening medium reaches onto the calcium silicate panel, e.g., through the capillary tube mat or between the capillary tubes, respectively.

The moistening device can optionally have one or several measuring devices for determining the moisture content of the calcium silicate panel or of the calcium silicate panels, e.g., one or several moisture sensors, wherein the measuring devices are arranged in or on the calcium silicate panel. The moisture content of the calcium silicate panels can be monitored and responded to with the help of the measuring devices, in that, e.g., the moistening with the help of the moistening device takes place as a function of the measured moisture content. The moistening device thus preferably has a control for a metered release of the moistening medium to the calcium silicate panels, wherein the control is preferably connected to the dispensing device or devices and/or to the measuring device or devices. The release of

the moistening medium to the calcium silicate panels can take place in a time-controlled or quantity-controlled manner with the help of the control, in that certain quantities of the moistening medium are released, e.g., in certain time intervals. However, the control preferably takes place as a function of the measuring values, which are recorded, e.g., by means of the measuring devices, so that a controlled or regulated release particularly preferably takes place in such a way that a specified moisture content is reached. It is thus possible, e.g., to operate the arrangement in such a way that a specified moisture content is set, e.g., a specified saturation level of the calcium silicate panels of at least 10%, preferably at least 20%, e.g., at least 30%. It lies within the scope of the invention that the saturation level of the calcium silicate panel is 10% to 50%, e.g., 25% to 35%, for example approximately 30%. The saturation level is the level of saturation of the calcium silicate panel with the moistening medium, e.g., with water, based on a maximum saturation of the calcium silicate panels of 100%. In the case of maximum saturation of 100%, the calcium silicate panel can absorb approximately 3.5 times its dead weight of water.

The active addition of water for moistening the calcium silicate panels can be advantageous, e.g., during the cooling of a room, which has already been described in detail, because the described cooling effect can be increased by supplying water and thus the intensified moisture of the calcium silicate panels. The water, which is additionally supplied in a metered manner, is cooled in the cooled calcium silicate panel and is stored therein and is thus released to the room to be cooled in the form of radiant cooling and evaporation cooling, namely even after deactivation of the active cooling. This will be discussed below.

The supply of a moistening medium and thus the active moistening of the calcium silicate panels is also

advantageous or particularly advantageous, respectively, when the temperature-control arrangement is used and thus operated for heating a room. The water, which is additionally supplied in a metered manner, is heated up in the heated calcium silicate panel and is stored therein due to the special hygroscopic properties thereof and is released into the room to be heated in the form of heat radiation and evaporation heat. This is expedient in particular because the heating takes place in a dry manner, i.e., no condensate accumulates – unlike during the cooling. The addition of water is thus of particular interest in order to be able to use the hygroscopic properties of the calcium silicate even during the heating.

The capillary tube mat, through which warm water flows, and the heat generated therewith is released to the water, which is input in the calcium silicate panels, this water thus heats up steadily. This heat is stored in the calcium silicate panel and is released to the room to be heated to a large extent via the heat radiation and the evaporation heat. A heat storage and, due to the very good heat conductivity of the water, a high heat radiation with additional evaporation heat thus takes place as process due to the preferably steady supply of the heat in the water via the capillary tube mat and into the water, which is input in the calcium silicate panel.

It is of interest that the moistened calcium silicate panels heat or cool the room during the heating (or also cooling) by means of radiant heat and evaporation heat or radiant cooling and evaporation cooling, receptively, e.g., by means of a heat pump. When the heating/cooling is deactivated, e.g., when the heat pump is deactivated, a heating or cooling of the room, respectively, also still takes place, namely especially by means of the evaporation heat or evaporation cooling, respectively, which acts even when the heat pump is deactivated. The described effects are intensified by means

of the active moistening. In contrast to the systems known from the prior art, optionally produced water in the calcium silicate panels thus does not have a negative effect but the system reacts in an expressly positive manner to water because the heating effect and/or the cooling effect are intensified. The water, which is absorbed or actively supplied in the calcium silicate panel, thus supports the function of the system according to the invention.

In order to keep the heat generation or cold generation, respectively, balanced between heat radiation and evaporation heat or radiant cooling and evaporation cooling, respectively, to heat conductivity and water absorption capacity of the calcium silicate panel as well as of the humidity in the heated room, a specified saturation level is preferably set in the calcium silicate panel, whereby a saturation level of, e.g., 20% to 40%, e.g., 25% to 35%, e.g., approximately 30% water has turned out to be particularly advantageous.

As already mentioned, it is of particular interest that in particular the evaporation heat or evaporation cooling, respectively, still acts for a long period of time after deactivation of the temperature control and thus after deactivation of the heat or energy supply, respectively. High energy savings compared to conventional heating or cooling methods can be attained therewith. Responsible for this is the high heat storage capacity of the water in the calcium silicate panel, which, as yield during deactivated heating (or cooling) has the effect that a passive heating (or cooling) of the room still takes place. An enormous energy saving effect compared to conventional devices and methods is attained at the same time. Reaching a pleasant room climate due to the humidity, which can be adjusted to be constant, is a further advantage.

As already mentioned, the temperature-control medium, e.g., cooling medium or heating medium, in particular water, flows above the calcium silicate panel in the capillary tube mats in a cycle from a heat generator (in particular in the form of an air-water heat pump) via a heat exchanger, and thus controls the temperature of the calcium silicate panel. The heat storage capacity of the calcium silicate panel in the dry normal state is generally similarly low, e.g., as the heat storage capacity of a gypsum plasterboard. It is of interest, however, that the heat storage capacity of water is significantly higher than, e.g., the heat storage capacity of gypsum plasterboard. Even though the calcium silicon panel also has a relatively low heat conductivity in the dry state, the heat conductivity increases significantly due to the moisture in the calcium silicate panel, in particular when water is additionally introduced into the calcium silicate panel. The combination of the calcium silicate panel with the described capillary tube mats, in particular during the heating (but also during the cooling) is also particularly advantageous for these reasons.

Moreover, it is an important recognition of the invention that the radiant heat (or radiant cooling, respectively) in combination with the evaporation heat (or evaporation cooling, respectively) continues to have an effect even many hours after deactivation of an active temperature control (heating or cooling). Significant energy savings compared to conventional heating methods (or cooling methods) can be attained therewith. Responsible for this is the high heat storage capacity of the water in the calcium silicate panel, which, as yield during deactivated heating (or cooling) has the effect that a passive heating/cooling of the room still takes place. An enormous energy saving effect results at the same time. As already mentioned, a further advantage of the invention is reaching a pleasant room climate. An evaporation of the warm water stored in the calcium silicate panel into the room to be heated thus takes place, e.g., during the

heating, in addition to the radiant heat of the water stored and heated in the calcium silicate panel, which, in turn, leads to an increase of the humidity and thus prevents the heated room from drying out. Humidity in the room remains relatively constant and leads to the mentioned, pleasant room climate, due to a steady evaporation and an air exchange of the room to be heated. The energy extracted during the evaporation of the environment remains in the water vapor as latent, i.e., as hidden energy. When the warm air rises in the room, it cools down, whereby the water vapor partly condenses. The latent, thus hidden energy, is released again during this process and thus heats up the environment in terms of an evaporation heat. This form of heating is steady and not limited in time. The calcium silicate panel serves as heat storage for the medium water here and simultaneously as moisture reservoir. The same applies for the described cooling.

As a result of the highly hygroscopic property of the material calcium silicate, the calcium silicate panel can absorb 3.5 times the mass of water with regard to the dead weight thereof.

The invention does not only relate to the described device but additionally to a method for the installation or production, respectively, of the temperature-control arrangement according to the invention.

In addition, the invention relates to a method for controlling the temperature of a room, e.g., for cooling a room, by means of the temperature-control arrangement according to the invention.

The invention will be explained in more detail below on the basis of drawings, which only represent an exemplary embodiment, in which

Fig. 1 shows a temperature-control arrangement according to the invention in a simplified, perspective illustration and

Fig. 2 shows a cross section through the temperature-control arrangement according to Fig. 1.

An arrangement or a device, respectively, is shown in the figures, which serves the purpose of controlling the temperature, in particular cooling, a room 1 in a building. The room generally has several walls and a ceiling, wherein this ceiling 2 is also referred to below as supporting element 2 because the temperature-control arrangement is assembled in the region of the ceiling of the room in the illustrated exemplary embodiment. The invention is thus illustrated in an exemplary manner as ceiling cooling, but it can likewise be realized as wall cooling.

One or several calcium silicate panels 3 are fastened (directly or indirectly) to the supporting element 2, i.e., to the ceiling 2, wherein these calcium silicate panels 3 each have a rear side R facing the supporting element 2 and a front side V facing away from the supporting element 2 and thus facing the room 1. In addition, a piping system 4, through which a temperature-control medium, e.g., water, flows, is provided for controlling the temperature, e.g., cooling. This piping system is a capillary tube mat 4. The capillary tube mat 4 consists essentially of a plurality of capillary tubes 5, which are arranged at a distance from one another in the register and which are provided with main tubes 6 for the supply and discharge of the water. According to the invention, it is provided that this piping system and thus the capillary tube mat 4 is arranged on the rear side of the calcium silicate panels 3 and thus between the supporting element 2 and the calcium silicate panel 3.

Moreover, the calcium silicate panel 3 can be provided on its front side V with a (permeable) plaster layer 7, which is only suggested in the drawings, and/or with a (permeable) paint layer or a coat of paint, respectively. In addition, an insulating material or an insulating material layer, respectively, which is likewise not illustrated, can be arranged between the capillary tube mat 4 and the supporting element 2 (i.e., the ceiling). It is generally possible to directly fasten the calcium silicate panels 3 to the supporting element (i.e., the ceiling) by interconnecting the capillary tube mat 4 and optionally the insulating material, e.g., by means of screws or the like. However, a substructure 8, e.g., a metallic substructure for the realization of a suspended ceiling, is arranged on the ceiling 2 in the exemplary embodiment according to Fig. 1. The calcium silicate panels 3 are thus not fastened directly to the ceiling 2 but to the substructure 8, e.g., by means of screw connections.

It is of particular importance that the calcium silicate panels 3 are not used as supporting panels or ground panels, respectively, on the side of the capillary tube mat 4 facing the ceiling 2 but are arranged on the side of the capillary tube mat 4 facing the room 1 as cold transfer element (or alternatively as heat transfer element). The system is preferably used for cooling the room, wherein the cold supplied via the capillary tubes is transferred to the calcium silicate panel as part of the cooling. Said calcium silicate panel absorbs the cold, stores it within the panel and releases it from there to the room 1 to be cooled. It is particularly advantageous that the calcium silicate panel 3 absorbs the condensate accumulating at the capillary tube mats 4 and the panel 3 when falling below the dew point and stores it in the calcium silicate panel 3, so that the panel 3 subsequently does not only release the stored cold as “radiant cooling” but also as evaporation cooling to the room 1. The high storage capacity of the calcium silicate is

particularly advantageous, which provides for a long-lasting and thus also time-shifted release of the cold. It is advantageous in particular in the case of the arrangement in the region of a ceiling 2 of a room illustrated in the drawings that the condensate created at the capillary tube mats 4 is absorbed directly and completely by the calcium silicate panel 3 arranged therebelow due to the gravity.

The calcium silicate panel can be a commercially available building panel, which can have, e.g., a thickness D of 2 cm to 3 cm.

It is also of interest that no fixed connection of the capillary tube mats 4 to the calcium silicate panels 3 is required and that the calcium silicate panels 3 also do not need to be prepared in a specific manner for the assembly of the capillary tube mats 4. On the contrary, it is possible to fasten the calcium silicate panels 3 to the ceiling 2 or to the substructure by interconnecting the mats 4, which are loosely placed onto the panels. As part of the assembly, however, it can be expedient to pre-fix the capillary tube mats 4 to the ceiling 2 or to the substructure prior to the assembly of the calcium silicate panels.

For the installation of the system according to the invention, it is generally expedient to initially “roughly” prefix the capillary tube mats 4 to the ceiling 2 or to the non-illustrated substructure and to test the installed capillary tube mats with regard to their function and tightness. This is so because several prefabricated capillary tube mats are generally installed and connected to one another, e.g., welded together, in the region of a ceiling. The calcium silicate panels 3 can then be assembled, so that the previously suspended mats 4 rest essentially loosely on the panels 3, i.e., the weight of the mats 4 can also be absorbed by the fastened calcium silicate panels 3 during operation. This also has the advantage that the cold

(or heat) is transferred particularly well from the capillary tube mats 4 to the calcium silicate panels 3 arranged therebelow. After the assembly of the calcium silicate panels 3, the front side V thereof, which faces the room, can be plastered, e.g., with a permeable plaster 7 and the surface can subsequently be provided with a likewise permeable coat of paint.

The system according to the invention is particularly suitable for cooling the room 1, in that a cooling medium, e.g., water, flows through the capillary tube mats 4 and the calcium silicate panels 3 are thus cooled. The cooling below the dew point is of particular interest because the condensate created at the capillary tube mats 4 in this case is absorbed completely by the calcium silicate panels 3 and is stored therein. This provides for a cooling in phases of activated cooling, e.g., heat pump, as well as in phases of deactivated cooling, e.g., heat pump. The calcium silicate panels 3 absorb the created condensate when the cooling is activated (or when the cooling generator is activated, respectively) and release the absorbed moisture to the room 1 when the cooling is deactivated (or when the cooling generator is deactivated, respectively). On the one hand, the calcium silicate panels 3 serve as cold storage for the cooling medium water and, on the other hand, as moisture reservoir for the condensate. As a result of the highly hygroscopic property of the material calcium silicate, the calcium silicate panel 3 can absorb a multiple of the mass of water in the form of condensate with regard to the dead weight thereof. As a whole, an energetically efficient cooling of a room 1 with pleasant and healthy room climate can be accomplished without the risk of mold formation.

The system according to the invention develops its advantages in particular during the cooling of rooms. It is of interest, however, that the system can also be used for heating rooms without structural changes, so that the cooling and heating

can be realized in one system. The invention provides for a complete CO2 neutrality and is thus particularly environmentally friendly. A pleasant and healthy room climate can be attained all year round as a result of the radiation energy and the humidity regulation, namely in environments in a wide range of climate zones with different temperature and humidity. In particular, the problem, which arises in the prior art, of the condensate formation when falling below the dew point is mastered perfectly. The advantages are also created by means of the passive cooling in consideration of the evaporation cooling. The formation of mold is avoided by means of the properties described as a whole and in particular also by means of the high pH value of calcium silicate. In addition, it is advantageous that calcium silicate is not flammable and extremely heat resistant. In addition, the system is low-maintenance, can be used in all building types and leads to a significant reduction in energy costs.

Tests with the described system have confirmed the described advantages and effects. In particular the high storage capacity for the accumulating condensate when falling below the dew point has in particular been shown by means of the calcium silicate panels and the storage capacity of the cold input into the calcium silicate panels even in the case of deactivated cooling. The energy savings in the case of deactivated, but still passive cooling has likewise been shown. It has been shown by means of measurements that the thermal storage capacity and the storage capacity for condensate in the calcium silicate panel is so high and constant that a cooling is ensured consistently even passively, thus by means of evaporation when the cooling is deactivated, and the energy expenditure for this type of cooling is significantly lower compared to conventional cooling methods. A consistent active cooling by means of cooling generator is thus not necessary with the invention. In addition, it has been shown that the humidity in a room

has a constant value with the invention even when the cooling is deactivated. Condensate, which cools passively, still remains in the calcium silicate panels even after energy deactivation in response to lowered external temperatures and the evaporation of the condensate in the room, which accumulates as a result thereof, without a sufficient storage capacity for the absorption of newly accumulating condensate in the following sections of the active cooling being impacted thereby. The relative consistency of the humidity leads to the likewise important aspect, namely the pleasant and healthy room climate, which is of particular importance, for example in hospitals, medical or social institutions.

The temperature-control arrangement according to the invention can optionally be equipped with a moistening device for moistening the calcium silicate panels with a moistening medium, e.g., with water. This option is not explicitly illustrated in the figures. It can be realized, e.g., in that one or several dispensing devices are provided above the calcium silicate panels illustrated in the drawings (and, e.g., above the capillary tube mats) for the (metered) dispensing of a moistening medium, e.g., water. The moistening device can optionally have one or several measuring devices for determining the moisture content of the calcium silicate panel. These can be, e.g., moisture sensors, which are arranged in or on the calcium silicate panel. They are also not illustrated in the figures. As already described, the additional moistening with the help of a moistening device can be advantageous for the heating as well as for the cooling. Provided that a moistening device is provided, the optionally mentioned insulating layer can be forgone, if necessary, or the insulating layer is arranged above the moistening device (or downstream from the moistening device, respectively), so that it does not impact the moistening of the calcium silicate panel and is also not moistened itself.

As a whole, an arrangement or a system, respectively, can be realized by means of the measures according to the invention, which is suitable for heating as well as for cooling a room (in a combined system), namely with the described advantages. A CO2 neutral or virtually CO2 neutral heating as well as cooling can be performed in particular by using a heat pump and renewable energies (for the operation of the heat pump) and an enormous contribution to climate protection can thus be made.

CLAIMS

1. An arrangement for controlling the temperature of, in particular for cooling or heating, a room (1) in a building, with

   - a ceiling forming a supporting element (2),

   - at least one calcium silicate panel (3) arranged on the supporting element (2), which has a rear side (R) facing the supporting element (2) and a front side (V) facing away from the supporting element (2) and facing the room (1) and

   - at least one piping system, through which a temperature-control medium, e.g., water, can flow and is formed as capillary tube mat(4),

   wherein the capillary tube mat (4) is arranged on the rear side of the calcium silicate panel (3) between the supporting element (2) and the calcium silicate panel (3),

   whereas the calcium silicate panel (3) is fastened to the supporting element (2) or to a substructure by interconnecting the capillary tube mat (4), which is loosely placed onto the panel.

2. The arrangement according to claim 1, wherein the calcium silicate panel (3) has a thickness (D) of 1 cm to 5 cm, e.g., 1 cm to 4 cm, preferably 2 cm to 3 cm.

3. The arrangement according to claim 1 or 2, wherein the calcium silicate panel (3) is provided on its front side (V) with at least one cladding layer (7), e.g., with a (permeable) plaster layer and/or with a (permeable) paint layer.

4. The arrangement according to claim 3, wherein the calcium silicate panel (3) is plastered with a plaster layer of a calcium silicate plaster, wherein the plaster layer has a thickness of, e.g., 0.5 mm to 5 mm, preferably 1 mm to 3 mm.

5. The arrangement according to one of claims 1 to 4, wherein the capillary tube mat (4) is made of plastic, e.g., of polypropylene (PP) or on the basis of polypropylene (PP).

6. The arrangement according to one of claims 1 to 5, wherein an insulating material or an insulating material layer, respectively, is arranged between the capillary tube mat(4) and the supporting element (2).

7. The arrangement according to one of claims 1 to 6, wherein the calcium silicate panel (3) is fastened, e.g., screwed, to the supporting element (2) or to a substructure by interconnecting an insulating material.

8. The arrangement according to one of claims 1 to 7, wherein the capillary tube mat (4) is pre-fixed to the supporting element (2) or a substructure.

9. The arrangement according to one of claims 1 to 8, characterized by a moistening device for moistening the calcium silicate panel or calcium silicate panels, by means of which a moistening medium, e.g., water, can be applied or is applied, respectively, to the calcium silicate panel(s).

10. The arrangement according to claim 9, wherein the moistening device has one or several dispensing devices, e.g., nozzles, spray devices, splashing devices or dripping devices, which are arranged, e.g., above the calcium silicate panel.

11. The arrangement according to claim 9 or 10, wherein the moistening device has one or several measuring devices for determining the moisture content of the calcium silicate panel, e.g., moisture sensors, which are arranged in or on the calcium silicate panel.

12. The arrangement according to one of claims 10 to 11, wherein the moistening device has a control for a metered release of the moistening medium to the calcium silicate panel, wherein the control is preferably connected to the dispensing device and/or to the measuring device.

13. A method for the installation of a temperature-control arrangement according to one of claims 1 to 12, wherein one or several calcium silicate panels (3) are arranged to the supporting element (2) by interconnecting at least one capillary tube mat (4), so that the capillary tube mat (4) is arranged on the rear side of the calcium silicate panels (3) between the supporting element (2) and the calcium silicate panels (3) and the calcium silicate panels (3) face the room (1),

    whereas the calcium silicate panels (3) are fastened to the supporting element or to a substructure (8) by interconnecting the capillary tube mat (4), which is placed loosely onto the panel (3), and the piping system (6) is fixed thereby.

14. The method according to claim 13, wherein the capillary tube mat (4) is initially prefixed, e.g., tensioned, to the supporting element (2), i.e., to the ceiling or to the substructure (8) prior to fastening the calcium silicate panel (3) to the supporting element (2) or the substructure.

15. A method for controlling the temperature of a room (1), in particular for cooling or heating a room (1), by means of a temperature-control arrangement according to one of claims 1 to 12, which is arranged in the region of at least a ceiling, wherein a temperature-control medium flows through the capillary tube mat (4) and the temperature of the calcium silicate panel (3) is controlled thereby.

16. The method according to claim 15 for cooling the room (1), wherein the calcium silicate panel (3) is cooled via the capillary tube mat (4), through which a cooling medium flows and releases the cold to the room (1), e.g., as evaporation cooling, inter alia.

17. The method according to claim 15 or 16, for cooling the room (1), wherein the cooling, e.g., a cooling generator, is optionally activated and deactivated at time intervals, wherein the calcium silicate panel (3) is cooled to below the dew point when the cooling is activated (e.g. activated cooling generator) and the calcium silicate panel (3) absorbs the condensate created thereby and wherein the calcium silicate panel (3) releases the absorbed moisture to the room (1) when the cooling is deactivated (e.g., deactivated cooling generator).

18. The method according to claim 15 or 16, for heating the room (1), wherein the heating (e.g., a heat generator) is activated and deactivated at time intervals, wherein the calcium silicate panel (3) is heated up when the heating is activated.

19. The method according to one of claims 15 to 18, wherein the calcium silicate panel is moistened with a moistening medium, e.g., with water.

20. The method according to claim 19, wherein the moistening medium is applied to the calcium silicate panel as a function of the moisture content of the calcium silicate panel.

21. The method according to claim 19 or 20, wherein the calcium silicate panel is moistened with the proviso that the saturation level of the calcium silicate panel is at least 10%, preferably at least 20%, e.g., at least 30% and/or that the saturation level of the calcium silicate panel is 10% to 50%, e.g., 25% to 35%, for example approximately 30%.

22. The method according to one of claims 15 to 18, wherein the room to be cooled or to be heated is heated or cooled, respectively, by means of the supplied moistening medium when the heating/cooling is activated (e.g. activated heat pump) by means of radiant heat or radiant cooling, respectively, and by means of evaporation heat or evaporation cooling, respectively, when the heating/cooling is deactivated (e.g., deactivated heat pump).