A temperature control mat 5 is described, in particular for the rapid cooling of a vehicle seat covering 4. The temperature control mat comprises at least two interconnected thin films of plastic 5a, 5b, forming a fluid chamber system 10, and openings 11 distributed over the temperature control mat 5. For temperature control, initially a temperature control fluid is directed through the fluid chamber system. Subsequently, the system is emptied and an air stream is directed through a spacing structure 6, in order to dissipate moisture passing through the openings 11.
CONDITIONING SYSTEM FOR COOLING AND HEATING SURFACES, PARTICULARLY AUTOMOBILE SEATS

BACKGROUND OF THE INVENTION

[0001] The invention relates to a temperature control system, which can be used for the rapid cooling and possibly also heating of surfaces—in particular of car seats. In addition, the invention relates to a seat and/or rest element, in particular with leather covering, and to a complete car seat, respectively fitted with such a temperature control system. Finally, the invention also relates to a temperature control mat for such a temperature control system and to a temperature control method for cooling and possibly heating a seat and/or rest element.

[0002] It is known not only to heat but also to cool seats—in particular car seats. Cooling is necessary if car seats heat up under strong solar irradiation to high temperatures, which can lead to serious burns of the skin. This problem arises in particular in the case of dark leather seats. In general, the driver must wait until the seat has cooled down to a temperature comfortable for sitting, whether by means of the car’s air-conditioning system or by means of natural ventilation. Therefore, a fundamental concern is to lower the surface temperature of seats to a comfortable level in a short time.

[0003] It is known from U.S. Pat. No. 6,003,950 to provide between the seat covering and the cushion core a fiber-like insert which is enclosed by a film. The part of the film which faces the seat covering has openings for the passage of air. Air is then sucked through the seat covering and the insert by means of a fan, in order to cool the seat.

[0004] It is known from U.S. Pat. No. 6,254,179 B1 to arrange a meandering system of hoses or pipelines through which water flows in a flat cushion underneath the seat covering, in order to heat or cool the seat area according to requirements. The temperature of the water in the lines is controlled by means of a complex heat exchanger system, which is connected for example to the vehicle’s heating and air-conditioning system.

[0005] A system of a similar construction is also described in DE 44 32 497 A1. In this case, the pipeline system for the cooling liquid is arranged in a temperature control mat between two layers of air-permeable material, in order that condensed water possibly occurring on the lines can dry. The temperature control mat may serve as a seat support or be an integral component of the vehicle seat.

[0006] Because of the relatively rigid nature of the hoses or pipes, the system of pipes undesirably presses through the seat covering and adversely affects the feel of the seat. If the system of pipes is arranged further in the interior of the seat to remedy this disadvantage, however, a significant reduction in efficiency occurs because of the poor heat transfer associated with the greater distance from the temperature-controlling surface.

[0007] It is disadvantageous, furthermore, that, in the case of the previously described systems, no moisture resulting for example from the perspiration of a person sitting on the surface is removed. This may have the consequence on hot days of clothing becoming soaked with perspiration.

[0008] Instead of a liquid, a gas may also be used for controlling the temperature of the seat. Such a system is described for example in U.S. Pat. No. 4,572,430. In this case, temperature-controlled air is directed from the rear side into the seat and backrest cushion. The seat covering is air-permeable, so that the air can leave the seat again on the front side.

[0009] A similar system is proposed in U.S. Pat. No. 6,723,810 B1. There, the temperature-controlled air is directed into air chambers lying under the seat covering. Individual chambers are merely inflated and serve exclusively for increasing the comfort of the underlying structure of the seat. Other chambers are perforated on their side facing the seat covering and serve for controlling the temperature of the seat, in that the temperature-controlled air is forced to the outside through the perforation of the air-chamber wall and further through the seat covering, which is likewise perforated.

[0010] Although no lines press through the seat covering in the case of the two systems last described, the removal of moisture is not ideal in these cases either, although a certain drying is reliably achieved by the air stream emerging from the seat. However, the person sitting on the seat closes the pores in the seat, so that at these points the transporting of moisture and exchange of air is virtually completely blocked. Moreover, the air emerging from the open pores flows past the person, which is felt to be uncomfortable and may be harmful to health, in particular in the lumbar region.

[0011] In addition, perforated seat coverings, in particular made of leather, have a tendency to become clogged with dust and dirt particles and are also not desired for design reasons. A further disadvantage is that the systems described only begin to work when the car is started, i.e. the driver initially sits down on a hot seat, before the cooling of the seat begins.

[0012] It is therefore the object of the present invention to propose a solution for cooling heated-up surfaces—in particular of car seats with leather coverings—to a comfortable temperature in a very short time, and at the same time for ensuring efficient transporting away of moisture, in particular perspiration, through the seat covering. At the same time, sitting comfort and surface appearance are to be maintained.

[0013] This object is achieved by a temperature control system or temperature control mat and a method for controlling the temperature of a seat and/or rest element with the features of the independent patent claims. Advantageous developments and refinements of the invention are specified in claims dependent on these independent claims.

SUMMARY OF THE INVENTION

[0014] The temperature control mat according to the invention is, on the one hand, air-permeable and, on the other hand, comprises a fluid chamber system, through which a temperature control fluid is directed. For this purpose, two or more layers of liquid-impermeable plastic are connected to each other, for example welded or adhesively bonded, in such a way that the fluid chamber system is formed in the space between the layers of plastic. A number of fluid chamber systems that are separated from one another may also possibly be formed between the layers of plastic.
A fluid chamber system formed between the layers of plastic comprises one or more fluid chambers for receiving the temperature control fluid and one or more fluid inlets and outlets in connection with the fluid chambers for supplying and removing the temperature control fluid to and from the fluid chamber system. The maximum volume of the fluid chamber system in one embodiment may be 0.3 l/m² to 3 l/m². Some or all of the fluid chambers of the fluid chamber system are in flow connection with one another, so that the temperature control fluid can flow from the fluid inlet or the fluid outlets through the interconnected fluid chambers of the fluid chamber system to the fluid outlet or the fluid outlets. The connecting zones between the fluid chambers are referred to hereafter as “fluid passages”.

The air permeability of the temperature control mat is based on openings arranged in a distributed manner passing through the temperature control mat. These openings pass through the layers of plastic forming the fluid chamber system in such a way that the fluid chamber system forms a closed system.

To ensure the transporting of moisture through the seat covering, the temperature control mat is combined with an open spacer structure. Any two-dimensional, open structure which on the one hand permits a through-flow of gas to dissipate water vapor passing through the seat covering and on the other hand is adequately flexible and nevertheless stable under pressure, so that it does not collapse even under the weight of a person imparting a load to it, can be used as the spacer structure. The spacer structure may be securely connected to the temperature control mat, for example sewn or preferably adhesively bonded, so that the temperature control mat including the spacer structure can be easily handled and integrated into a seat. The spacer structure preferably lies between the temperature control mat and the seat cushion, so that the sequence of the layer structure is as follows: seat covering, temperature control mat, spacer structure, seat cushion, and any additional layers lying inbetween.

This arrangement is particularly effective, because the temperature control mat lies directly underneath the seat covering. This produces great heat conduction and short diffusion paths for water vapor. The perspiration moisture passing through the seat covering then passes through the openings in the temperature control mat and into the open spacer structure and can be diffused away from there. The transporting away of the moisture is preferably assisted by an air stream, which is directed through the spacer structure parallel to the surface of the seat covering, in order to remove the transmitted moisture actively. The temperature control mat on one side of the spacer structure and the seat cushion, usually consisting of closed-cell foam, on the other side of the spacer structure in this case define an air-direcing duct for the air directed through the spacer structure.

It goes without saying that it is also possible to provide the spacer structure on the other side of the temperature control mat, that is between the seat covering and the temperature control mat. In this case, the effectiveness of the temperature control mat is greatly reduced, however, because of the distance from the seat covering, and the through-openings in the temperature control mat are no longer important for allowing perspiration moisture through the temperature control mat. Rather, the openings can then be used for directing an air stream from the rear side through the openings of the temperature control mat into the spacer structure.

If such a temperature control mat combined with a spacer structure is placed in a seat and/or backrest element between the outer seat covering and the actual cushion material, the temperature of the seat covering can be influenced very rapidly and cooled down to body temperature within about 60 seconds. The cooling down of a leather seat covering from about 85° C. to a comfortable body temperature of 37° C. to 40° C. can be achieved for example in one minute. For this purpose, the temperature control fluid flows through the fluid chambers of the fluid chamber system until the desired seat surface temperature is reached. Preferably used as the temperature control fluid is an environmentally compatible liquid, for example water, possibly mixed with an anti-freezing agent, such as glyced or salt solution for example, and an anti-rotting agent and other additives. The use of liquid offers the advantage over a gas of greater heat capacity along with good heat transfer properties, whereby the temperature control of the seat covering is particularly effective.

On account of this effectiveness, the seat covering can be brought to the desired temperature in a very short time, even before a person sits down on it. For example, the temperature control can be switched on automatically when the vehicle is unlocked. Activation by remote control or a timer circuit is likewise possible. In particular, it is not necessary to start the vehicle in order to make the power required for the temperature control of the seat covering available. The temperature control liquid does not necessarily have to be cooled down to cool the seat covering, but may be pumped from a storage tank which is located at a relatively cool place, for example in the region of the vehicle floor, so that the temperature control liquid is at most at ambient temperature. This storage tank preferably has an insulating casing. The supply of liquid contained in it may be additionally cooled, for example during driving or possibly also when the engine is switched off, if the vehicle battery produces sufficient power. A Peltier element comes into consideration for example as the cooling element.

According to the same principle, the seat covering can be heated up. For this purpose, a heated fluid, such as water for example, flows through the fluid chamber system. In a preferred embodiment, the fluid is heated by a heating element to a temperature of approximately 40° C. to 50° C.

The temperature control fluid is pumped through the fluid chamber system until the desired temperature is reached. Subsequently, the fluid chambers of the fluid chamber system are pumped empty. Since the fluid chamber system is formed by interconnected films of plastic, the pumped-empty chambers collapse and form a largely planar surface. To ensure complete emptying of all regions of the fluid chamber system, it is advantageous to integrate spacers, for example thin fibers, woven or non-woven fabrics, into the fluid chamber system. When the fluid chamber system has been emptied, the temperature control mat consequently does not press through the seat covering, so that the original sitting comfort properties are restored immediately after the desired seat covering temperature is reached. The visual impression of the surface is not adversely affected by the temperature control mat. A person sitting on the seat does not feel the temperature control mat at all.
If a person then sits down on the seat, brought to an acceptable temperature in advance, this person will perspire to the usual extent or—in the case of hot outside temperatures—possibly also to an increased extent. In the case of conventional seats, this often leads to clothing that is against the seat covering becoming soaked by perspiration. In this connection, the openings arranged in a distributed manner in the temperature control mat are of great importance. This is so because these openings offer the possibility of removing this perspiration moisture passively or preferably actively. A precondition for this is firstly that the moisture can pass through the seat covering. In the case of textile coverings, this is readily ensured, since textile coverings act like a wick for moisture. Standard leather car seat coverings are not breathable, or scarcely so, i.e., they can at best only remove minimal amounts of water vapor. However, now there are also breathable leathers, which are adequately moisture-permeable without perforation, and can therefore be used for seat coverings. Instead of vapor-permeable leather coverings, it goes without saying that perforated leather may also be used for the seat covering.

Although the previously described temperature control mat is intended essentially for the cooling of surfaces, it can also be used for the heating of surfaces. The two functions can also be combined. A preferred embodiment provides for this purpose a bypass line in the fluid circuit, by which the cooling fluid reservoir is bypassed. In the bypass line there is a heating element, preferably a continuous flow heater, with which the temperature control fluid is heated, in order by this means to heat the surface. It goes without saying that the heating function of the temperature control mat according to the invention may also be combined with conventional heating elements, such as for example with an electrical resistance heater in the seat and/or backrest element and the like, merely to assist the latter.

The particular advantages achieved by the invention are to be seen in that it provides a rapidly acting temperature control system—in particular for rapid cooling/heating and efficient moisture removal—which does not adversely affect the sitting comfort or the appearance of the surface to be cooled, is effective and is not felt to be uncomfortable by a person sitting on the seat. In addition, the temperature control mat according to the invention can be handled easily and can be integrated into a seat and backrest element in a simple way.

A further advantage of the temperature control system according to the invention with the temperature control mat according to the invention is the resistance to the typical loads to which a seat element of a car seat is subjected. Car seats are subjected to sustained loads, which also have to be withstood by the temperature control system integrated into the seat. Conventional pipeline and hoseline temperature control systems can in this case be displaced and mechanically damaged considerably over time unless they are integrated into the seat element in a complex way. By comparison with this, the temperature control mat according to the invention can be securely connected in a simple way to the seat covering or the cushion core by adhesive bonding and/or sewing. But even without such fixing, the temperature control mat according to the invention is not displaced, because of its extent over a large area under the seat covering. This does not occur in particular if the temperature control mat is securely combined with a spacer structure. The high resistance of the temperature control mat according to the invention is also additionally based on the very smooth surface of the films of plastic of the temperature control mat—in particular in the case of fluoropolymers—which on account of this very property does not rub against the seat covering, so that no frictional wear occurs. Finally, it should also be mentioned that the layers of plastic forming the fluid chamber system may have additional reinforcing layers, for example in the form of a nylon woven fabric.

The aforementioned advantages can be optimized by suitable choice of the layers of plastic forming the fluid chamber system.

To be able to produce the temperature control mat in a simple way, the layers of plastic should be capable of being welded, laminated, coextruded, sintered or blow-molded with one another. In principle, the following materials are suitable for example: thermoplastic polyurethane (TPU), thermoplastic polyester (TPE), polylamide (PA), polytetrafluoroethylene (PTFE), expanded polytetrafluoroethylene (ePTFE), polyvinylidene fluoride (PVDF), ethylene/propylene copolymer (ETFE), fluorinated ethylene propylene (FEP) and other fluoropolymers. These materials are preferably fiber- or fabric-reinforced.

Of these materials, TPU is suitable to a particular extent because of its flexibility along with good affinity for adhesive bonding with other materials, in particular with leather. Fluoropolymers are suitable because of their diffusion impermeability and good sliding properties, and accompanying resistance to wear, but are less well able to bond adhesively with seat covering materials. Fluoropolymers are additionally highly temperature-resistant and are therefore particularly suitable in combination with a heating element integrated into the cushion. Such heating elements may be up to 120°C hot. A particularly temperature-resistant fluoropolymer is, for example, PTFE. Finally, fluoropolymers are distinguished by high chemical resistance, which is significant when additives are used in the temperature control fluid.

In addition, the layers of plastic from which the fluid chamber system is formed should be as thin and flexible as possible, in order that the fluid chamber system can be emptied without difficulties and thereby collapses without any major folds, so that the deactivated temperature control mat cannot be felt or seen through the cushion covering. The layers of plastic may, for example, respectively have a thickness in the range from 10 µm to 1 mm, good results having been achieved for example with a layer thickness of 200 µm in each case.

For a low-maintenance system, it is advantageous to operate the fluid circuit in the fluid chamber system as a closed system. In this case, great value should be attached to the diffusion impermeability of the films of plastic used, in order that fluid losses over the service life are kept low.

However, the variant of a partly open system is also possible. In this case, the emptying and complete filling of the fluid chamber system is additionally assisted by at least one of the layers of plastic forming the fluid chamber system being liquid-impermeable but air-permeable, at least in certain regions, so that an exchange of air can take place through the fluid-chamber wall, in particular the venting of
undesired inclusions of air. Particularly suitable in this connection is expanded polytetrafluoroethylene (ePTFE) with a low porosity, to keep the evaporation losses low during operation. Tests with a low porosity of, for example, 2% to 30% (measured with a Capillary Flow Porometer CFP-1500-AXLS from PMI—Porous Materials, USA) and a high water ingress pressure of over 6 bar have produced good results.

[0034] The openings in the temperature control mat which serve for moisture removal may comprise 20% to 80% of the projected surface area of each of the layers of plastic forming the fluid chamber system. Good results have been obtained for example with an opening surface area accounting for 30% to 40% of the projected total surface area. The contour of the openings may be chosen as desired. In particular, they do not have to be circular and may be of different sizes. The openings should offer the least possible diffusion resistance and therefore in any event be microscopic, in order not to hinder the moisture removal through the openings. An average opening diameter for example lie in the range from 1 mm to 30 mm. Good results have been obtained for example with an average opening diameter of approximately 5 mm. On account of the thin wall thickness of the fluid chamber system and the large openings passing through the fluid chamber system, a low diffusion resistance is achieved for the water vapor passing through the openings. Moisture-laden air can pass relatively unhindered through the openings into the spacer structure and is transported away by the air flowing through the spacer structure.

[0035] Just as the openings may have any desired contour, size and arrangement within the temperature control mat, the chambers of the fluid chamber system may also have extremely different forms. It goes without saying that a uniform arrangement of the fluid chambers is to be preferred for the purpose of uniform temperature control of the seat covering. There is in this case the possibility of realizing one or more fluid chamber systems in a temperature control mat, it being possible in turn for each fluid chamber system to have one or more fluid inlets and/or fluid outlets. One or more common fluid inlets and outlets may be provided, but fluid inlets and outlets that are independent from one another are to be preferred, to permit a continuous flow through the fluid chambers. It is particularly advantageous if precisely one fluid inlet and one fluid outlet are respectively provided for a seat element and a rest element and if the respective fluid chamber systems have numerous fluid chambers in fluid connection with one another, so that the temperature control fluid flows on one side into the fluid chamber system and flows through the numerous fluid chambers partly in parallel and partly in succession, in order subsequently to flow out again from the fluid outlet.

[0036] Such a structure is on the one hand uncomplicated in its production and integration into a circuit system. On the other hand, the flow paths are short, so that the flow resistance is low and the heat transfer over the entire length of flow is virtually uniform. The fluid passages formed between fluid chambers in connection with one another should have a length in the range from 3 mm to 50 mm, in order to achieve optimum mixing of the fluid.

[0037] An effective heat transfer is assisted furthermore by the fact that the temperature control mat, in the state in which temperature control fluid is flowing through it, swells slightly and presses against the seat covering. The total thickness of the filled temperature control mat ranges between approximately 0.5 mm and 10 mm.

[0038] The invention is explained below by way of example on the basis of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039] FIG. 1a shows a car seat with integrated temperature control mats schematically in cross section.

[0040] FIG. 1b shows the arrangement of the temperature control mats according to FIG. 1 in the car seat in plan view.

[0041] FIG. 2 shows the detail A from FIG. 1 during a cooling or heating phase.

[0042] FIG. 3 shows the same detail as FIG. 2 after a completed cooling or heating phase, during the moisture removal phase.

[0043] FIG. 4 shows the detail from FIG. 3 in realistic relative sizes.

[0044] FIG. 5 shows a first exemplary embodiment of a temperature control mat in plan view.

[0045] FIG. 6 shows a second exemplary embodiment of a temperature control mat in plan view.

[0046] FIG. 7 shows a third exemplary embodiment of a temperature control mat in plan view.

[0047] FIG. 8 shows a schematic representation of a temperature control circuit.

DETAILED DESCRIPTION OF THE INVENTION

[0048] FIG. 1a shows a car seat 1 comprising a seat element 2 and a backrest element 3. Located under the seat coverings 4 both of the seat element 2 and of the backrest element 3 there is in each case a temperature control mat 5, which is kept at a distance from the cushion core 7 by a spacer structure 6. Water (H₂O) is pumped as a temperature control fluid by means of a pump P from a storage tank 9 through the temperature control mat 5 through a system of fluid lines 8, which is represented as dashed lines with thin, black arrows, in order to control the temperature of (temperature control phase), in particular to cool (cooling phase), the seat covering 4 from the rear side. After completion of the temperature control phase, air is made to flow through the spacer structure 6 by means of a fan (white arrows), in order to assist the dissipation of perspiration moisture passing through the seat covering 4.

[0049] FIG. 1b shows the arrangement of the temperature control mat 5 in the car seat 1 according to FIG. 1 in plan view.

[0050] The cooling phase (or heating phase) is schematically represented in cross section in FIG. 2 in somewhat more detail. The temperature control mat 5 comprises regularly arranged, interconnected fluid chambers 10, the individual fluid chambers being spaced apart from one another by openings 11 penetrating through the temperature control mat 5. When the fluid chamber system formed by fluid chambers 10 is filled with the cooling liquid, the fluid chambers 10 expand to a thickness which should lie between
0.5 and 10 mm, and come to bear closely against the rear side of the seat covering 4. As a result, a particularly effective heat transfer is achieved between the temperature control fluid in the fluid chambers 10 and the seat covering 4. The flow through the fluid chamber system may take place intermittently or continuously. The structure of the fluid chamber system presses slightly through the seat covering 4 in this temperature control phase.

[0051] When a desired seat covering temperature has been reached, a shut-off valve, not represented in FIG. 1, in the supply line of the system of fluid lines 8 to the temperature control mat 5 is closed and all the temperature control fluid remaining in the temperature control mat 5 is pumped back into the storage tank 9. When this happens, the fluid chambers 10 collapse, so that the temperature control mat 5 also collapses. This is schematically represented in somewhat more detail in FIG. 3. On account of the thin and flexible films of plastic from which the fluid chamber system is formed, the temperature control mat 5 in the collapsed state no longer presses through the seat covering 4. Any minor folds are not significantly noticeable.

[0052] If a person sits down on the temperature-controlled seat after the cooling phase, the second temperature control phase begins, aimed at removing moisture perspired by the person through the seat covering 4 and the openings 11 of the temperature control mat 5. For this purpose, the spacer structure 6 is provided between the cushion core 7 and the temperature control mat 5. Any open structure which on the one hand is flexible, in order to make the seat comfortable to sit on, but on the other hand cannot be completely compressed under exposure to pressure, so that ventilation through the spacer structure 6 remains ensured even under any circumstances, comes into consideration as the spacer structure 6. Suitable for example are nonwoven or knitted polymer-fiber fabrics. The dissipation of the moisture transported through the seat covering 4 is assisted by an actively produced air stream in the spacer structure 6, which is indicated in FIG. 3 by arrows.

[0053] The detail represented in FIG. 3 is reproduced once again in FIG. 4, enlarged with the individual layers in realistic proportions. The seat covering 4 has, for example, a thickness of 1.2 mm and is water-vapor-permeable.

Breathable leather, micro-perforated leather, microfibers such as Alcantara or a woven textile covering may be used as the material for the seat covering. The seat covering should preferably have a Ret value of 5 to 20 m²Pa/W. The Ret value, as a specific material property of textile fabrics and other textile material structures, defines their water-vapor transmission resistance. In this case, the latent evaporation heat flux through a given area in consequence of an existing steady-state partial pressure is determined. The Ret value is ascertained by means of the Hohenstein skin model test, which is described in the standard test specification No. BPI 1.4 of September 1987 of the Bekleidungsphysiologisches Institut e.V. Hohenstein.

[0054] If it is a leather covering, it has usually largely sealed by a protective layer 12. The moisture permeability of a leather seat covering 4 therefore depends essentially on the water-vapor transporting properties of the protective layer 12. For the purposes of the present invention, the leather covering should preferably have an MVTR value (according to DIN 53 333) of greater than 10 mg/cm²h. Breathable leathers with an MVTR value of more than 12 mg/cm²h are particularly preferred. Such leathers are obtainable for example from the Vogl leather factory in Mattinghofen/Austria. In the case of a non-breathable, in particular fully sealed leather covering, a micro-perforation of the covering also comes into consideration. This is to be understood as meaning a leather with pores usually produced in a needling process, with a pore diameter of 80 µm to 100 µm. Microperforated leathers with a thickness of between 1.9 mm and 2.5 mm achieve an MVTR value of between 2 and 6 mg/cm²h, which may be adequate for the purposes of the invention.

[0055] The perspired moisture then diffuses through the breathable seat covering 4 to the temperature control mat 5 from the openings 11 of the temperature control mat 5 through the openings 11 of the temperature control mat 5. Breathable leathers with a thickness of plastic 5a, 5b, lying one on top of the other and connected to each other in a suitable way. In the emptied state, the temperature control mat 5 has a slightly rough surface due to fold formations of the thin films of plastic 5a, 5b. As a result, moisture can also reach an opening 11 of the temperature control mat 5 from those points of the seat covering 4 under which an opening 11 is not directly located.

[0056] On account of the two thin films 5a, 5b with a thickness of for example 200 µm in each case, the path through the openings 11 is very short. In one embodiment, the filled temperature control mat 5 has a thickness of 4 mm. In particular, no build-up of moisture forms in the openings 11 and no boundary layer forms between the air in the openings 11 and the air flowing through the spacer structure 6, so that the moisture diffused through the seat covering 4 is reliably entrained by the air stream in the spacer structure 6. For the same reason, the openings of the temperature control mat 5 from those points of the seat covering 4 under which an opening 11 is not directly located.

[0057] The spacer structure 6 has, for its part, a thickness of approximately 6 mm to 10 mm in the exemplary embodiment represented. Depending on the material used for the spacer structure 6, it may be meaningful to make the spacer structure 6 thicker or thinner.

[0058] With its rear side, the spacer structure 6 is adjacent to the cushion core 7, which is for example a closed-cell foam core. The air stream directed through the spacer structure 6 (arrow) is therefore guided essentially parallel to the covering between the temperature control mat 5 and the closed-cell cushion core 7.

[0059] The spacer structure 6 and the temperature control mat 5 may be adhesively bonded to each other, whereby the entire arrangement can be easily handled and can be correspondingly easily integrated into a car seat. If the temperature control mat 5 is not adhesively bonded to the spacer 6, it is essential that the spacer structure 6 has a non-abrasive surface, since otherwise damage to the thin films of plastic 5a, 5b of the temperature control mat 5 would have to be feared in the long term.

[0060] The temperature control mat 5 is preferably connected, preferably adhesively bonded, to the seat covering 4—with or without spacer structure 6. As a result, rubbing between the seat covering 4 and the temperature control mat
is avoided, whereby the service life of the temperature control mat 5 is correspondingly increased.

[0061] The necessary air throughput through the spacer structure 6 for removing moisture from the seat covering 4 is extremely low, since only little moisture is removed through the seat covering. Therefore, it is adequate if air is blown from the passenger compartment of the vehicle through the spacer structure 6 in an uncomplicated way by means of a simple fan with a power of, for example, 0.3 to 3 W. In one embodiment, the spacer structure 6 is connected directly or indirectly to the vehicle’s ventilation system or air-conditioning system.

[0062] In FIG. 5, a first exemplary embodiment of a temperature control mat 5 is represented in plan view. The temperature control mat 5 comprises two films which are welded or laminated to each other and penetrated by regularly distributed openings 11. As a result, a fluid chamber system comprising numerous fluid chambers 10 in connection with one another is formed. The two interconnected films 5a, 5b may also be produced by a blow-molded and laid-flat film bubble or by coextrusion, the openings 11 being cut out from the film stack in a subsequent method step with simultaneous welding of the films.

[0063] Water (H₂O) as the temperature control fluid is directed into the fluid chamber system via a fluid inlet 13 and out again through a fluid outlet 14. The temperature control fluid H₂O is thereby distributed uniformly in the fluid chamber system and—by contrast with a meandering system of lines—passes from the fluid inlet 13 to the fluid outlet 14 over a relatively short path. However, as a departure from the exemplary embodiment represented in FIG. 5, the fluid chamber system may also have one or more line-like fluid chambers, which are arranged in a parallel or meandering manner. A number of fluid inlets and/or fluid outlets may also be provided. However, the exemplary embodiment according to 5 is particularly efficient, can be easily produced and can be integrated with little effort into the seat because of the only two inlets and outlets.

[0064] FIG. 6 shows a second exemplary embodiment of a temperature control mat 5 likewise schematically in plan view. In this case, the openings 11 are arranged offset in relation to one another, whereby they are packed more closely and the removal of moisture through the openings is correspondingly more effective.

[0065] FIG. 7 shows a third exemplary embodiment of a temperature control mat 5 likewise schematically in plan view. In this case, two fluid inlets 13 and two fluid outlets 14 are provided. Fluid can flow via a fluid-inlet distributing chamber 13a and a fluid-outlet collecting chamber 14a simultaneously into one and from a plurality of fluid chambers 10 adjacent thereto, which for their part are arranged partly in parallel and partly one behind the other in the direction of flow. The fluid chambers 10 define fluid passages of any desired length, which should preferably have a length of approximately 50 mm or less. Between the fluid chambers 10, the films forming the temperature control mat 5 are welded to each other. Provided in these welded regions are the openings 11, through which the moisture removal takes place. The temperature control mat 5 is in this case fixed on the seat cushion, not represented here, by means of seams 22. However, adhesive bonding is to be preferred, since it does not show in the seat covering.

[0066] FIG. 8 schematically shows a suitable temperature control system. Water H₂O is pumped by means of a pump P from the storage tank 9 through the temperature control mat 5 and back into the storage tank 9. The volume of temperature control fluid in the overall system may lie, for example, in the range from 500 ml to 1500 ml, the storage tank 9 holding for example 800 ml or 1000 ml and the temperature control mat 5 holding between 50 ml and 250 ml, for example 200 ml. The operating pressure of the pump P lies in the range between 0.2 and 2 bar, for example approximately 0.5 bar. The pump running time preferably lies between 10 seconds and 120 seconds, but as far as possible should not exceed 90 seconds. The power necessary for this can be comfortably provided by the vehicle’s own battery. Even if the temperature control fluid in the storage tank 9 is at ambient temperature of 32° C. to 40° C., it is possible with this system for a leather seat covering for example to be brought to a desired temperature of approximately 37° C. to 44° C. in a maximum of 90 seconds. Cooling by 40 K within less than 60 seconds is achievable. If the seat covering temperature is lowered to 35° C., for example, the temperature control mat 5 is pumped empty and the pump P is stopped. It goes without saying that higher operating pressures are also possible, provided that the fluid chamber system is designed for higher pressures. Operating pressures of 1.5 to 2 bar are currently realistically achievable. For safety reasons, the temperature control mat should withstand operating pressures of up to approximately 3 bar. The higher the operating pressure, the harder the temperature control mat 5 presses against the seat covering and the more effective the heat transfer and consequently the temperature control of the seat covering. Consequently, the heat transfer can be controlled by the system pressure.

[0067] The temperature in the storage tank 9 can be monitored by means of a temperature sensor and if need be cooled down by a suitable cooling device. A Peltier element is suitable for example as the cooling device 15. In addition, the storage tank 9 is encased with an insulation 16, in order to prevent heat exchange with the warmer surroundings.

[0068] Once the desired seat covering temperature has been reached, the valve 17 in the supply line of the system of fluid lines 8 is blocked and the temperature control mat 5 is pumped empty. In the subsequent moisture removal phase during driving, air is directed past the spacing structure 6, not represented in FIG. 6, on the temperature control mat 5, as described above, by means of a simple fan.

[0069] A special development provides a bypass 18, with which the cooling fluid storage tank 9 is bypassed. By appropriate switching of the shut-off valve and a further shut-off valve 19, which are accordingly formed as multi-way valves, the fluid present in the temperature control system can be directed through the bypass 18 and heated by means of a heating element 20 arranged therein, for example a continuous flow heater. As a result, the temperature control system may serve both as seat heating and as seat cooling. On account of the operating pressure, the temperature control mat 5 in turn presses against the seat covering 4, whereby an efficient heat transfer is ensured. This heat transfer is additionally assisted by the weight of the person sitting on the seat. The heating element can be regulated by a temperature sensor 21 arranged in the discharge line of the system of fluid lines 8. Further temperature sensors 21 are provided in the temperature control mat or directly on the
seat covering and in the cooling liquid storage tank 9. All the temperature sensors 21 are connected to a control system, not represented, in which the measured temperature values are processed and the individual components of the temperature control system are correspondingly controlled.

Test Result

[0076] With the system described above it was possible to lower the surface of a leather seat covering from a starting temperature of 85°C to a temperature of 44°C within less than 1 minute, the temperature control liquid comprising a temperature of 40°C and the system an overall volume of 800 ml.

We claim:

1. A temperature control mat (5), in particular for use in a seat element (2) and/or rest element (3), comprising:
   - at least two layers of liquid-impermeable plastic (5a, 5b), which are connected to each other in such a way that they form a fluid chamber system in between;
   - at least one fluid inlet (13) and at least one fluid outlet (14) for directing a fluid through the fluid chamber system; and
   - openings (11), which are arranged in a distributed manner in the at least two layers of plastic (5a, 5b) and penetrate the latter in such a manner that water vapor can pass through the openings (11) past the fluid chamber system.

2. The temperature control mat as claimed in claim 1, the openings (11) forming 20% to 80% of the projected surface area of the interconnected layers of plastic (5a, 5b).

3. The temperature control mat as claimed in claim 2, the fluid chamber system having a maximum volume of 0.3 l/m² to 3 l/m².

4. The temperature control mat as claimed in claim 1, the openings (11) having an average diameter in the range from 1 mm to 20 mm.

5. The temperature control mat as claimed in claim 2, the openings (11) having an average diameter in the range from 1 mm to 20 mm.

6. The temperature control mat as claimed in claim 1, the at least two layers of plastic (5a, 5b) being connected to each other in such a way that, when the fluid chamber system is filled with a fluid, the maximum distance between the at least two layers of plastic lies from 0.5 mm to 10 mm.

7. The temperature control mat as claimed in claim 2, the at least two layers of plastic (5a, 5b) being connected to each other in such a way that, when the fluid chamber system is filled with a fluid, the maximum distance between the at least two layers of plastic lies in the range from 0.5 mm to 10 mm.

8. The temperature control mat as claimed in claim 3, the at least two layers of plastic (5a, 5b) being connected to each other in such a way that, when the fluid chamber system is filled with a fluid, the maximum distance between the at least two layers of plastic lies in the range from 0.5 mm to 10 mm.

9. The temperature control mat as claimed in claim 1, the at least two layers of plastic (5a, 5b) being connected to each other in such a way that the fluid chamber system is subdivided into a number of chambers (10), each chamber (10) defining a fluid passage.

10. The temperature control mat as claimed in claim 3, the at least two layers of plastic (5a, 5b) being connected to each other in such a way that the fluid chamber system is subdivided into a number of chambers (10), each chamber (10) defining a fluid passage.

11. The temperature control mat as claimed in claim 9, the fluid passages being formed with an average length in the range from 3 mm to 15 mm.

12. The temperature control mat as claimed in claim 9, a number of or all the fluid passages being connected to a common fluid distributing chamber (13a) and/or fluid collecting chamber (14a).

13. The temperature control mat as claimed in claim 11, a number of or all the fluid passages being connected to a common fluid distributing chamber (13a) and/or fluid collecting chamber (14a).

14. The temperature control mat as claimed in claim 11, one or more common fluid inlets and outlets being provided.

15. The temperature control mat as claimed in claim 1, a single fluid inlet (13) and a single fluid outlet (14) being provided for the entire temperature control mat.

16. The temperature control mat as claimed in claim 9, a single fluid inlet (13) and a single fluid outlet (14) being provided for the entire temperature control mat.

17. The temperature control mat as claimed in claim 1, each of the at least two layers of plastic having a thickness in the range from 10 μm to 1 mm.

18. The temperature control mat as claimed in claim 11, the thickness of each of the at least two layers of plastic being approximately 200 μm.

19. The temperature control mat as claimed in claim 1, at least one of the at least two layers of plastic being air-permeable, at least in certain regions.

20. The temperature control mat as claimed in claim 1, at least one of the layers of plastic consisting of thermoplastic polyurethane (TPU).

21. The temperature control mat as claimed in claim 1, at least one of the layers of plastic consisting of a fluoropolymer.

22. The temperature control mat as claimed in claim 20, at least one of the layers of plastic consisting of a fluoropolymer.

23. The temperature control mat as claimed in claim 21, the fluoropolymer being polytetrafluoroethylene (PTFE).

24. The temperature control mat as claimed in claim 23, the PTFE being compressed, expanded polytetrafluoroethylene (ePTFE) with a porosity in the range from 2% to 30%, in order to assist the venting of the fluid chamber system.

25. A seat element (2) and/or rest element (3) with an outer covering (4) and a cushion core (7) under the outer covering and with a temperature control mat (5) positioned between the covering (4) and the cushion core (7), as claimed in claim 1.

26. The seat element and/or rest element as claimed in claim 25, an open spacer structure (6) being provided between the covering (4) and the cushion core (7), in order to permit ventilation through the spacer structure (6).

27. The seat element and/or rest element as claimed in claim 26, the spacer structure (6) being positioned between the temperature control mat (5) and the cushion core (7).

28. The seat element and/or rest element as claimed in claim 25, the temperature control mat (5) not pressing visibly through the surface of the outer covering (4).
29. The seat element and/or rest element as claimed in claim 25, the cover (4) comprising a water-vapor-permeable leather material.

30. The seat element and/or rest element as claimed in claim 29, leather material having an MVTR value of over 10 mg/cm²/h, in particular greater than 12 mg/cm²/h.

31. The seat element and/or rest element as claimed in claim 25, the temperature control mat (5) being connected to the covering (4).

32. The seat element and/or rest element as claimed in claim 25, the spacer structure (6) being connected to the temperature control mat (5).

33. A temperature control system comprising a seat element (2) and/or rest element (3) as claimed in claim 25 and further comprising a liquid circuit system, to which the temperature control mat having one or more common fluid inlets and outlets, is connected via the fluid inlet and outlet openings (13, 14).

34. The temperature control system as claimed in claim 33, further comprising in the liquid circuit system a pump (P) downstream of the outlet (14), in order to suck liquid through the fluid chamber system, and an inlet shut-off valve (17) upstream of the inlet (13), in order to interrupt the liquid flow into the fluid chamber system.

35. The temperature control system as claimed in claim 33, further comprising ventilation to produce an air stream over a surface of the temperature control mat (5), in order to dissipate moisture and vapor entering the seat element (2) and/or backrest element (3) through the covering (4).

36. The temperature control system as claimed in claim 33, further comprising a cooling device (15) in the liquid circuit system for cooling the liquid.

37. The temperature control system as claimed in claim 33, the cooling device (15) being set up such that the necessary power for the cooling device can be provided by the vehicle’s own battery.

38. The temperature control system as claimed in claim 37, the cooling device (15) being activatable by remote control or time switches.

39. The temperature control system as claimed in claim 33, further comprising a liquid reservoir (9), the cooling device (15) being provided for cooling the liquid in the liquid reservoir (9).

40. The temperature control system as claimed in claim 39, further comprising an insulation (16) for the liquid reservoir (9).

41. The temperature control system as claimed in claim 33, further comprising a heating device (20) in the liquid circuit system for heating the liquid.

42. The temperature control system as claimed in claim 36, further comprising a heating device (20) in the liquid circuit system for heating the liquid.

43. The temperature control system as claimed in claim 41, further comprising a bypass line (18), through which the liquid in the liquid circuit system is directed when the heating device (20) is activated.

44. A vehicle seat comprising:

a seat element (2) and/or rest element (3) having an outer covering (4) and a cushion core (7) under the outer covering;

e a temperature control mat (5) positioned between the covering (4) and the cushion core (7), wherein the temperature control mat (5), comprises:

at least two layers of liquid-impermeable plastic (5a, 5b), which are connected to each other in such a way that they form a fluid chamber system in between;

at least one fluid inlet (13) and at least one fluid outlet (14) for directing a fluid through the fluid chamber system; and

openings (11), which are arranged in a distributed manner in the at least two layers of plastic (5a, 5b) and penetrate the latter in such a manner that water vapor can pass through the openings (11) past the fluid chamber system.

45. A vehicle seat as claimed in claim 44, further comprising a temperature control system comprising a liquid circuit system, to which the temperature control mat having one or more common fluid inlets and outlets, is connected via the fluid inlet and outlet openings (13, 14).

46. The vehicle seat as claimed in claim 45 having a temperature control system further comprising a liquid reservoir (9), and a cooling device (15) being provided for cooling the liquid in the liquid reservoir (9), wherein the liquid reservoir (9) being arranged underneath the vehicle seat.

47. A vehicle seat as claimed in claim 44 further comprising a spacer structure (6) being positioned between the covering (4) and the cushion core (7), in order to permit ventilation through the spacer structure (6).

48. A method for controlling the temperature of a seat element and/or rest element, the seat and/or rest element having an outer covering (4) and, under the covering (4), a cushion core (7), comprising:

passing a cooling or heating fluid into a closed fluid chamber system, which is positioned between the covering (4) and the cushion core (7), so that the fluid chamber system fills with the fluid; and

when a setpoint temperature is reached at a predetermined point of the seat and/or rest element, draining the fluid from the fluid chamber system, whereby the fluid chamber system empties.

49. The method as claimed in claim 48, wherein the fluid chamber system inflates during filling and collapses during emptying.

50. The method as claimed in claim 48, the fluid being passed constantly or intermittently through the fluid chamber system when the fluid chamber system is filled with fluid.

51. The method as claimed in claim 48, further comprising the step of producing an air stream over a surface of the fluid chamber system.

52. The method as claimed in claim 48, the fluid being a liquid.

53. The method as claimed in claim 48, comprising using a temperature control system comprising a seat element (2) and/or rest element (3) having an outer covering (4) and a cushion core (7) under the outer covering, and a temperature control mat (5) positioned between the covering (4) and the cushion core (7), wherein the temperature control mat (5) comprises:

of at least two layers of liquid-impermeable plastic (5a, 5b), which are connected to each other in such a way that they form a fluid chamber system in between;
at least one fluid inlet (13) and at least one fluid outlet (14) for directing a fluid through the fluid chamber system; and

openings (11), which are arranged in a distributed manner in the at least two layers of plastic (5a, 5b) and penetrate the latter in such a manner that water vapor can pass through the openings (11) past the fluid chamber system,

and further comprising a liquid circuit system, to which the temperature control mat having one or more common fluid inlets and outlets, is connected via the fluid inlet and outlet openings (13, 14).

54. A method as claimed in claim 48 comprising providing an open spacer structure (6) between the covering (4) and the cushion core (7), in order to permit ventilation through the spacer structure (6), comprising the step of directing an air stream through the spacer structure (6) parallel to the covering (4).