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Mass and heat transfer surface
as well as
mass and heat transfer reactor with such a
mass and heat transfer surface

5 The invention concerns a mass and heat transfer surface in accordance with Claim 1 and a mass and heat transfer reactor using such a mass and heat transfer surface in accordance with Claim 10 as well as a process to dehumidify and cool air using such a mass and heat transfer reactor.

10 In air conditioning units for the air conditioning of buildings and in applications for process technology the problem often arises, that a certain air flow is to be cooled and dehumidified. For air dehumidification contact reactors are used, in which the airborne water vapour is being absorbed by hygroscopic substances (sorbents). During this absorption process the sorbents become saturated by adhesion of water vapour and are reconditioned in a subsequent desorption process. For this
15 process the sorbent and/or the air surrounding the sorbent is/are heated to a specific reconditioning temperature, at which the sorbent releases the water back into the air. The reconditioned sorbent is then used again for the absorption process.

20 For these processes absorbers are used, which operate either with suitable hygroscopic liquids (Kathabar Systems, USA; Albers Air, USA) or with hygroscopic solids (e.g. Munters Corporation, Sweden; Siegle & Epple, Germany). An appropriate apparatus is described by Munters in the US-Patent 4,002,040. Furthermore, reactors are known, in which the liquid sorbent is sprinkled onto vertical panels of a plate type heat exchanger bundle, which are cooled during the process. (Ficom Pty. Ltd., Australien). Besides that, so called "thin film reactors" are
25 known, in which a liquid sorbent is distributed by means of a mechanical wiper to form a thin film on the mass and heat transfer surface.

30 All the devices mentioned above have the following disadvantages, which become apparent in particular during absorption or desorption of water vapour by means of liquid sorbents (desiccants). The sorbents are usually watery salt solutions and are extremely corrosive especially at the higher temperatures prevailing during desorption. Therefore either the use of extremely corrosion resistant steel is

mandatory or the steel needs to be coated with a protective layer (e.g. enamel). These measures are extremely expensive. If cheaper materials are used, e.g. plastics (Polymers), the problem arises, that a continuous moistening of the plastic surfaces is extremely difficult to accomplish due to the hydrophobic properties of plastics (Polymers). To establish a sufficiently continuous closed film on the mass transfer surface, a much larger amount of salt solution needs to be applied than required for the purpose of carrying (absorbing) the respective amount of water vapour. A massflow ratio (air / salt solution) which is close to the physically-chemically required ratio can therefore not be established. This results in higher power requirements for pumping and higher investment cost. Furthermore, a significant change of the concentration in the salt solution cannot be accomplished and consequently a cost efficient storage of salt solution and thus dehumidification energy (potential) is not possible. Other reasons for the less than ideal heat and mass transfer are often disadvantageous flow directions of the media (air, sorbent).

In most cases a sufficiently high temperature spread of the heating and cooling media is not accomplished, which increases the cooling water demand and reduces the surface-specific efficiency of the re-cooler. This in turn causes additional cost. Furthermore, by sprinkling or spraying the sorbent onto the surface, droplets are being generated, which are detached from the mass and heat transfer surface and may be carried out of the reactor by the airflow, unless they are restrained by a special separator. Such separators lead to higher manufacturing cost and also to an increased pressure loss in the airflow and consequently to higher operation cost due to additionally required fan power.

DE 40 36 932 A1 describes a sintered metal coating on a base plate with small solid particles, which are fixed to the base plate and provide small voids in between. However, this known porous layer cannot and is not supposed to assist forming a thin liquid film but on the contrary, is supposed to cause an amount of liquid to boil i.e. vaporise. This is achieved by the large inner surface of the sintered metal layer. Even if this was desired, it would be impossible to create an extremely thin and continuous film of liquid with this known sintered metal layer. If the liquid was applied onto the sintered metal layer (without boiling it by means of heat input), the sintered metal structure would absorb the liquid like a sponge. Only after saturation of the sintered metal layer a continuous film would form on the surface. However, this film of liquid is then no longer extremely thin, as it's thickness is equivalent to the thickness of the sintered metal layer. Only the surface of the soaked sintered metal layer would be

available for the mass transfer. The majority of the liquid volume is not available for the mass transfer, as it is impossible to create an extremely thin film of liquid by using the layer of sintered metal in accordance with D5.

Also from DE 691 01 298 T2 and DE 694 18 915 T2 heat transfer surfaces are
5 known, which are equivalent to DE 40 36 932 A1 with regard to the structure of the heat transfer surface.

DE 692 01 860 T2 describes a mass and heat transfer element, where a porous and heat conducting material is applied onto a porous and gas permeable wall. In this case the mass transfer is achieved through the porous wall.

10 The objective of DE 199 49 437 A1 is, "to develop a layered device which has a great internal stability due to integrated support members while containing an insulating agent in the form of a micro-porous solid matter, which is a free flowing bulk material and on the other hand can be used for storage of thermal energy via the adsorption/desorption mechanism". Depending on the layer material, it serves to
15 insulate or as a thermal energy storage. In any case, a transfer of thermal energy takes place. As the storage of thermal energy is based on the adsorption/desorption mechanism, a mass transfer takes place. However, a mass transfer does not take place continuously, but only until saturation (in case of adsorption) of a micro-porous solid matter, which acts as the adsorbent.

20 The patent publications DE 34 39 526, DE 36 27 266, DE 29 18 932, DT 26 05 753 und DE 35 11 126 describe the use of devices and processes to distribute liquid on a surface for mass and heat transfer by using a non-woven, bonded fabric.

However, these bonded, non-woven fabrics have the following disadvantages:

Non-woven fabrics are prone to be clogged by dust particles, which are carried
25 by the air, which is to be dehumidified.

Mechanical roughening of the surface leads to a non-homogenous surface on the reactor plates and to an incomplete moistening of the mass and heat transfer surfaces. The same applies to the surface treatment with plasma.

Non-woven fabrics made from plastics are not sufficiently hydrophilic and
30 therefore can hardly reduce the interface tension between plate material and sorbent to significantly improve the moistening of the surface. Their ability to improve the

moistening is based on the so-called "capillary effect". Some of these non-woven fabrics are coated with substances, which cause a temporary hydrophilic effect on their surface. However, these substances are washed out during operation and become ineffective. Besides, these substances are then carried in the recycled sorbent and change its properties to its disadvantage.

In combination with the used liquids, non-woven fabrics made from natural fibres are not stable in the desired process conditions. They dissolve in these liquids.

Many non-woven fabrics cannot withstand the combined stress of exposure to temperature (5°C - 100°C) and chemicals during the reconditioning process of the diluted sorbents and are destroyed.

Non-woven fabrics are relatively expensive when used as a means to improve the moistening of surfaces inside dehumidifiers. They are usually not fixed permanently to the surfaces, but loosely attached between the plates of the mass and heat transfer bundle, held in place by brackets or wedged in by some other kind of attachment device. Such devices protrude into the free airflow cross-section and consequently cause additional pressure loss due to increased flow-resistance in the gas (air) stream. Furthermore, a large portion of the liquid flows down between non-woven fabric and heat and mass transfer plate without getting into direct contact with the process gas. It therefore hardly participates in the mass transfer. A further problem related to the partial fixture of the non-woven fabrics on the transfer surface is posed by "pocket-formation", where liquid is trapped in wrinkles or bulges of the non-woven fabric and the fabric commences to flutter due to the gas flow. This also leads to undesired pressure loss and can even lead to partial obstruction of the free cross section and hamper the mass transfer. In case the non-woven fabric is loosely or only partially attached to the plate, a wrinkle-free installation is difficult.

With a mass and heat transfer reactor in accordance with DE 43 21 743 A1 the majority of the above mentioned problems is solved. In this publication a mass and heat transfer reactor is described, which integrates duct systems within one reactor, which keeps the substance in the heat transfer duct system isolated from the mass transfer duct system but allows heat transfer between the two circuits. The reactor consists of a multitude of stacked reactor double-plates, standing upright and separated from each other. A heat transfer duct system is contained inside each plate and between two neighbouring plates a mass transfer duct system is formed. At the

upper end of the vertical reactor double plates, a liquid distributor is attached and the outer surfaces of the reactor double plates serve as mass and heat transfer surfaces and are moistened by the liquid distributor. To establish a thin film on the mass and heat transfer surfaces, the surfaces are either equipped with a non-woven fabric,
5 mechanically roughened or plasma treated. The use of a non-woven fabric leads to a relatively thick "thin film" with the disadvantages mentioned earlier.

Therefore the task of the invention described herein is to further develop the mass and heat transfer surfaces known from DE 43 21 743 A1 and the mass and heat transfer reactor known from DE 43 21 743 A1 in such a way, that a formation of a
10 very thin liquid film can be ensured, which extends evenly over the entire mass and heat transfer surface of the mass and heat transfer reactor.

The solution of this task is achieved by the characteristics described in Claims No. 1 and 10, respectively.

A coating or surface structure respectively, to reduce the effect of surface
15 tension of the mass and heat transfer surface with small and smallest solid particles, is appropriate for the generation of a very thin and yet continuous liquid film. The formation of an extremely thin, continuous liquid film requires a thin coating with solid particles, preferably with only one or merely a few layers of these solid particles. The solid particles are fixed on the base surface, arranged next to each other
20 and at least partially in contact with each other in such a way that gaps and voids remain between them. These gaps and voids cause the capillary effect which ensures the continuous moistening of the mass and heat transfer surfaces.

Due to their shape in combination with this directly adjacent arrangement, these solid particles form a zone of a strong capillary effect. This effect is strong
25 enough to overcome the interfacial tension, which prevents the formation of a continuous film, and thus enables the formation of a continuous liquid film.

At the same time the contact surface between coating body and liquid, dependent on the carrier materials used, has a lower interfacial surface tension than the uncoated contact surface between carrier material and liquid. This fact promotes
30 the moistening and thus the formation of the film.

If the vapour pressure of the moistening liquid or one of its components is negligible compared to the surrounding gaseous media, the liquid remains in the gaps

and voids between the solid particles forming the coating and the base surface even during a shutdown of the reactor. During restart of the process this enables an immediate coalescence of liquid which is freshly applied onto the coating with liquid having remained in the coating to an extensive, continuous thin film.

5 This additionally provides the option, to vary the relation between gas and liquid flow rate by varying the liquid flow rate significantly during operation without destroying the continuous liquid film.

By varying the size of the solid coating particles the coating can be adapted with regard to its film generating properties to suit liquids with varying properties
10 and to suit various processes.

In accordance with an advantageous design of the invention in accordance with Claim 2, the individual solid particles are approximately equal in size. This supports the formation of a homogeneous liquid film. It is not necessary that the solid particles are of equal shape or of any regular shape.

15 In accordance with an advantageous design of the invention in accordance with Claim 3, the solid particles form a single layer on the base surface of the reactor double plate or on the mass and heat transfer surface, respectively. By means of a single layer, a very thin coating and consequently a very thin fluid film can be achieved.

20 In accordance with an especially preferred design of the invention the solid particles are sand grains of natural quartz sand. Therefore the surface of the mass and heat transfer surface is equivalent to the surface of sandpaper. Sand is cheap and the manufacturing technology for manufacturing sandpaper can be used for the manufacturing of mass and heat transfer surfaces in accordance with the invention
25 described herein.

In accordance with Claim 10 of the invention the mass and heat transfer reactor has two duct systems, in which the substances are separated from each other but heat transfer is possible. One system (the heat transfer duct system 14) is a duct system, which is filled with a liquid or gaseous heating or cooling agent (HKM). The other
30 duct system (mass transfer system 16) is filled with a gaseous media and a further liquid media FM. Furthermore the mass and heat transfer reactor contains at least one mainly vertical reactor double plate, which has an upper end, a lower end, a first and

second main surface as well as a void between the first and the second main surface, where the heat transfer duct system is situated in the void; at least one of the main surfaces is designed as a mass and heat transfer surface in accordance with Claims 1 to 9; on this mass and heat transfer surface the gaseous and the liquid media are flowing in a counter-flow direction; on the upper end of this reactor double plate a liquid distributor generates a thin liquid film of the liquid media on the mass and heat transfer surface.

The remaining sub-claims refer to further advantageous designs of the invention.

Further details, characteristics and advantages of the invention can be obtained from the following description of a preferred design of the invention.

Shown are:

Fig. 1 a schematic display of a typical design of the invention

Fig. 2 a schematic cross section through one of the mass and heat transfer surfaces

Fig. 3 a view from front of the liquid distributor

Fig. 4a a detail of the rear view of the liquid distributor

Fig. 4b a cross section of the item in Fig. 4a along line D-D;

Fig. 5a, b and c cross sections along lines A-A, B-B and C-C in Fig. 3;

Fig. 6 and 7 a alternative design of the liquid distributor and

Fig. 8 a detail of Fig. 3.

The typical design of the invention shown in Fig. 1 has a multitude of vertical reactor double plates 2, which are arranged side-by-side with some space in-between. Each of the reactor double plates 2 has one upper end 4, one lower end 6, one first and second main surface 8 and 10, respectively, and a void 12 between first and second main surface 8 and 10. The void 12 is formed as a heat transfer duct system 14, in which e.g. water can circulate as a heating or cooling media HKM. Between the individual reactor double plates 2, a mass transfer duct system 16 is formed. The

first and second main surfaces 8 and 10 of the reactor double plates 2 are designed as mass and heat transfer surfaces 18. The mass and heat transfer surfaces 18 are moistened continuously from the top by a liquid medium FM or a sorbent. From the bottom, in counter flow direction, a gaseous medium flows between the reactor double plates, which - in case of absorption - releases a gaseous component into the sorbent FM and absorbs the same gaseous component from the sorbent FM in case of desorption.

At the upper end 4 of the reactor double plates 2, a liquid distributor 20 is attached, which provides sorbent FM across the entire width of the reactor double plates 2 on all mass and heat transfer surfaces 18 to form a thin film of liquid. Details of the liquid distributor 20 are described in Fig. 3, 4 and 5.

The mass and heat transfer surfaces 18 have a coating 21 consisting of small solid particles 22, for example sand grains, as shown as typical in Fig. 2. The mass and heat transfer surfaces 18 thus have a surface like sandpaper. Between the solid particles or sand grains 22, respectively, gaps and voids 24 are formed. By way of their capillary effect, these small gaps and voids cause the even distribution of sorbent FM in the form of a thin liquid film 26 on the mass and heat transfer surfaces 18. As shown in Fig. 2, the sand grains 22 are applied individually, next to each other on the mass and heat transfer surfaces 18. This single layer application enables the formation of a very thin film of liquid.

The coating 21 and the sand grains 22, respectively are fixed permanently on the mass and heat transfer surface 18, using glue. Alternatively, the coating can be fixed onto an intermediate carrier, which is not shown, which itself can be fixed onto the mass and heat transfer surfaces 18.

Fig. 3 to 5 show a typical design of a liquid distributor 20, which is used to apply the liquid sorbent FM from the upper end 4 of the reactor double plates 2 onto the mass and heat transfer surfaces 18. The liquid distributor 20 consists of a base body 27 in form of a rectangular plate with a front side 28 and a rear side 29. The width b and thickness d of the liquid distributor correspond to the width and thickness of the reactor double plates 2. Along the upper edge of the liquid distributor 20, front and rear liquid outlet openings 30 and 32 are situated at regular intervals side by side, whereby the front and rear openings 30 and 32 are alternating. Therefore the front liquid outlets 30 moisten the front side 28 of the liquid distributor

20 and the first main surface 8 of a reactor double plate 2, while the rear liquid outlet openings 32 moisten the rear side 29 and the second main surface 10.

The liquid outlet openings 30 und 32 receive the liquid or sorbent FM, respectively, via a liquid supply system 34. The liquid supply system 34, which is
5 shown on the front side 28, includes a common main supply 36 and a multitude of sub-mains 38. The liquid main supply 36 is branched by repetitive bifurcations 40 into liquid supply sub-mains 38, until one liquid supply sub-main 38 is available for each liquid outlet opening 30 und 32. The design as shown in Fig. 3 has 64 liquid outlet openings 30 leading to the first main surface 8 and 64 liquid outlet openings 32
10 leading to the second main surface 10. The liquid main supply 36 branches at the first bifurcation 40 into two sub-mains 38, which are split another five times, every time into two sub mains until one individual sub main 38 is available for each of the 128 liquid outlet openings 30 and 32.

The liquid main supply 36 is equipped with a connection pipe 42, which lies
15 above the upper edge of the liquid distributor 20 and serves to feed the liquid sorbent into the system. The liquid main supply 36 ends at the lowest point of the liquid supply system 34 and the liquid supply sub-mains 38 are always directed either horizontally or vertically, pointing upwards against gravity. This arrangement of liquid supply sub mains 38 prevents the formation of gas bubbles in the liquid supply
20 system 34, which could lead to a discontinuous film formation.

The details in Fig. 5a und Fig. 5c show, that the liquid supply openings 30 and 32 are shaped tapered, with the wider opening pointing outwards. This shape prevents the formation of droplets when liquid sorbent FM leaves the liquid outlet openings 30 and 32 and ensures the continuous moistening of the mass and heat
25 transfer surfaces 18. In the area below the liquid outlet openings 30 and 32, both front side 28 and rear side 29 of the liquid distributor 20 are equipped with the same coating 21 as the mass and heat transfer surfaces 18. This ensures a continuous formation of a liquid film, starting from the liquid outlet openings 30, 32 and reaching to the lower end 6 of the mass and heat transfer surfaces 18.

30 The liquid distributor 20 is plugged onto the respective reactor double plate 2 with a plug and socket connection 44. The cross section of the plug and socket connection 44 resembles the letter "M", as displayed in Fig. 5a, 5b and 5c. It is equipped with a centre plugging strip 46, which protrudes out of the bottom and left,

right, in the front and at the rear a front cover strip 48 and a rear cover strip 50. The front cover strip 48 overlaps the first main surface 8 and the rear cover strip 50 overlaps the second main surface 10

Fig. 6 und 7 show a cross section of alternative designs of the liquid distributor
20. The designs in accordance with Fig. 6 und 7 are different from the design in
accordance with Fig. 5 with regard to the shape of the liquid outlet openings 30 and
32. The front and rear liquid outlet openings 30 and 32 are at the same level and are
not staggered sideways, as in the design in accordance with Fig. 5. In the design in
accordance with Fig. 6 the liquid supply sub-mains are directly connected with the
10 liquid supply openings 30 and 32 and lead diagonally outwards and upwards to the
top. In the design in accordance with Fig. 7 these last liquid supply sub-mains 38 lead
horizontally outwards. In the design in accordance with Fig. 7 the bifurcation 40 is
rounded off to prevent turbulence and irregularities in the flow speed.

Fig. 8 shows a detail of Fig. 3 with rounded bifurcations 40. At the bifurcations
15 40 the liquid supply sub-mains are provided with a wedge-shaped bulge, which
complements the rounded form of the bifurcation.

To prevent the clogging of the smallest liquid supply sub-mains, the minimum
cross section of the liquid supply sub-mains 38 is designed to be twice the size of the
largest expected dust particle (typically 1 mm²).

20 Regarding further details of the design of the liquid distributor reference is
made to patent application DE 101 41 526.5 with the title "Ultra low flow liquid
distributor" in it's entirety.

The mass and heat transfer reactor as described above is suitable in particular
for the dehumidification and cooling of air. The air is dehumidified by means of a
25 sorbent while at the same time the absorbing liquid, usually a watery salt solution
containing one or several salts, is considerably diluted (absorption). Alternatively, the
air is humidified and the sorbents re-concentrated (Desorption). The heating and
cooling liquid, which circulates in the heat transfer duct system 14 separated from the
liquid sorbent FM and the air GM, transfers heat into or out of the sorption process
30 (Desorption or Absorption). To achieve the maximum possible cooling water
temperature difference for absorption the cooling water HKM is ducted in counter-
flow or cross-counter-flow direction to the airflow. For desorption it is ducted

counter flow or cross-counter flow direction to the sorbent (FM). For absorption the most concentrated sorbent will be cooled the most, which keeps the vapour pressure equilibrium for the sorbent as low as possible. For the desorption the most concentrated sorbent is brought into contact with the hottest heat medium HKM, which causes the highest possible increase in water vapour pressure equilibrium in the sorbent. Both measures provide the greatest possible mass transfer potential for the respective process (Absorption or Desorption), respectively.

The mass and heat transfer surfaces 18, which separate the sorbent FM and the air GM from the cooling and heating agent HKM, at the void 12 between the reactor double plates 2 are in complete contact with the heating and cooling media HKM and the other side, i.e. the mass and heat transfer surfaces 18 are moistened with the liquid sorbent FM. The liquid sorbent FM forms an extremely thin, continuous film 26 on the mass and heat transfer surfaces 18, which flows down the mass and heat transfer surfaces 18, following gravity. Due to the pure contact with liquids, on the inner side as well as on the outer side of the reactor double plates 2, a high heat transfer coefficient and consequently a high heat transfer rate is achieved regarding the heat transfer from the heating and cooling liquid HKM through the separating wall into the sorbent FM and to the air GM, which is flowing along the thin film of sorbent 26. This also ensures an optimal mass transfer. The continuous sorbent film 26 is achieved by the use of a special coating 21 consisting of small solid particles 22, which enables an extremely small amount of sorbent to form a continuous moist surface on the mass and heat transfer surfaces 18 and which runs continuously to the bottom. The extremely small amount of sorbent is distributed by the liquid distributor 20 across the upper edge of the mass and heat transfer surfaces 18 over the entire width of the reactor double plate 2, without forming droplets, which could be carried out by the airflow. The liquid distributor does not or only minimally protrude into the free cross section for the airflow between the reactor double plates 2, so that no significant disturbance of the airflow occurs, which would lead to an increased pressure loss.

The entire the mass and heat transfer reactor can be manufactured in plastic (Polymers) and can be designed very thin. The thickness of the individual reactor double plates 2 for example is 3mm. In the void 12 between the reactor double plates 2 fins (not shown) are inserted at regular intervals, so that the cooling liquid HKM flows through in the form of a meander. In the mass transfer duct system 16, which is

formed between the reactor double plates 2, air GM flows against gravity while liquid sorbent FM flows with gravity, forming a direct, continuous counter flow.

Legend:

2	Reactor double plate
4	upper end of 2
6	lower end of 2
8	first main surface of 2
10	second main surface of 2
12	void between 2
14	heat transfer duct system
16	mass transfer duct system
18	mass and heat transfer surfaces
20	liquid distributor
21	coating of 18, 2
22	small solid particles, sand grains
24	gaps and voids
26	liquid film of sorbent FM
27	base body of 20
28	front side
29	rear side
30	front liquid outlet openings
32	rear liquid outlet openings
34	liquid supply system
36	liquid supply mains
38	liquid supply sub-mains
40	Bifurcation
42	connection pipe of 36
44	Plug and socket connection
46	centre plugging strip
48	front cover strip
50	rear cover strip
52	wedge-shaped bulge

Claims

1. A mass and heat transfer surface for developing a thin film of liquid fluid on a base surface and a coating (21) applied on that base surface – respectively a surface structure to reduce the effect of surface tension, the mass and heat transfer surfaces comprising:
 - the coating (21) consisting of a thin layer of small solid particles (22)
 - the solid particles (22) being fixed onto the base surface and
 - gaps and voids remaining between the solid particles (22), due to their shape and allocation on the base surface
2. A mass and heat transfer surface in accordance with Claim 1, wherein the individual solid particles (22) being approximately of equal size.
3. A mass and heat transfer surface in accordance with Claim 1 or 2, wherein the coating (21) of solid particles being single layered.
4. A mass and heat transfer surface in accordance with one of the above Claims, wherein the solid particles (22) being grains of sand.
5. A mass and heat transfer surface in accordance with one of the above Claims, wherein the solid particles (22) consisting of components of natural sand, in particular silicate, aluminium silicate and/or silicium dioxide.
6. A mass and heat transfer surface in accordance with one of the above Claims, wherein the solid particles (22) being attached to the substrate by means of an adhesive.
7. A mass and heat transfer surface in accordance with Claim 6, wherein the adhesive being a glue.
8. A mass and heat transfer surface in accordance with Claim 6, wherein the adhesive being an intermediate layer of foil, in which the solid particles 22 are embedded in such a way that they protrude and where the intermediate foil is fixed onto the base surface.
9. A mass and heat transfer surface in accordance with one of the above Claims 1 to 5, wherein the base surface being a reversible thermoplastic or a reversible

chemoplastic material, in which the solid particles (22) are embedded in such a way that they protrude from the surface.

10. A mass and heat transfer reactor comprising:

two duct systems (14, 16), which are isolated from each other with regard to the mass flow, but are coupled with regard to the heat transfer, whereby there is a flow of a liquid or gaseous heating or cooling media (HKM) in one duct system (heat-transfer duct system 14) and in the other duct system (mass transfer duct system 16) a flow of a gaseous media (GM) and another liquid media (FM);

at least one mainly vertically arranged reactor double plate (2) with one upper end (4) and one lower end (6), a primary and a secondary main surface (8, 10) and a void (12) between primary and secondary main surface (8, 10); whereby

the heat transfer duct system (14) is accommodated in the void (12);

at least one of the main surfaces (8, 10) is designed to serve as mass and heat transfer surface (18);

at this mass and heat transfer surface (18) the gaseous media (GM) and the liquid media (FM) are ducted in such a way as to establish a counter flow; and

at the upper end (4) of this at least one reactor double plate, a liquid distribution system (20) is connected in such a way as to establish a thin film of moisture (26) of the liquid media (FM) on this (at least one) mass and heat transfer surface (8, 10), wherein

the at least one mass and heat transfer surface (18) being designed in such a way that one of the Claims 1 to 9 is fulfilled.

11. A mass and heat transfer reactor in accordance with Claim 10, wherein

several reactor double plates (2) being stacked with a distance between each other;

the gaseous media (GM) flowing against gravity from the bottom to the top between the individual reactor double plates (2); and

the liquid media (FM) flowing in direction of gravity as a thin film of moisture (26) down the mass and heat transfer surfaces (18).

12. A mass and heat transfer reactor in accordance with Claim 10 or 11, wherein the heating or cooling media (HKM) being ducted in the void (12) in the reactor double plates (2) in the form of a meander from top to bottom.
13. A mass and heat transfer reactor in accordance with one of the Claims 10 to 12,
5 wherein the reactor double plates (2) consisting of plastic (Polymers).
14. A mass and heat transfer reactor in accordance with one of the Claims 10 to 13, wherein the liquid-distributor (20) comprising:
an even number of liquid supply-openings (30, 32) to release liquid, being
positioned in equal distance from each other along the upper edge (4) of the
10 mass and heat transfer surface (18);
a liquid supply system (34), originating from a common liquid supply
mains (36) and splitting up in a number of sub mains (38) by repetitive
bisections at bifurcation points (40) until finally each of the sub-mains (38)
ends in one of the supply-openings (30, 32); and
15 the liquid supply sub mains (38) being located below the liquid supply
openings (30, 32).
15. A mass and heat transfer reactor in accordance with Claim 14, wherein the liquid release openings (30, 32) in the liquid distributors (20) being designed tapered, opening outwards.
- 20 16. A mass and heat transfer reactor in accordance with Claim 14 or 15, wherein the total flow-distances from the liquid supply mains (36) to the individual liquid release openings (30, 32) being equal for each respective liquid supply sub-mains (38).
- 25 17. A mass and heat transfer reactor in accordance with one of the Claims 14 to 16, wherein the liquid supply sub-mains (38) being designed in such a way that the flow of liquid is effected against gravity from the bottom to the top or perpendicular to gravity (across).
- 30 18. A mass and heat transfer reactor in accordance with one of the Claims 14 to 17, wherein the liquid supply sub-mains (38) being rounded at the bifurcations (40).

19. A mass and heat transfer reactor in accordance with one of the Claims 14 to 18,
wherein the liquid supply sub-mains (38) being designed in such a way that the
cross-section of the sub-mains are halved at each bifurcation.
20. A mass and heat transfer reactor in accordance with one of the Claims 14 to 19,
5 wherein the liquid distributor(s) (20) being fixed to the reactor double plate(s)
by means of an attachment device (44).