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(54) METHOD FOR DRYING OF TIMBER USING WARM AIR

VERFAHREN ZUR HOLZTROCKNUNG MITTELS WARMLUFT

PROCÉDÉ DE SÉCHAGE DE BOIS DE CONSTRUCTION AU MOYEN D'AIR CHAUD

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Description

[0001] The present invention concerns a method for drying of material in a progressive dryer, in particular timber material collected in stacks, through flushing with a circulating flow of air, the condition of which is caused to adopt wet and dry temperatures that are suitable for the quality of the material through the supply of heat to the circulating flow of air and the withdrawal of moisture from the same by ventilation.

[0002] Air is used as a drying medium to transfer heat and transport moisture, which air is circulated with a specific temperature, moisture content and rate of flow through the material with the aid of fans. The drying air is heated with the aid of an air-heating arrangement that comprises heating coils. The drying air is caused to pass through the material such that moisture and water evaporate from the material and are absorbed by the drying air. In order for the drying air that is circulated in the drying chamber, which air eventually becomes saturated with moisture, to be able to absorb more water from the material, it must be dehumidified, which normally takes place through ventilation, whereby the air is diluted with cold, relatively dry outdoor air - fresh air.

[0003] WO0225192 A1, JP2000351103 A and JP2008307790 A disclose different processes for drying timber.

[0004] For the drying of timber either batch dryers or progressive dryers are used. The drying in a batch dryer takes place in batches in closed chambers. The dryer is filled with timber and the drying subsequently continues until the complete batch is fully dry. In progressive dryers one stack of timber at a time is fed forwards stepwise through the dryer. The drying climate varies in zones along the drying channel. The drying climate varies all the time and the drying process is adapted according to the timber to be dried, the desired final moisture content and the desired final quality. The climate in the drying chamber is controlled through regulation of pre-determined parameters such as, among other things, dry and wet temperatures. The dry temperature is controlled with the aid of regulation of the heat emitted from a heating coil, while the wet temperature is controlled through regulation of the degree of opening of ventilation openings, and possibly also watering or steam-treatment equipment. The difference in temperature between a dry thermometer and a wet thermometer reflects the relative air humidity, whereby a relatively small difference in temperature corresponds to a relatively high air humidity. In order for the wood to dry, it is necessary that the water that is bound in and around the cells is transported out of the wood. The rate of this process depends primarily on the temperature and the prevalent psychrometric difference, i.e. the difference between the dry and wet temperatures, the moisture content of the wood and the rate of flow of the air.

[0005] It is known that the energy consumption of a dryer facility during drying can be reduced by dividing the

dryer facility into a number of zones and by recovering as far as is possible the heat content from one zone to another zone that has a larger requirement for heat at that moment. A heat exchanger is normally used in this case in which the ventilation is carried out in such a manner that the exhaust air (with a higher temperature) that is output from one zone is allowed to transfer part of its enthalpy to the supply air (with a lower temperature) that is input to another zone. It is known to arrange the drying channel of progressive dryers as two drying zones in the form of a preheating zone and a main drying zone, for an efficient use of energy. The heat energy in the exhaust air that is ventilated out from the main dryer is transferred with the aid of heat exchangers to the preheating zone, in which the timber is preheated before it is fed into the main drying zone for a controlled and monitored drying operation. In another case, it is known that exhaust air that is output from the main dryer can be mixed with fresh air from the surrounding atmosphere and that the resulting mixture can be used as supply air in the preheating zone, with the result that the preheating zone works with colder drying air than the main drying zone. The disadvantage of such a method that has a preheating zone with a moderate drying capacity for sawn timber material is that the risk of drying cracks becomes large, since the initial part of the drying process takes place at a relatively low temperature. A high wet temperature is desirable during this phase of the drying process, when large drying tensions in the timber easily give rise to the formation of cracks, since the wood will in this case become more plastic, and drying tensions may in this way be reduced.

[0006] Another complication that can arise during the drying of timber is what is known as "thermo tolerant moulds", which can grow on the timber and form spores during the drying process due to relatively low temperatures in the preheating stage. The mould grows and gives a grey-black discolouration of the timber that in the worst case makes it necessary to discard the timber. By maintaining a relatively high temperature of approximately 50 °C during the initial phase, which means that the dry temperature of the air will vary between 55 and 70 °C, it is possible to limit the growth conditions for fungi and moulds. A period of a few hours at these high temperatures is sufficient in this part of the process to control this.

[0007] Relatively high energy costs are to be expected in the future and thus the requirement for drying processes with low energy consumption will increase considerably. Furthermore, the requirements on the quality of the timber will increase, whereby timber with surface defects in the form of cracks or discolouration due to mould cannot be accepted.

[0008] A first purpose of the present invention, therefore, is to achieve a method for the drying of material using warm air that makes it possible to make the drying process more efficient not only in batch dryers but also in progressive dryers and in this way to achieve a reduced energy consumption. A second purpose of the invention is to achieve a method for the drying of material using

warm air that makes it possible to avoid timber with surface defects, discolourations and mould. A third purpose of the invention is to achieve a progressive dryer that can carry out the drying process with a low energy input and that makes it possible to avoid timber with surface defects and discolourations.

[0009] These purposes of the invention are achieved through a method of the type that is specified in patent claim 1.

[0010] As a basis for the invention lies the idea to allow a dryer to function inversely with respect to what has until now been the conventional method of drying material, which, particularly when it is a matter of timber, involves moving in a series of process stages that follow one after the other from a relatively cold drying climate to a warm drying climate. According to the principles of the invention, however, the inverse takes place, i.e. to move during the process stages from a relatively warm drying climate to a cold drying climate. The many advantages of drying material, in particular timber, in this manner will be made clear below.

[0011] One interesting application of the invention is constituted by a timber-drying channel with longitudinal circulation that is divided into two limited drying zones, connected in series, by a door that can be raised and lowered, where the subsequent second zone is regulated at a dry temperature that is lower than the wet temperature in the first zone, and where the heat consumption for the second subprocess is provided by enthalpy, in the form of heat energy from warm, moist air in the first zone, being transferred and delivered to the second zone through a heating coil arranged in the said zone. In addition to its energy efficiency, such an arrangement has considerable advantages that will be described in more detail below.

[0012] Application of the invention in a dryer facility with two processes connected in series with different levels of wet temperature provides - in addition to a considerably reduced consumption of heat - a considerably more important advantage with respect to the drying of high-quality timber in a dryer with longitudinal circulation. The condition of the drying air in a dryer with longitudinal circulation depends to a large extent on evaporation from the timber in the drying channel. Cracks and mould can be avoided due to a high temperature in the first zone. A large part of the energy can be recovered, transferred and used in the subsequent second drying zone due to the fact that no exchange of air takes place in the first zone. Another advantage is that the heat from the first zone that is stored in the timber can be used in the subsequent second drying zone.

[0013] The invention will be described in more detail below with reference to the attached drawings, of which:

Figure 1 shows schematically a method according to the invention in a first design where the drying process is divided into two subprocesses A, B and the use of a heat recovery system that transfers heat

between the subprocesses through a heat-bearing fluid medium, and Figure 2 shows schematically a method according to the invention in a second design where the drying process is divided into two subprocesses A, B and a heat recovery system, in which a heat recovery system that transfers heat between the subprocesses by exchanging the different flows of air of the two subprocesses is a component.

[0014] Figure 1 shows the present invention in a first design as a schematic arrangement that uses a fluid medium in order to transfer heat between subprocesses. The drying process is divided into two subprocesses A and B whereby the drying in subprocess A takes place at a relatively high wet temperature $T_{vA}=50\text{ }^{\circ}\text{C}$, while the drying in subprocess B takes place at a relatively low wet temperature $T_{vB}=20\text{ }^{\circ}\text{C}$. According to the invention, the drying in subprocess B takes place at a dry temperature T_{tB} that is lower than the wet temperature T_{vA} for the drying in subprocess A, i.e. $T_{tB}<T_{vA}$. The material 1 to be dried in the subprocesses is flushed in separate zones, each in a separate chamber, by circulating flows 2 of drying air, which flushing is achieved by means of fans 3. The circulating air in subprocess A is heated in conventional manner by a heating coil 5 fed by hot water. The exhaust air 6 from the subprocess B may be led out from the chamber and replaced by fresh supply air 26 that has been obtained from the surrounding atmosphere. No exchange of air normally takes place in subprocess A or, in relevant cases, only a limited such exchange takes place. Subprocess A proceeds essentially according to the principle of condensation whereby water vapour bound in the circulating drying air 2 is cooled and is condensed out in the drying zone by a condensation process.

[0015] Heat can be transferred between the two subprocesses A, B with the aid of a heat recovery system, through a heat-bearing fluid medium, whereby it should be understood that enthalpy is principally transferred from subprocess A to subprocess B. A condensation heat exchanger 7 arranged in the first subprocess A and a heating coil 8 arranged in subprocess B are components of the system. A closed circuit 9 is arranged to circulate with the aid of a circulation pump (not shown in the drawings) a heat-bearing medium between the condensation heat exchanger 7 in subprocess A and the heating coil 8 in subprocess B. The circuit runs in loops 9a, 9b for the exchange of energy between the circulating drying air in subprocesses A and B, whereby the loop 9a absorbs heat from condensed water vapour in the drying air in subprocess A and transfers this heat through the loop 9b to the heating coil 8 in subprocess B. The heat consumption for subprocess B is in this case provided through the enthalpy that has been obtained from the condensed water vapour in the circulating air from subprocess A. As has been mentioned above, no exchange of air with the surrounding atmosphere takes place at subprocess A. The combination of these two arrangements gives an

extremely low consumption of heat for the drying process as a whole and, as a consequence of the relatively high temperature in subprocess A, problems with discolouration and cracks can be avoided. It should be understood that the second drying zone for subprocess B can, when necessary, be equipped with additional power, which may be constituted by a heating coil.

[0016] Figure 2 shows the present invention in a second design as a schematic arrangement that transfers heat between subprocesses by exchanging the different flows of air of the processes in a heat exchanger of, for example, countercurrent flow type or cross-heating type. Just as has been described above, the drying process is divided into two subprocesses A and B whereby the drying in subprocess A takes place at a relatively high wet temperature $T_{vA}=50\text{ }^{\circ}\text{C}$, while the drying in subprocess B takes place at a relatively low wet temperature $T_{vB}=20\text{ }^{\circ}\text{C}$. According to the invention, the drying in subprocess B takes place at a dry temperature T_{tB} that is lower than the wet temperature T_{vA} for the drying in subprocess A, i.e. $T_{tB}<T_{vA}$. The material 1 to be dried in the subprocesses A, B is flushed by circulating flows 2 of air that are achieved by means of fans 3. The circulating air in subprocess A is heated in conventional manner by a heating coil 5 fed by hot water. The exhaust air 16 from subprocess A is carried to the heat exchanger 14 in subprocess B and is divided after its passage through this heat exchanger into a saturated air flow 17 and a condensation flow 18. The exhaust air 19 from subprocess B is mixed with the saturated air flow 17 at 20 and the mixture is allowed to pass through an external heat exchanger 21, after which the condensate 22 is separated and the saturated air flow 23 is divided into a subflow 24, which is expelled from the facility, and a subflow 25, which is used as supply air for subprocess A with a high wet temperature. The supply air 26 to the subprocess B with low wet temperature is preheated in the heat exchanger 21. The consumption of heat for subprocess B is supplied fully or partially through the enthalpy in the exhaust air 16 from subprocess A and no separate external supply air (fresh cold air from the surrounding atmosphere) needs to be obtained for subprocess A. The combination of these two arrangements gives an extremely low consumption of heat for the overall process. It should be understood that the second drying zone for subprocess B can, when necessary, be equipped with additional power, which may be constituted by a heating coil.

[0017] During the application of the invention in a channel with longitudinal circulation with zones connected in series for the drying of timber, the drying channel is divided by means of a door 100 that can be raised and lowered into two neighbouring zones I and II, which are suggested by dashed lines in Figure 1. As has been described above for subprocess A, zone I is regulated at a high wet temperature, such as $50\text{ }^{\circ}\text{C}$, and, as has been described above for subprocess B, zone II is regulated at a low wet temperature, such as $20\text{ }^{\circ}\text{C}$. Zone II has been designed as a channel in which circulating air flows

through the timber as a countercurrent flow against the direction of transport of the timber, and as concurrent flow in the first zone I. It should be realised that the specified directions of the circulating flows are given solely as examples and may be changed in practice. The circulating air in zone I is heated in conventional manner in heating coils 5. The drying air in zone I is dehumidified by passing through a condensation heat exchanger 7 located in the circulation flow in zone I, where the condensate that is formed emits heat to a heat-bearing fluid medium that passes through the condensation heat exchanger. The heat that is emitted in zone I is transferred through a fluid medium to the heating coil 8 in zone II. Since the drying process in subprocess B takes place at a dry temperature T_{tB} that is lower than the wet temperature T_{vA} of the drying process in subprocess A, i.e. $T_{tB}<T_{vA}$, no extra heat supply from an external source is necessarily needed in zone II.

[0018] It should be understood that it would be possible for one design invention to include a combination of the two embodiments of the invention that have been described above with reference to Figures 1 and 2. That is to say, a heat recovery system that not only transfers heat from subprocess A to subprocess B through a heat-bearing fluid medium, but also a heat recovery system that transfers heat from subprocess A to subprocess B through exchanging the different flows of air from the two subprocesses, or by mixing them. It should furthermore be realised that the invention can be used at any drying system at all that can be divided into at least two subprocesses A, B, independently of whether the processes are connected to each other in parallel or in series for the transfer of heat.

Claims

1. A method for drying of timber using warm air in a progressive dryer, where the drying process is divided into at least a first and a second subprocess (A, B) each in a chamber arranged in series with each other; wherein the timber is allowed to pass from the first to the second subprocess; wherein the circulating air (2) of the two subprocesses in the relevant drying chamber is conditioned to different wet temperatures (T_{vA}, T_{vB}); and wherein no exchange of air with the surrounding atmosphere takes place in the first subprocess (A);
characterised in that the circulating air (2) in the first subprocess (A) is given a higher wet temperature (T_{vA}) than the circulating air (2) in the second subprocess (B);
the second subprocess (B) is given a dry temperature (T_{tB}) that is lower than the wet temperature (T_{vA}) in the first subprocess (A);
and heat in the circulating air (2) in the first subprocess (A) is recovered and transferred to the second subprocess (B).

2. A method according to claim 1, whereby heat in the circulating air (2) in the first subprocess (A) is recovered and transferred to the second subprocess (B) through the circulating air (2) in the two subprocesses (A, B) exchanging heat with each other.
3. A method according to claim 1 or 2, whereby circulating air (2) in the first subprocess (A) is dehumidified through water vapour that is bound in the circulating air being cooled and caused to condense in the drying chamber of the first subprocess (A).
4. A method according to claim 3, whereby the drying chamber of the first subprocess (A) is equipped with a condensation heat exchanger (7) with which the circulating air (2) in the first subprocess (A) can be caused to condense, the drying chamber of the second subprocess (B) is equipped with a heating coil (8) with which the circulating air (2) in the drying chamber of the second subprocess (B) can be heated, and that a heat-bearing medium is caused to circulate between the condensation heat exchanger (7) in the first subprocess (A) and the heating coil (8) in the second subprocess (B).
5. A method according to claim 1, whereby heat in the circulating air (2) in the two subprocesses (A, B) is recovered and transferred through exhaust air flows from the two subprocesses being mixed (20) with each other and caused to pass through a heat exchanger (21) that is common to the processes for the preheating of the supply air (26) to the second subprocess (B) and, after passage through the heat exchanger (21), to constitute supply air for the first subprocess (A).
6. A method according to claim 4, whereby heat is transferred between the two subprocesses (A, B) through the use of a heat exchanger (14, 21) of, for example, countercurrent flow type or cross-heating type, in order to exchange the flows of air that include supply air and exhaust air (25, 26; 16, 19) between the subprocesses.
7. A method according to any one of claims 1-6, whereby a heat recovery system is used that not only transfers heat from the first subprocess (A) to the second subprocess (B) through a heat-bearing medium of, for example, a fluid in which the circulating air (2) in the first subprocess (A) is dehumidified through water vapour that is bound in the circulating air being cooled and caused to condense in the drying chamber of subprocess (A), but also a heat recovery system that transfers heat from the first subprocess (A) to the second subprocess (B) through exchanging the different flows of air of the two subprocesses that include supply air and exhaust air (25, 26; 16, 19) between the subprocesses.

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8. A method according to claim 7, whereby heat in the circulating air in the two subprocesses (A, B) is recovered and transferred through exhaust air flows from the two subprocesses being mixed (20) with each other and caused to pass through a heat exchanger (21) that is common to the processes for the preheating of the supply air (26) to the second subprocess (B) and, after passage through the heat exchanger (21), to constitute supply air for the first subprocess (A).

Patentansprüche

1. Verfahren zur Holz Trocknung unter Verwendung von Warmluft in einem progressiven Trockner, wobei der Trocknungsprozess in mindestens einen ersten und einen zweiten Unterprozess (A, B) aufgeteilt ist, die jeweils in einer Kammer in einer Reihe nebeneinander angeordnet sind; wobei das Holz vom ersten zum zweiten Unterprozess geleitet werden kann; wobei die zirkulierende Luft (2) der beiden Unterprozesse in der betreffenden Trocknungskammer auf unterschiedliche Nasstemperaturen (TvA, TvB) konditioniert wird; und wobei kein Luftaustausch mit der umgebenden Atmosphäre im ersten Unterprozess (A) erfolgt; **dadurch gekennzeichnet, dass** die zirkulierende Luft (2) im ersten Unterprozess (A) eine höhere Nasstemperatur (TvA) erhält als die zirkulierende Luft (2) im zweiten Unterprozess (B); der zweite Unterprozess (B) eine Trockentemperatur (TtB) erhält, die niedriger ist als die Nasstemperatur (TvA) im ersten Unterprozess (A); und Wärme in der zirkulierenden Luft (2) im ersten Unterprozess (A) rückgewonnen und zum zweiten Unterprozess (B) übertragen wird.
2. Verfahren nach Anspruch 1, wobei Wärme in der zirkulierenden Luft (2) im ersten Unterprozess (A) rückgewonnen und zum zweiten Unterprozess (B) durch die zirkulierende Luft (2) in den beiden Wärme miteinander austauschenden Unterprozessen (A, B) übertragen wird.
3. Verfahren nach Anspruch 1 oder 2, wobei die zirkulierende Luft (2) im ersten Unterprozess (A) durch Wasserdampf entfeuchtet wird, der in der zirkulierenden Luft gebunden ist, die gekühlt und in der Trocknungskammer des ersten Unterprozesses (A) zur Kondensation gebracht wird.
4. Verfahren nach Anspruch 3, wobei die Trocknungskammer des ersten Unterprozesses (A) mit einem Kondensationswärmetauscher (7) ausgestattet ist, mit dem die zirkulierende Luft (2) im ersten Unterprozess (A) zur Kondensation gebracht werden kann, die Trocknungskammer des zweiten Unterprozesses (B) mit einer Heizwicklung (8) ausgestattet

ist, mit der die zirkulierende Luft (2) in der Trocknungskammer des zweiten Unterprozesses (B) beheizbar ist, und dass ein wärmetragendes Medium zwischen dem Kondensationswärmetauscher (7) im ersten Unterprozess (A) und der Heizwicklung (8) im zweiten Unterprozess (B) zur Zirkulation gebracht wird.

5. Verfahren nach Anspruch 1, wobei Wärme in der zirkulierenden Luft (2) in den beiden Unterprozessen (A, B) rückgewonnen und durch Abluftströme aus den beiden Unterprozessen (20) übertragen wird, die miteinander gemischt und durch einen Wärmetauscher (21), der den Prozessen für die Vorwärmung der Versorgungsluft (26) zum zweiten Unterprozess (B) gemeinsam ist, geleitet und nach der Leitung durch den Wärmetauscher (21) dazu gebracht werden, Versorgungsluft für den ersten Unterprozess (A) zu bilden.
6. Verfahren nach Anspruch 4, wobei Wärme zwischen den beiden Unterprozessen (A, B) unter Verwendung eines Wärmetauschers (14, 21) beispielsweise vom Gegenstromtyp oder Kreuzwärme-Typ übertragen wird, um die Luftströme, die Versorgungsluft und Abluft (25, 26; 16, 19) enthalten, zwischen den Unterprozessen auszutauschen.
7. Verfahren nach einem der Ansprüche 1 bis 6, wobei ein Wärmerückgewinnungssystem verwendet wird, das nicht nur Wärme vom ersten Unterprozess (A) zum zweiten Unterprozess (B) durch ein wärmetragendes Medium aus beispielsweise einem Fluid überträgt, wobei die zirkulierende Luft (2) im ersten Unterprozess (A) durch Wasserdampf entfeuchtet wird, der in der zirkulierenden Luft gebunden ist, die gekühlt und in der Trocknungskammer des Unterprozesses (A) zur Kondensation gebracht wird, sondern auch ein Wärmerückgewinnungssystem, das Wärme vom ersten Unterprozess (A) zum zweiten Unterprozess (B) durch Austausch der unterschiedlichen Luftströme der beiden Unterprozesse, die Versorgungsluft und Abluft (25, 26; 16, 19) enthalten, zwischen den Unterprozessen überträgt.
8. Verfahren nach Anspruch 7, wobei Wärme in der zirkulierenden Luft in den beiden Unterprozessen (A, B) rückgewonnen und durch Abluftströme aus den beiden Unterprozessen übertragen wird, die miteinander gemischt (20) und durch einen Wärmetauscher (21), der den Prozessen für die Vorwärmung der Versorgungsluft (26) zum zweiten Unterprozess (B) gemeinsam ist, geleitet und nach der Leitung durch den Wärmetauscher (21) dazu gebracht werden, Versorgungsluft für den ersten Unterprozess (A) zu bilden.

Revendications

1. Procédé de séchage de bois en utilisant de l'air chaud dans un séchoir progressif, le processus de séchage étant divisé en au moins un premier et un deuxième sous-processus (A, B) chacun dans une chambre disposée en série les uns avec les autres ; le bois étant autorisé à passer du premier au deuxième sous-processus ; l'air en circulation (2) des deux sous-processus dans la chambre de séchage concernée étant conditionné à des températures humides (TvA) et (TvB) différentes ; et aucun échange avec l'atmosphère environnante n'ayant lieu dans le premier sous-processus (A) ; **caractérisé en ce que** l'air en circulation (2) dans le premier sous-processus (A) reçoit une température humide (TvA) supérieure à celle de l'air en circulation (2) dans le deuxième sous-processus (B) ; le deuxième sous-processus (B) reçoit une température sèche (TtB) inférieure à la température humide (TvA) dans le premier sous-processus (A) ; et la chaleur dans l'air en circulation (2) dans le premier sous-processus (A) est récupérée et transférée dans le deuxième sous-processus (B).
2. Procédé selon la revendication 1, dans lequel la chaleur dans l'air en circulation (2) dans le premier sous-processus (A) est récupérée et transférée dans le deuxième sous-processus (B) par le biais de l'air en circulation (2) dans les deux sous-processus (A, B) en échangeant de la chaleur l'un avec l'autre.
3. Procédé selon l'une quelconque des revendications 1 ou 2, dans lequel l'air en circulation (2) dans le premier sous-processus (A) est déshumidifié par la vapeur d'eau liée à l'air en circulation refroidie et amenée à se condenser dans la chambre de séchage du premier sous-processus (A).
4. Procédé selon la revendication 3, dans lequel la chambre de séchage du premier sous-processus (A) est équipée d'un échangeur de chaleur à condensation (7) avec lequel l'air en circulation (2) dans le premier sous-processus (A) peut être amené à se condenser, la chambre de séchage du deuxième sous-processus (B) étant équipée d'un serpentin de chauffage (8) avec lequel l'air en circulation (2) dans la chambre de séchage du deuxième sous-processus (B) peut être chauffé, et qu'un milieu caloporteur est amené à circuler entre l'échangeur de chaleur à condensation (7) dans le premier sous-processus (A) et le serpentin de chauffage (8) dans le deuxième sous-processus (B).
5. Procédé selon la revendication 1, dans lequel la chaleur dans l'air en circulation (2) dans les deux sous-processus (A, B) est récupérée et transférée par les flux d'air d'échappement des deux sous-processus

mélangés (20) l'un à l'autre et amenés à passer à travers un échangeur de chaleur (21) commun aux processus de préchauffage de l'air d'alimentation (26) dans le deuxième sous-processus (B) et, après passage dans l'échangeur de chaleur (21), pour constituer de l'air d'alimentation pour le premier sous-processus (A). 5

6. Procédé selon la revendication 4, dans lequel la chaleur est transférée entre les deux sous-processus (A, B) par l'utilisation d'un échangeur de chaleur (14, 21), par exemple du type à flux à contre-courant ou du type à chauffage croisé, afin d'échanger les flux d'air comprenant l'air entrant et l'air sortant (25, 26; 16, 19) entre les sous-processus. 10 15

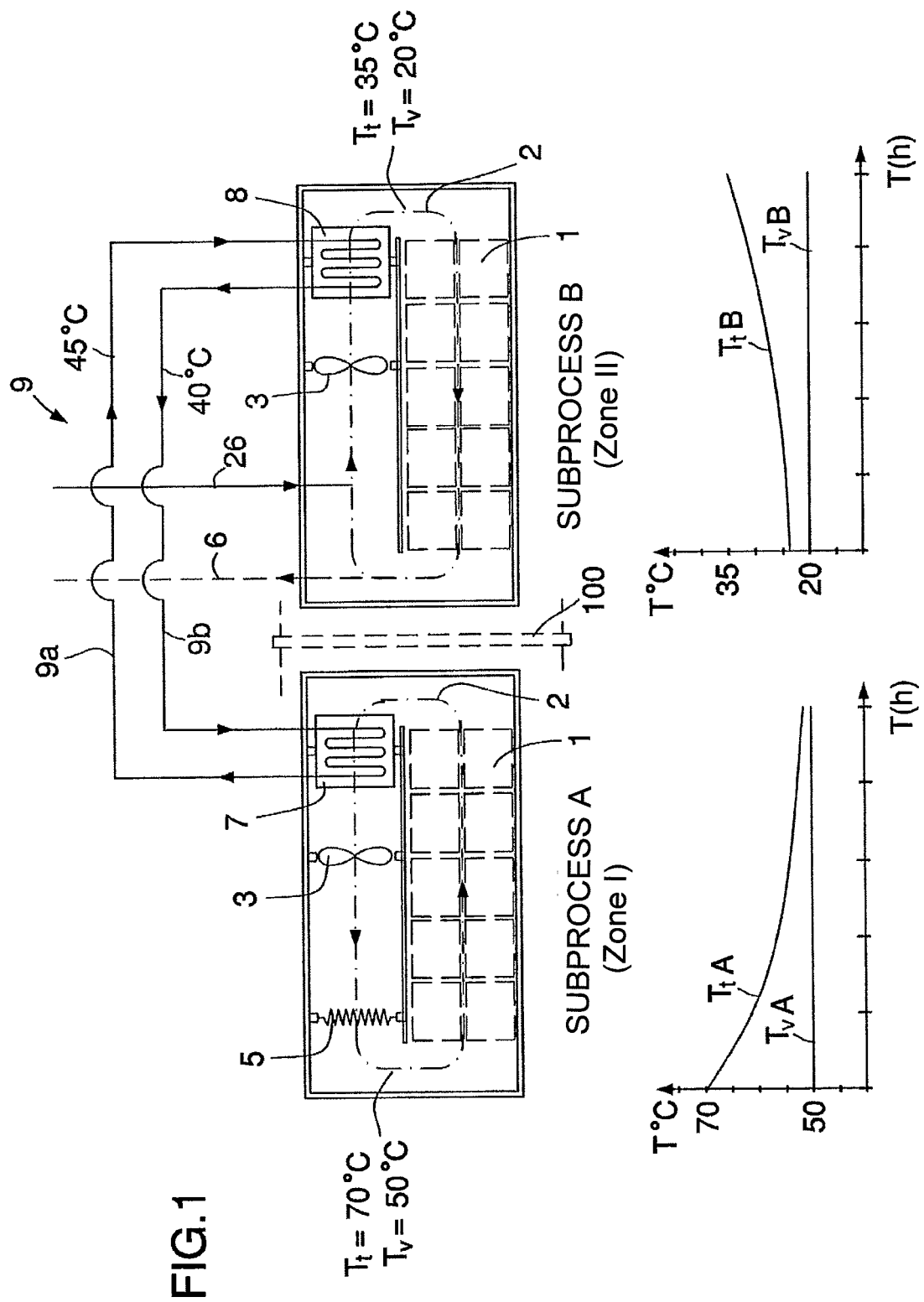
7. Procédé selon l'une quelconque des revendications 1 à 6, dans lequel on utilise un système de récupération de chaleur qui ne transfère que la chaleur du premier sous-processus (A) au deuxième sous-processus (B) à travers un milieu caloporteur, par exemple, d'un fluide dans lequel l'air en circulation (2) dans le premier sous-processus (A) est déshumidifié par la vapeur d'eau liée à l'air en circulation refroidi et amenée à se condenser dans la chambre de séchage du sous-processus (A), mais aussi un système de récupération de chaleur qui transfère la chaleur du premier sous-processus (A) au deuxième sous-processus (B) en échangeant les différents flux d'air des deux sous-processus comprenant l'air fourni et l'air d'échappement (25, 26; 16, 19) entre les sous-processus. 20 25 30

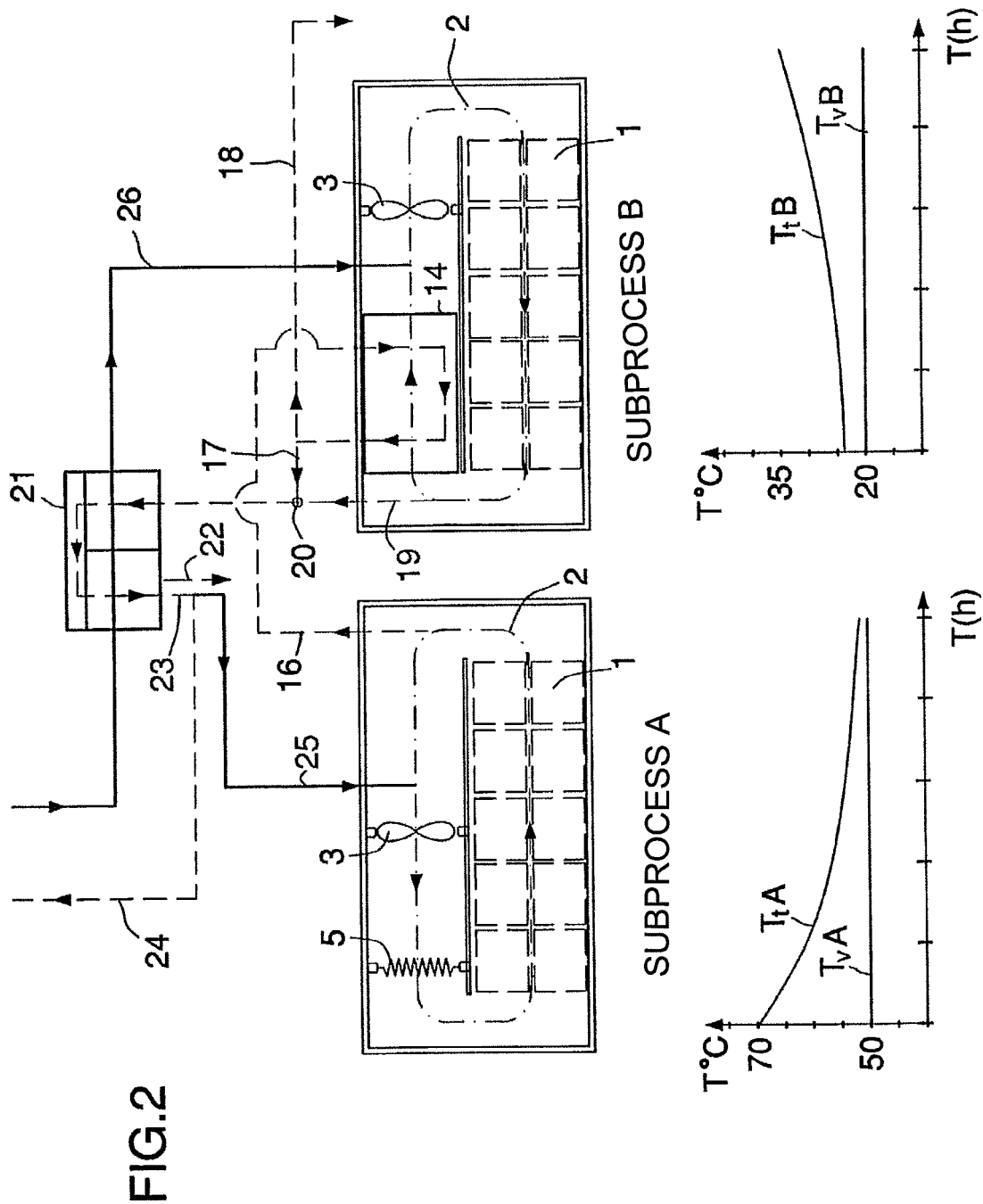
8. Procédé selon la revendication 7, dans lequel la chaleur dans l'air en circulation dans les deux sous-processus (A, B) est récupérée et transférée par les flux d'air d'échappement des deux sous-processus mélangés (20) l'un à l'autre et amenés à passer à travers un échangeur de chaleur (21) commun aux processus pour le préchauffage de l'air d'alimentation (26) dans le deuxième sous-processus (B) et, après passage dans l'échangeur de chaleur (21), pour constituer de l'air d'alimentation pour le premier sous-processus (A). 35 40 45

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REFERENCES CITED IN THE DESCRIPTION

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