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(54) **A DRYING SYSTEM AND A METHOD FOR AVOIDING THE FORMATION OF CONDENSATION IN A DRYING SYSTEM**

(57) A drying system (1) is provided comprising a drying device (2), a recuperator (7) and a first sink heater (3), the drying device (2) being configured to dry a solid material and comprising an inlet (18) and an outlet (19), the recuperator (7) comprising an inlet (7a) and an outlet (7b) and being configured to heat and/or cool down an operating medium, the operating medium flowing from the drying device (2) to the recuperator (7), wherein the first sink heater (3) is configured to heat a process medium. A method for avoiding the formation of condensation in a drying system (1) is also provided.

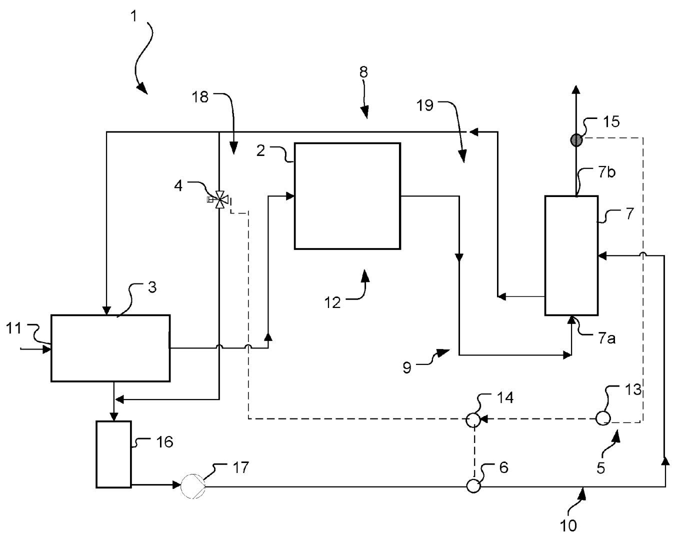

Fig. 1

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Description

Technical Field

[0001] The present invention relates to a drying system comprising a drying device, a recuperator and a first sink heater, the drying device being configured to dry a solid material and comprising an inlet and an outlet, the recuperator comprising an inlet and an outlet and being configured to heat and/or cool down an operating medium, the operating medium flowing from the drying device to the recuperator, wherein the first sink heater is configured to heat a process medium. A method for avoiding the formation of condensation in a drying system is also provided.

Background Art

[0002] Drying plants are usually quite large energy intensive installations with a high specific thermal energy demand on a high temperature level of above for example 200 °C, which is often provided by a primary energy combustion process, which is provided either directly or indirectly by steam or other medium, with high greenhouse gas emissions. The combustion process provides heating energy to a process gas or process medium - usually ambient air - at a temperature as high as needed for the entry into the drying process, usually between about 80°C and 240 °C, sometimes even higher. Drying systems or dryers can be of different types, such as flash dryers, ring dryers, fluidised bed dryers or spray dryers.

[0003] Drying plants may comprise devices for air handling for all air streams needed for the process (i.e. air heaters, supply fans, dehumidifiers, coolers, and systems for exhaust air cleaning etc., which equipment in the present context is designated the air handling unit), product handling (i.e. feed pump, atomizer etc.), air disperser, drying chamber, heat recovery, and powder recovery. All systems can be provided with pre- and post-treatment equipment, for example evaporators, homogenizers, fluid bed dryer/cooler, agglomerator, de-duster and conveyor etc., so that the plant meets individual product specifications, operational safety, and environmental protection requirements. Also, the plants are available in open, closed, semi-closed and aseptic cycle versions.

[0004] The use of a heat exchanger or recuperator for heat transfer from dryer exhaust gas for the single task of pre-heating a process gas in a drying facility is a well-known concept. Certain types of heat exchangers (e.g. plate, finned tube, plain tube, or shell and tube heat exchangers etc.) can be used and integrated in drying systems.

[0005] However, when integrating a heat exchanger into an industrial drying plant it is generally advantageous that no dust is present in the exhaust of the dryer. If particles of dust are present in the exhaust pipe of the dryer, then the heat exchanger surfaces may be blocked when condensation is formed and thus fouling of the heat exchanger may occur, which compromises the operation of the whole system and hygienic state of the system. Especially during winter and/or at night when the ambient temperature is low, condensation is more likely to happen.

[0006] The integration of a recuperator in drying system may therefore entail drawbacks which set the operation of the whole system at risk.

Summary of the Invention

[0007] The present invention relates to an improved drying system that can result in increased energy and cost savings while ensuring a stable and safe operation of the recuperator.

[0008] In a first aspect of the invention, this and further objects are achieved with a drying system of the kind mentioned in the introduction, which is furthermore characterized in that the drying system further comprises a humidity control system, the humidity control system comprising a sensor and a first controller coupled to the sensor, the sensor being configured to at least detect the humidity of the process medium, wherein the humidity control system is configured to automatically and continuously calculate the dew point temperature of the process medium and control the flow of the operating medium such that the temperature of the operating medium is higher than or to a pre-set approach to the dew point temperature of the process medium, so that the formation of condensation in the system is avoided.

[0009] The 'pre-set approach' to the dew point temperature means that the temperature of the operating medium may be close approach to the dew point temperature in the dryer exhaust, i.e. a little lower than, a little higher than or equal to the dew point temperature. If the temperature of the operating medium is a little lower than or almost equal to the dew point temperature, that will be acceptable provided that the temperature of the (metal or similar, such as glass, plastic etc.) tube or pipe surface where the operating medium flows into is just above the dew point temperature.

[0010] Preventing condensation at all times may provide the added benefit for limiting corrosion within the exhaust of the dryer and also eliminate the need for treatment of liquid effluent, which may be contaminated by traces or particles of dust present within the dryer exhaust. Further advantages of the system may be savings up to 20% or more of the total energy required for heating the dryer day and night throughout the year. In addition, the risk of fouling and the need for effluent treatment or extra-ordinary maintenance may be avoided.

[0011] The dryer exhaust may further comprise or extend to the inlet and outlet of the recuperator.

[0012] In a preferred embodiment, the system features two connected heat exchangers, one located in the exhaust stack or outlet of a dryer, namely the recuperator, for recovering heat from the hot exhaust gases and the other located at the dryer inlet, namely the first sink heater, for pre-heating the process medium or incoming drying air.

[0013] These two heat exchangers may be connected by a closed loop system of pipework, where a circulating operating medium such as a water flow, transfers heat from one heat exchanger to the other. Heat/energy recovered by the recuperator may heat the circulating operating medium and this in turn may be cooled in the first sink heater, as it pre-heats the incoming process medium. This cooled operating medium may then be returned to the recuperator, for recovering more heat from the dryer exhaust and the cycle may continue, as a closed loop. Water circulation may be provided by a dedicated pump, which may be included within the circuit.

[0014] In general, the lower the temperature at the exhaust of the dryer, the lower heat recovery is achieved.

[0015] To further overcome the risk of condensation, which is most common in heat exchangers installed in the humid exhaust gases of dryers and can worsen the risk of fouling, a control system may be provided to maintain temperatures above the point where condensation may occur. A smart/intelligent humidity controller, often with multiple probes, detectors or sensors for extra security/reliability, may therefore constantly monitor the conditions: humidity, temperature, etc., within the dryer exhaust and calculate the dew point temperature (at which condensation will occur).

[0016] In a preferred embodiment, the humidity control system further comprises a second controller being in signal connection with the first controller, the second controller being configured to monitor the temperature of the operating medium, the drying system further comprising bypass means such as a valve configured to allow the operating medium to by-pass the first sink heater, wherein the second controller is configured to control the opening and/or closing of the by-pass means as a function of the temperature of the operating medium.

[0017] The probes or sensors may be located before or after the recuperator, depending upon the probe type and conditions within the dryer exhaust gas stream. The first controller may then communicate with the second temperature controller, by adjusting its setpoint temperature to a value, which is just above, or at a pre-set close approach to the dew point measured in the dryer exhaust. A second humidity probe may be installed in the system, serving as a back-up to the first probe in case dust is accumulated.

[0018] The second controller may monitor the temperature of the operating medium circulating within the closed circuit pipework, before it is fed to the recuperator. Output from the second controller may be used to control by-pass means such as a valve that is installed within the circuit, which modulates the quantity of circulating operating medium that by-passes the pre-heater or first sink heater, thereby limiting cooling and maintaining the circulating operating medium's temperature above, or at a pre-set close approach to the dew point temperature in the dryer exhaust.

[0019] Maintaining temperatures in the humid dryer exhaust above the dew point temperature, may guarantee that condensation will never occur under all operating conditions, automatically compensating for changes in ambient temperature, exhaust gas temperature, moisture content and all levels of system turn-down. Constant, continuous and automatic intelligent control may allow for optimum/maximum heat recovery to be achieved at all times, without any risk of condensation, which would lead to fouling or blockage of heat exchanger surfaces. This way, maximum heat recovery and efficiency may be achieved at all times with a robust, reliable and effectively maintenance free heat recovery system.

[0020] In an example according to the invention, a dryer with approx. 50,000 kg/h of exhaust gases, which runs with an exhaust temperature of 80°C (94°C stack temperature, following a rather high-pressure fan), may achieve 20% energy savings which is equivalent to significant cost savings. The payback period of the drying system is therefore some weeks instead of years which would have been rather common in such installations. Furthermore, the energy savings may be associated with significant CO_2 emissions savings.

[0021] In an embodiment, the system further comprises a second sink heater connected in series with the first sink heater, the second sink heater being configured to heat the process medium. Multiple sink heaters acting as preheaters may be installed in the drying system in series with each other and/or in parallel. In an embodiment, the first sink heater is connected in series with the second sink heater and the process medium is an air stream flowing from the first sink heater into the second sink heater. In alternative embodiments, the second sink heater is not connected in series with the first sink heater but is placed on a different air stream. A second process medium is therefore flowing into the second sink heater, which generates the exhaust medium, while the process medium of the first sink heater flows into the dryer.

[0022] In a preferred embodiment, the process medium is a gaseous stream such as air.

[0023] In a preferred embodiment, the operating medium comprises water and/or a heat transfer fluid such as glycol. The mixture of water and heat transfer fluid circulates within the circuit of the system. The heat transfer fluid may prevent the operating medium from freezing in low ambient temperatures, thus ensuring an all-year round operation of the system.

[0024] In an embodiment, the recuperator is a plain tube heat exchanger. To overcome the risk of dust, which is invariably present in the dryer exhaust, blocking and/or fouling, the heat exchanger is installed with stack, plain (un-finned) tubes, which can also be easily cleaned/washed, if necessary. Fixed water sprays may be installed if necessary, to allow cleaning in place while the heater coils can be very easily removed for cleaning or maintenance. The recuperator may also be installed as multiple sections, arranged in series with access between the banks of tubes, to facilitate inspection and easy cleaning.

[0025] In an embodiment, the first sink heater is a finned tube heat exchanger. The first sink heater installed at the dryer inlet may preferably be a finned tube heat exchanger, employing high efficiency extended surface finned tubes, where no dust is present and filtered ambient air is pre-heated. Finned tube heat exchangers are usually of a smaller size, thus requiring less space in the system. Other types of heat exchangers may be envisioned, too. The first sink heater or first sink heat exchanger may be a U-tube or floating head exchanger, a plate tube or shell and tube heat exchanger.

[0026] In an embodiment, the drying system further comprises an expansion tank, the expansion tank being connected with the outlet of the first sink heater and/or the recuperator.

[0027] Additionally or alternatively, the drying system further comprises a circulating pump configured to circulate the operating medium. The dedicated pump may provide circulation of the operating medium flowing in the circuit, e.g. water in a continuous manner.

[0028] In a preferred embodiment, the humidity control system further comprises a by-pass valve and/or other by-pass means installed between the recuperator and the first sink heater, the by-pass valve being configured to allow the operating medium by-pass the first sink heater. The by-pass means may be installed in (direct or indirect) connection with the heat exchangers, i.e. recuperator and the first sink heater. The by-pass means may be connected in series or in parallel with the heat exchangers. The by-pass means may be installed at an alternative position in the system. As explained previously, output from the second controller may be used to control by-pass means that is installed within the circuit, which modulates the quantity of circulating operating medium that by-passes the pre-heater or first sink heater, thereby limiting cooling and maintaining the temperature of the circulating operating medium above, or at a pre-set close approach to the dew point temperature in the dryer exhaust. The temperature of the operating medium may be maintained at 0.5-5°C above the dew point temperature in the dryer exhaust, i.e. 0.5, 1, 2, 3, 4 or 5°C higher, or at approximately the dew point temperature, such as 0.05-5°C above or below the dew point temperature, such as 0.05, 0.1, 0.2, 0.3, 0.4, 0.5 , 1, 2, 3, 4, or 5°C above or below the dew point temperature. If the temperature of the operating medium is a little lower than or almost equal to the dew point temperature, that will be acceptable provided that the temperature of the tube or pipe surface where the operating medium flows into is just above the dew point temperature.

[0029] In an embodiment, the drying system is installed in a drying plant. The drying plant may be any type of industrial drying plant, used for drying products. The list of products which may be dried is extensive and include among other ingredients for dairy, food, chemical, agrochemical, energy, biotechnology, pharmaceutical, semipharmaceutical, healthcare, food additives, food ingredients, microorganisms, proteins, peptides, starch, whey, and many more, and are not limited in application to the examples given but are wide open for all such products. Suitable products are defined by their drying characteristics and not by their use or origin.

[0030] In an embodiment, the outlet of the drying device comprises an exhaust pipe, the recuperator being positioned at or in connection with the exhaust pipe. The exhaust pipe or exhaust stack of the dryer or simply referred to as exhaust of the dryer may accommodate the recuperator such that heat is recovered from the hot exhaust gases.

[0031] In an embodiment, the humidity control system further comprises a temperature sensor coupled to the second controller, the temperature sensor being configured to measure the temperature of the operating medium and/or of the process medium before it is fed to the recuperator.

[0032] In an embodiment, the sensor or probe of the humidity control system is positioned at or in close proximity with the inlet and/or outlet of the recuperator.

[0033] According to a second aspect of the invention, a method of avoiding the formation of condensation in a drying system is provided, comprising a drying device with an inlet and an outlet, a recuperator and a first sink heater, the recuperator comprising an inlet and an outlet and wherein the drying system further comprises a humidity control system, the humidity control system comprising a sensor and a first controller coupled to the sensor, the method comprising the steps of:

the drying device drying a liquid and/or solid material,
the recuperator heating and/or cooling down an operating medium,
the operating medium flowing from the drying device to the recuperator,
the first sink heater heating a process medium,
the sensor being configured to at least detect the humidity of the process medium,
the humidity control system automatically and continuously calculating the dew point temperature of the process medium and controlling the flow of the operating medium such that the temperature of the operating medium is higher than or to a pre-set approach to the dew point temperature of the process medium, so that the formation of condensation in the system is avoided.

[0034] The components mentioned above and further below may not be physically connected, but there is a connection allowing a process or operating medium to flow into a first component and then to a second component etc. Additionally or alternatively, the components may be indirectly connected such that energy flows or is transferred from one to the other. Indirect connection between the components may be understood as the components being separated in different hydraulic systems.

Brief Description of Drawings

[0035] In the following description, embodiments of the invention will be described with reference to the schematic drawings, in which:

Fig. 1 shows a schematic view of a drying system in an embodiment of the present invention;
Fig. 2 shows a schematic view of a drying system in another embodiment of the invention; and
Fig. 3 shows a schematic view of a drying system in an embodiment of the invention installed in a drying plant.

Detailed description

[0036] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided for thoroughness and completeness.

[0037] Fig. 1 shows a schematic view of the main components of a drying system 1 comprising a drying device or dryer 2. The drying device 2 is configured to dry a solid and/or liquid material and comprises an inlet 18 and an outlet 19. The drying system 1 further comprises two connected heat exchangers, a recuperator 7 and a first sink heater 3. The recuperator has an inlet 7a and an outlet 7b. The recuperator 7 is intended to heat and/or cool down an operating medium. The recuperator 7 is located in the exhaust stack 9 of the dryer 2, for recovering heat from the hot exhaust gases. The first sink heater 3 is located at the dryer inlet 18, for pre-heating a process medium, i.e. the incoming drying air. The operating medium is flowing from the drying device 2 to the recuperator 7 in a closed circuit 8 and in this embodiment is a mixture of water or water and glycol. The first sink heater 3 acts as a preheater, being configured to preheat a process medium, which in this embodiment is a gaseous steam such as air. The two heat exchangers are thus connected by a closed loop system of pipework 10, where the circulating flow of water or water/glycol mixture transfers heat from one heat exchanger 7 to the other 3. Heat or energy recovered by the heat exchanger 7 in the dryer exhaust 9 heats the circulating water flow and this in turn is cooled in the second heat exchanger 3, as it pre-heats the incoming drying air via the inlet 11. The cooled water flow is then returned to the first heat exchanger 7, for recovering more heat from the dryer exhaust 9 and the cycle continues, as a closed loop. Exhaust exits the recuperator towards the atmosphere from outlet 7b. Water circulation is provided by a dedicated circulating pump 17, which is included within the circuit. The position of the circulating pump 17 may vary. An optional storage tank or expansion tank 16 is also included in the circuit, here positioned close to the outlet of the first sink heater 3. The expansion tank 16 can provide some flexibility to the system.

[0038] The risk of dust which is present in the dryer exhaust 9, necessitates the use of plain (un-finned) tubes for the recuperator 7, which can be easily cleaned/-washed, if necessary. The first sink heater 3 installed at the dryer inlet has high efficiency extended surface finned tubes, where no dust is present and filtered ambient air entering via inlet 11 is pre-heated.

[0039] To mitigate the risk of fouling and blocking, the drying system 1 further comprises an intelligent humidity control system 5, which is provided to maintain temperatures above that where condensation may occur. Details of the humidity control system are shown in Figs 1 and 2. The control system 5 constantly monitors the conditions such as humidity, temperature, etc., within the dryer exhaust 9 and calculates the dew point temperature (at which condensation will occur). The humidity control system 5 comprises in this embodiment a humidity sensor 15 and a first controller 13 coupled to the sensor 15. The humidity sensor 15 detects the humidity of the process medium, while the humidity control system 5 automatically and continuously calculates the dew point temperature of the process medium and controls the flow of the operating medium such that the temperature of the operating medium is higher than or at a pre-set approach to the dew point temperature. Specifically, the first controller 13 automatically and continuously calculates the dew point temperature and communicates it to the humidity control system 5, which in return controls the flow of the operating medium by-passing the preheater 3. In this way, the formation of condensation in the system 1 is avoided.

[0040] In Fig. 1, the humidity sensor 15 is located after the recuperator 7 in close proximity with the outlet 7b, while in Fig. 2 it is located before the recuperator 7 in close proximity with the inlet 7a. The position of the humidity sensor 15 depends upon the sensor type and conditions within the dryer exhaust gas stream. The first controller 13 that is coupled to the humidity sensor 15 then communicates with a second temperature controller 14, which is coupled to a temperature detector 6, by adjusting its set point temperature to a value, which is just above, or at a pre-set close approach to the dew point measured in the dryer exhaust 9. The dryer exhaust 9 also covers the inlet and outlet of the recuperator 7. As explained previously, the temperature of the pipe where the operating medium is flowing into is not necessarily exactly the same as the temperature of the operating medium. Hence, the system is configured to operate accounting for small differences between these two temperatures. The temperature sensor 6 monitors the temperature of the operating medium circulating in the circuit before it is fed to the recuperator 7. Output from the second controller 14 is used to control the by-pass valve

4 that is installed within the circuit 8. The by-pass valve 4 modulates the quantity of circulating water that by-passes the preheater 3, thereby limiting cooling of the water in the preheater 3 and maintaining the circulating water temperature above, or at a pre-set close to the dew point temperature in the dryer exhaust 9.

[0041] Thus, since temperatures in contact with the humid dryer exhaust 9 are maintained above the dew point, it is guaranteed that condensation will never occur under all operating conditions.

[0042] In the embodiment shown in Fig. 1 and 2, typical savings up to 480kWh are achieved for an ambient air temperature of 10°C and for preheating the process medium to 50°C. The dew point temperature in these conditions is 41°C and the temperature of the circulating operating medium before it is fed to the recuperator 7 is 42°C. The preheater 3 required for this embodiment has an area of 625m^2 while recuperator has an area of 121m^2. For an ambient temperature of 5°C, the expected energy savings for a similar system are 490kWh, while for an ambient temperature of 25°C, the energy savings are 395kWh.

[0043] Fig. 3 illustrates the installation of the drying system 1 in a drying plant 12 comprising the dryer 2. The dryer 2 has a drying chamber 20. Details of the humidity control system have been omitted. The drying plant 12 may comprise a cyclone and a bag filter (not shown). The first sink heater 3 is here provided as part of a heat exchanger, which is configured to preheat the incoming air via inlet 11. The heat exchanger may also comprise a valve prior to its inlet. The circulating operating medium flows in the closed circuit 8, thereby connecting the recuperator 7 with the first sink heater 3.

List of reference numerals

[0044]

1	Drying system
2	Drying device/dryer
3	First sink heater / preheater
4	By-pass valve
5	Humidity control system
6	Temperature transmitter
7	Recuperator
7a	Inlet of recuperator
7b	Outlet of recuperator
8	Circuit
9	Dryer exhaust
10	Piping
11	Ambient air inlet
12	Drying plant
13	First controller
14	Second controller
15	Humidity sensor
16	Tank
17	Circulating pump
18	Inlet of dryer
19	Outlet of dryer
20	Drying chamber

Claims

1. A drying system comprising a drying device, a recuperator and a first sink heater, the drying device being configured to dry a solid and/or liquid material and comprising an inlet and an outlet, the recuperator comprising an inlet and an outlet and being configured to heat and/or cool down an operating medium, the operating medium flowing from the drying device to the recuperator, wherein the first sink heater is configured to preheat a process medium,

   wherein the drying system further comprises a humidity control system, the humidity control system comprising a sensor and a first controller coupled to the sensor, the sensor being configured to at least detect the humidity of the process medium,
   wherein the humidity control system is configured to automatically and continuously calculate the dew point temperature of the process medium and control the flow of the operating medium such that the temperature of the operating medium is higher than or to a pre-set approach to the dew point temperature of the process medium, so that the formation of condensation in the system is avoided.

2. A drying system according to claim 1, wherein the humidity control system further comprises a second controller being in signal connection with the first controller, the second controller being configured to monitor the temperature of the operating medium , the drying system further comprising bypass means such as a valve configured to allow the operating medium to by-pass the first sink heater, wherein the second controller is configured to control the opening and/or closing of the by-pass means as a function of the temperature of the operating medium.

3. A drying system according to claim 1, wherein the system further comprises a second sink heater connected in series with the first sink heater, the second sink heater being configured to heat the process medium.

4. A drying system according to claim 1, wherein the process medium is a gaseous stream such as air.

5. A drying system according to claim 1, wherein the operating medium comprises water and/or a heat transfer fluid such as glycol.

6. A drying system according to claim 1, wherein the recuperator is a plain tube heat exchanger, a plate

heat exchanger, a finned tube heat exchanger or a shell and tube heat exchanger.

7. A drying system according to claim 1, wherein the first sink heater is a finned tube heat exchanger.

8. A drying system according to claim 1, wherein the drying system further comprises an expansion tank, the expansion tank being connected with the outlet of the first sink heater and/or the recuperator.

9. A drying system according to claim 1, wherein the drying system further comprises a circulating pump configured to circulate the operating medium.

10. A drying system according to claim 1, wherein the humidity control system further comprises a by-pass valve and/or other by-pass means installed between the recuperator and the first sink heater, the by-pass valve being configured to let the operating medium by-pass the first sink heater.

11. A drying system according to claim 1, wherein the drying system is installed in a drying plant.

12. A drying system according to claim 1, wherein the outlet of the drying device comprises an exhaust pipe, the recuperator being positioned in connection with the exhaust pipe.

13. A drying system according to claim 2, wherein the humidity control system further comprises a temperature sensor coupled to the second controller, the temperature sensor being configured to measure the temperature of the operating medium before the operating medium is fed to the recuperator.

14. A drying system according to claim 1, wherein the humidity sensor of the humidity control system is positioned at or in close proximity with the inlet and/or outlet of the recuperator.

15. A method of avoiding the formation of condensation in a drying system comprising a drying device with an inlet and an outlet, a recuperator and a first sink heater, the recuperator comprising an inlet and an outlet and wherein the drying system further comprises a humidity control system, the humidity control system comprising a sensor and a first controller coupled to the sensor, the method comprising the steps of:

the drying device drying a liquid and/or solid material,
the recuperator heating and/or cooling down an operating medium,
the operating medium flowing from the drying device to the recuperator,
the first sink heater heating a process medium,
the sensor being configured to at least detect the humidity of the process medium,
the humidity control system automatically and continuously calculating the dew point temperature of the process medium and controlling the flow of the operating medium such that the temperature of the operating medium is higher than or to a pre-set approach to the dew point temperature of the process medium, so that the formation of condensation in the system is avoided.

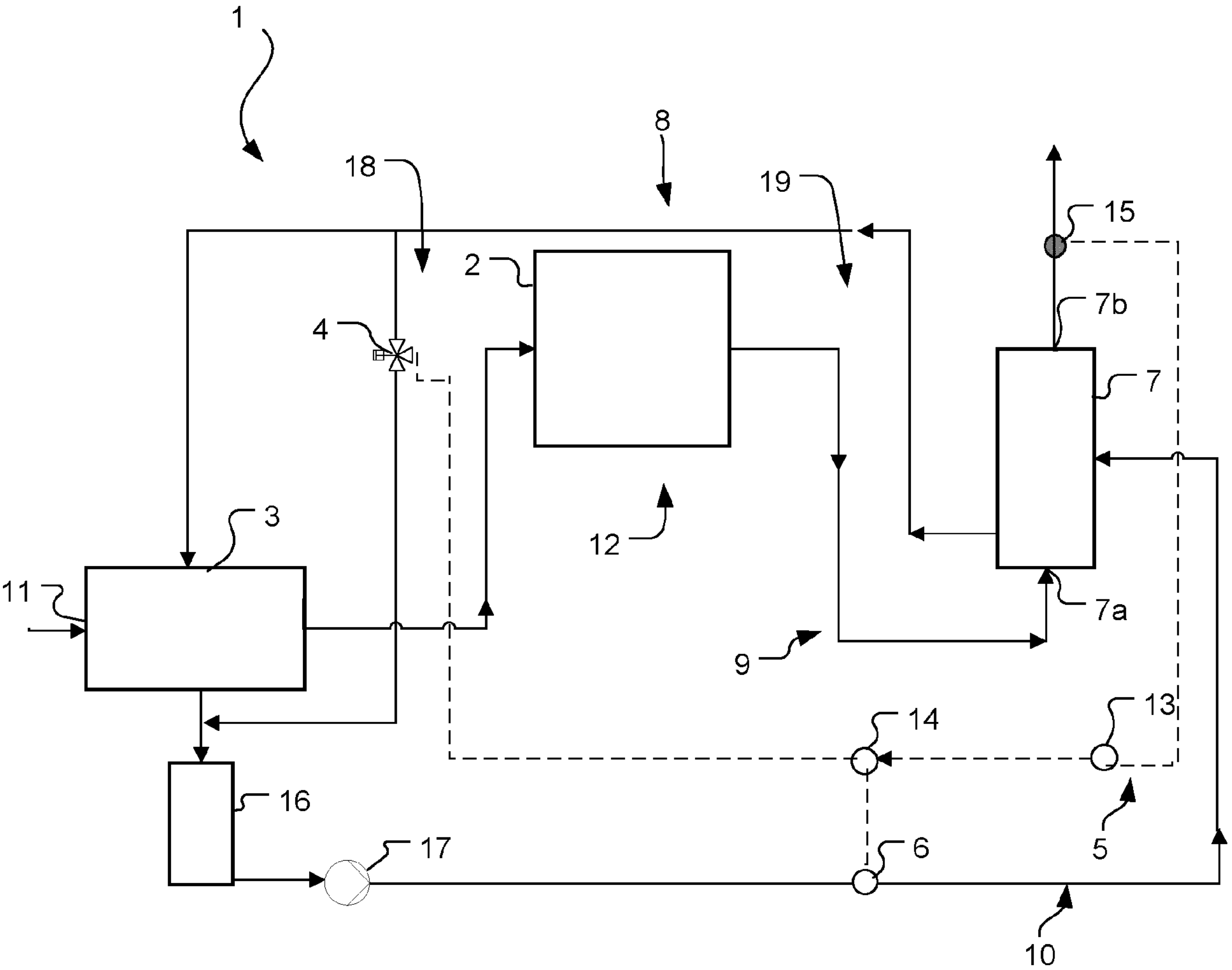

Fig. 1

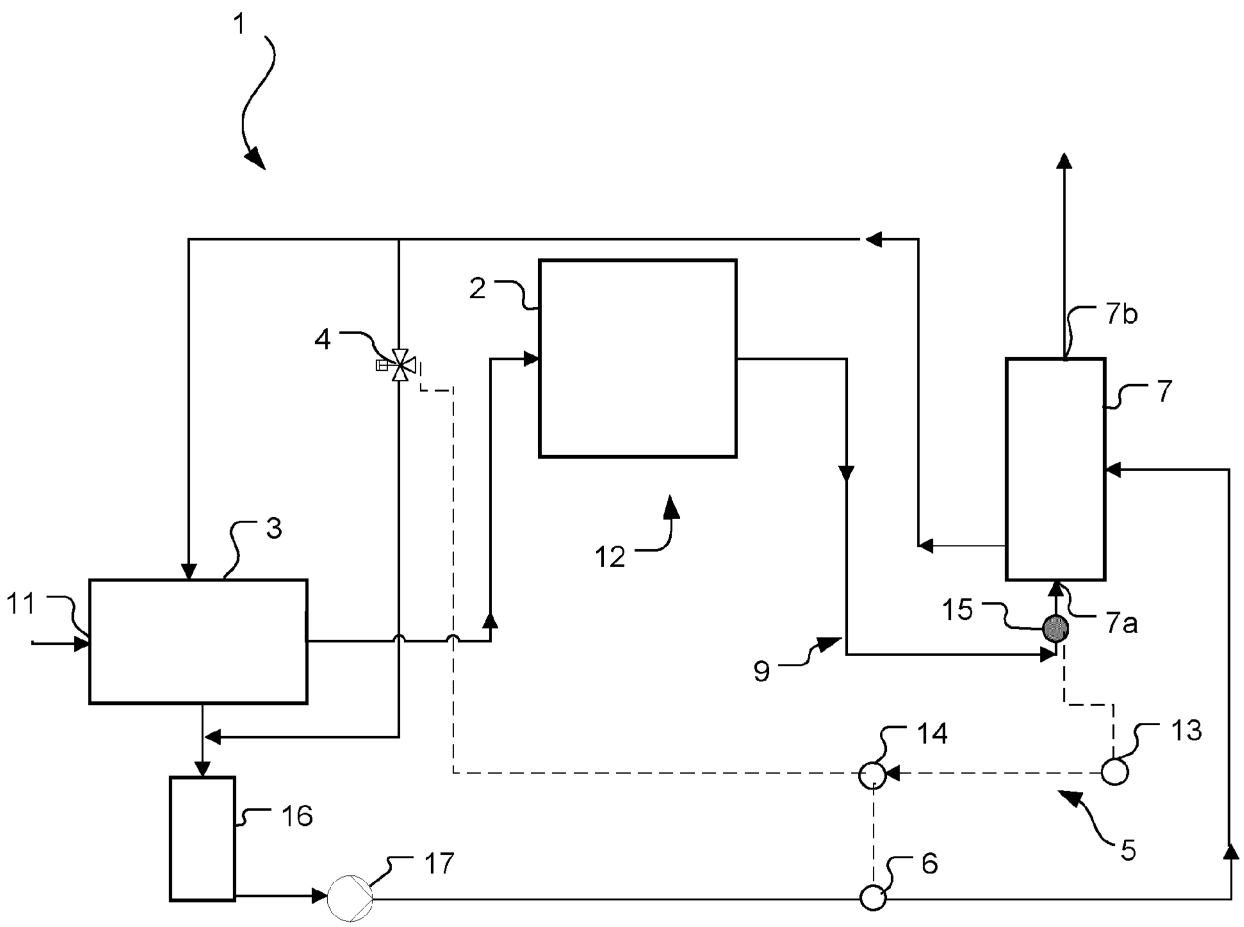

Fig. 2

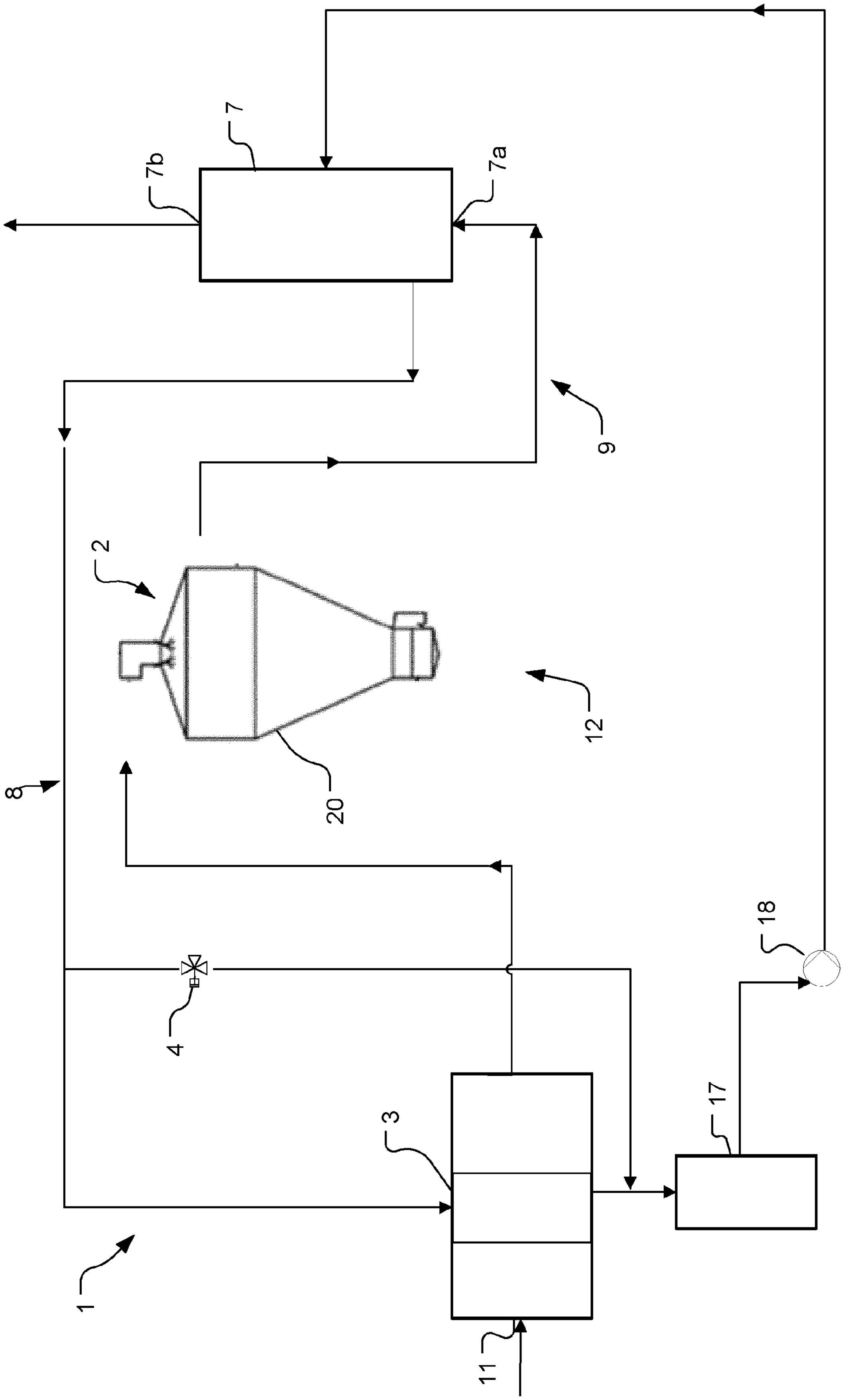

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 23 19 6295

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	FR 2 544 992 A1 (ALSTHOM ATLANTIQUE [FR]) 2 November 1984 (1984-11-02) * figures 1, 3 * * page 1, line 2 - line 6 * * page 4, line 35 - page 5, line 9 * -----	1,3-9, 11,12,15	INV. F26B21/10 F26B23/00 F26B21/12
Y	US 9 382 672 B2 (ASTEC INC [US]) 5 July 2016 (2016-07-05) * figure 4 * * column 6, line 19 - line 25 * * column 6, line 33 - line 40 * -----	1,3-9, 11,12,15	
A	KR 102 495 773 B1 (HU MASTER INC [KR]) 6 February 2023 (2023-02-06) * the whole document * -----	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

F26B

The present search report has been drawn up for all claims

2

Place of search	Date of completion of the search	Examiner
The Hague	15 February 2024	Fernandez Ambres, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
O : non-written disclosure
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 23 19 6295

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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