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**A Multifunctional Automatic Drying Room for Agricultural Products with Coupling Heat Supply of Solar Energy and Heat Pump**

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## Abstract of Description

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A multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump, the drying room comprises a drying chamber (1), a solar panel (2), a main air duct (3), a condensation chamber (4), a heating chamber (5) and a control unit, which is characterized in that, the solar panel (2) is connected with the main air duct (3) and can heat the air in the main air duct (3), the lower end of the drying chamber (1) is provided with a main air inlet (6), and the upper part of the side wall of the drying chamber (1) is provided with a main air inlet (7). The inlet of the main air duct (3) is connected with the outlet of the heating chamber (5), and the outlet of the main air duct (3) is connected with the main air inlet (6). The inlet of the condensation chamber (4) is connected with the main air outlet (7), and the outlet of the condensation chamber (4) is connected with the inlet of the heating chamber (5). The heating chamber (5) is provided with a heat pump mechanism (8) for heating air and a blower (9) for circulating air to the main air duct (3), and the condensation chamber (4) is provided with a dehumidification mechanism (10) for refrigeration and dehumidification of air. The control unit is connected with the heat pump mechanism (8) and the former can control the latter to work. Compared with the prior art, the device realizes the coupling heat supply mode of solar energy and heat pump heating, with precise control, high heat energy utilization rate, economical and practical advantages, etc. The invention can be applied in the fields of tobacco leaf curing, Chinese herbal medicine and economic crop dehydration and drying, and has the technical advantages of energy conservation and environmental protection.



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### **A Multifunctional Automatic Drying Room for Agricultural Products with Coupling Heat Supply of Solar Energy and Heat Pump**

#### **Technical Field**

The invention belongs to the field of material drying equipment technology, and relates to a multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump.

#### **Background Technology**

The full name of the drying equipment in English is drying equipment, which refers to a series of mechanical equipment combinations that dry the moisture or other liquids on the surface of the object through certain technical means. Currently, the most popular drying technologies mainly UV drying, infrared drying, electromagnetic drying and hot air drying. They have their own characteristics and are widely used in various mechanical equipment and food drying.

For example, the patent CN201210291742.5 discloses a dehumidification drying room with multi-purpose solar energy air source and heat pump cycle, which comprises a drying room, a control mechanism, a heat pump heat absorption mechanism and a dehumidification mechanism. The drying room is divided into a solarthermie chamber, a drying chamber and a heating chamber through a partition and a partition wall on the drying room. A circulating air outlet is provided on the partition of the drying room, and a solar panel is provided in the solarthermie chamber; a condenser and a second evaporator are installed on the partition wall, a circulating fan is connected to the part where the condenser is located in the drying chamber, and a small circulating fan is installed on the partition wall between the solarthermie chamber and the heating chamber; the control mechanism controls the working state of the compressor, fan and evaporator.

The above existing patents further complement the utilization rate of solar energy, but there are still some defects. The air duct design of the patent is unscientific, which can neither fully exchange the hot air and cold air, nor design the equipment that can improve the exchange efficiency of hot air and cold air, resulting in the low utilization rate of the heat energy and the low dehumidification effect and efficiency.

#### **Summary of the Invention**

In view of the above problems existing in the prior art, the invention provides a multifunctional automatic drying room for agricultural products with coupling heat

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supply of solar energy and heat pump. The technical problem to be solved by the invention is: how to improve the drying and dehumidifying effect and improve the drying and dehumidifying efficiency.

The purpose of the invention can be realized through the following technical solutions:

A multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump, the drying room comprises a drying chamber, a solar panel, a main air duct, a condensation chamber, a heating chamber and a control unit, which is characterized in that, the solar panel is connected with the main air duct and can heat the air in the main air duct, the lower end of the drying chamber is provided with a main air inlet, and the upper part of the side wall of the drying chamber is provided with a main air outlet. The inlet of the main air duct is connected with the outlet of the heating chamber, and the outlet of the main air duct is connected with the main air inlet. The inlet of the condensation chamber is connected with the main air outlet, and the outlet of the condensation chamber is connected with the inlet of the heating chamber. The heating chamber is provided with a heat pump mechanism for heating air and a blower for circulating air to the main air duct, and the condensation chamber is provided with a dehumidification mechanism for refrigeration and dehumidification of air. The control unit is connected with the heat pump mechanism and the former can control the latter to work.

The principle is as follows: the materials to be dried are generally placed in the drying chamber. After the solar panel absorbs the sunlight, the air in the main air duct is heated. After the blower is started to work, the main air duct generates the air flow. The hot air flow enters the drying chamber from the main air inlet at the bottom of the drying chamber. During the process of passing through the material, it can greatly evaporate the moisture in the material and flow together to the main air outlet. The main air outlet is provided on the upper part of the side wall of the drying chamber to make the hot air flow move upward more fully. After the hot air flow with water vapor reaches the condensation chamber, the water vapor is cooled and filtered due to the cooling and filtering effect of the dehumidification mechanism, and then the cooled air flow reaches the heating chamber. Generally, when the solar energy is sufficient, the control unit controls the heat pump mechanism not to work. The control unit is generally a common microcontroller that can be bought in the market, and the blower re-transmits the air flow in the heating chamber to the main air duct so as to realize the air circulation. The intelligent drying room adopts a control unit to control the heat pump mechanism, which can decide whether to open the heat pump

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mechanism according to the actual situation of solar energy. It has relatively advanced intelligence. The main air inlet and main air outlet of the drying chamber are located at the bottom and the upper side of the drying chamber respectively, which can make the hot air flow move upward through the material, and can greatly evaporate and taken away the moisture in the material during the process of passing through the material, so as to achieve a high drying and dehumidifying effect.

In the multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump, the solar panel is half surrounded by the outside of the drying chamber, and the inner surface of the solar panel and the outer surface of the wall panel of the drying chamber constitute the main air duct. The main air duct comprises an upper horizontal branch duct, a vertical branch duct and a lower horizontal branch duct that connected successively, and the upper horizontal branch duct is located at the top of the drying chamber and is connected with the heating chamber. The main air duct is directly composed of the inner surface of the solar panel and the outer surface of the wall panel of the drying chamber. The advantage is that the solar panel can directly heat the air in the main air duct, so as to improve the heat energy conversion rate. The air in the main air duct also heats and insulates the side wall of the drying chamber, so as to ultimately ensure the air temperature in the drying chamber is stable and is not easy to make the heat escape, thus improving the drying effect.

In the above multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump, the upper horizontal branch duct is provided with a first partition, and the first partition divides the upper horizontal branch duct into mutually parallel solarthermie air duct and heat pump air duct. The inlet end of the upper horizontal branch duct is provided with a steering door, and the steering door is hinged at the end of the first partition, which can select one to close the solarthermie air duct or the heat pump air duct by turning the steering door. When the sunlight is sufficient, the steering door will close the heat pump air duct, the advantage of this is to ensure the temperature in the drying chamber regardless of the weather, and ensure the drying efficiency and effect.

In the above multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump, the solarthermie air duct is provided with a light sensation probe, the drying chamber is provided with a temperature sensor, and the light sensation probe and the temperature sensor are connected with the control unit. The steering door is connected with a motor capable of driving its rotation, the motor is connected with the control unit, and the control

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unit can receive the electric signals detected by the light sensation probe and temperature sensor, and control the operation of the motor and the heat pump mechanism according to the processing results, so as to ensure the drying effect.

In the above multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump, the wall panels of the drying chamber, the heating chamber and the condensation chamber are all honeycomb panels, and the honeycomb panel comprises an outer panel, a honeycomb core panel and an inner panel which are overlapped and fixed mutually. The honeycomb panel has a good heat preservation effect, and the heat preservation coefficient can reach more than 0.2, which can prevent the heat from escaping and improve the drying efficiency.

Compared with the prior art, the advantages of the invention are as follows: the intelligent drying room adopts a control unit to control the heat pump mechanism, which can decide whether to open the heat pump mechanism according to the actual situation of solar energy, and has remarkable advantages of precise intelligent control, high energy utilization rate as well as cleaning and environmental protection.

### Description of Drawings

Figure 1 is a structure diagram of the intelligent multifunctional drying room.

In the figure, 1 drying chamber; 2 solar panel; 3 main air duct; 4 condensation chamber; 5 heating chamber; 6 main air inlet; 7 main air outlet; 8 heat pump mechanism; 9 blower; 10 dehumidification mechanism; 11 upper horizontal branch duct; 12 vertical branch duct; 13 lower horizontal branch duct; 14 first partition; 15 solarthermic air duct; 16 heat pump air duct; 17 steering door; 18 regenerator; 19 first flow channel; 20 second flow channel; 21 second partition; 22 compressor; 23 condenser; 24 evaporator.

### Detailed Description of the Presently Preferred Embodiments

The following is a further description of the technical solutions of the invention by the specific embodiments of the invention and in combination with the drawings, but the invention is not limited to these embodiments.

As shown in Figure 1, the drying room comprises a drying chamber 1, a solar panel 2, a main air duct 3, a condensation chamber 4, a heating chamber 5 and a control unit. The solar panel 2 is connected with the main air duct 3 and can heat the air in the main air duct 3, the solar panel 2 is half surrounded by the outside of the

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drying chamber 1, and the inner surface of the solar panel 2 and the outer surface of the wall panel of the drying chamber 1 constitute the main air duct 3. The main air duct 3 comprises an upper horizontal branch duct 11, a vertical branch duct 12 and a lower horizontal branch duct 13 that connected successively, and the lower horizontal branch duct 13 is located at the bottom of the drying chamber 1 and is connected with the main air inlet 6. The vertical branch duct 12 is located on the side of the drying chamber 1, and the upper horizontal branch duct 11 is located at the top of the drying chamber 1 and is connected with the heating chamber 5. The main air duct 3 is directly composed of the inner surface of the solar panel 2 and the outer surface of the wall panel of the drying chamber 1. The advantage is that the solar panel 2 can directly heat the air in the main air duct 3, so as to improve the heat energy conversion rate. The air in the main air duct 3 also heats and insulates the side wall of the drying chamber 1, so as to ultimately ensure the air temperature in the drying chamber 1 is stable and is not easy to make the heat escape, thus improving the drying effect. The upper horizontal branch duct 11 is located at the top of the drying chamber 1, which can make the solar panel 2 fully contact the sunlight on the top so as to improve the heat absorption effect. The main air duct 3 composed of the upper horizontal branch duct 11, the vertical branch duct 12 and the lower horizontal branch duct 13 makes the hot air flow half surround the flow channel of the drying chamber 1, which has a heating and heat preservation effect on the drying chamber 1, and also ensures the length of the main air duct 3, so as to make the solar panel 2 and the air fully contact the heating, and improve the drying effect of drying chamber 1.

The upper horizontal branch duct 11 is provided with a first partition 14, and the first partition 14 divides the upper horizontal branch duct 11 into mutually parallel solarthermie air duct 15 and heat pump air duct 16. The inlet end of the upper horizontal branch duct 11 is provided with a steering door 17, the steering door 17 is hinged at the end of the first partition 14, which can select one to close the solarthermie air duct 15 or the heat pump air duct 16 by turning the steering door 17. The steering door 17 can control which air duct the air flow of the heating chamber 5 is transmitted to. When the sunlight is insufficient, the steering door 17 closes the solarthermie air duct 15. Meanwhile, the heat pump mechanism 8 starts to work, and the heated air flow in the heating chamber 5 flows to the heat pump air channel 16.

The condensation chamber 4 is provided with a dehumidification mechanism 10 for refrigeration and dehumidification of air, and the control unit is connected with the heat pump mechanism 8 and the former can control the latter to work. As a solution, the heat pump mechanism 8 includes a compressor 22 and a reversible condenser 23, the two are connected, and the condenser 23 can generate heat after being reversed.

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As another solution, the heat pump mechanism 8 can be an electric heating element or an electric heating wire. As a solution, the dehumidification mechanism 10 is an evaporator 24, which can be refrigerated after being electrified. As another solution, the dehumidification mechanism 10 can also be a heat exchanger, which can be refrigerated through heat exchange. The inlet of the main air duct 3 is connected with the outlet of the heating chamber 5, and the outlet of the main air duct 3 is connected with the main air inlet 6. The inlet of the condensation chamber 4 is connected with the main air outlet 7, and the outlet of the condensation chamber 4 is connected with the inlet of the heating chamber 5. The heating chamber 5 is provided with a heat pump mechanism 8 for heating air and a blower 9 for circulating air to the main air duct 3. A regenerator 18 is provided at the intersection of the drying chamber 1, the condensation chamber 4 and the heating chamber 5. The regenerator 18 is provided with two intersecting and unconnected first flow channels 19 and the second flow channels 20, and the regenerator 18 can transfer the heat between the first flow channel 19 and the second flow channel 20. The first flow channel 19 is connected with the drying chamber 1 and the condensation chamber 4, and the second flow channel 20 is connected with the condensation chamber 4 and the heating chamber 5. The first flow channel 19 and the second flow channel 20 are located between the two outlets of the condensation chamber 4 and are divided by a second partition 21. The second partition 21 is vertically distributed, the top of the second partition 21 is against the regenerator 18, and the bottom of the second partition 21 is against the dehumidification mechanism 10. The effect of the regenerator 18 is heat exchange. The temperature of the air in the first flow channel 19 is higher and about 50°C, which comes directly from the drying chamber 1. The temperature of the air in the second flow channel 20 is lower and about 20°C after condensation and dehumidification. The regenerator 18 transfers the heat of the first flow channel 19 to the second flow channel 20, so that the air in the flow channel 19 is cooled to 30°C in advance, so that the air in the second flow channel 20 can be heated in advance and reached to about 40°C, thus improving the drying efficiency. The honeycomb panel has a good heat preservation effect, and the heat preservation coefficient can reach more than 0.2, which can prevent the heat from escaping and improve the drying efficiency.

The solarthermie air duct 15 is provided with a light sensation probe, the drying chamber 1 is provided with a temperature sensor, and the light sensation probe and the temperature sensor are connected with the control unit. The steering door 17 is connected with a motor capable of driving its rotation, the motor is connected with the control unit, and the control unit can receive the electric signals detected by the light sensation probe and temperature sensor, and control the operation of the motor and the heat pump mechanism according to the processing results. The light sensation

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probe can accurately detect the intensity of solar energy, and the temperature sensor can detect the air temperature in the drying chamber 1. The steering door 17 can achieve closed-loop control after connecting the motor, and the control unit can achieve intelligent closed-loop control, so as to accurately ensure the implementation of various heating methods, and ensure the drying effect. The materials to be dried are generally placed in the drying chamber 1. After the solar panel 2 absorbs the sunlight, the air in the main air duct 3 is heated. After the blower 9 is started to work, the main air duct 3 generates air flow. The hot air flow enters the drying chamber 1 from the main air inlet 3 at the bottom of the drying chamber 1. Due to the light weight and upward movement, the hot air can pass through the material. During the process of passing through the material, it can greatly evaporate the moisture in the material and flow together to the main air outlet 7. The main air outlet 7 is provided on the upper part of the side wall of the drying chamber 1 to make the hot air flow move upward more fully. After the hot air flow with water vapor reaches the condensation chamber 4, the water vapor is cooled and filtered due to the cooling and filtering effect of the dehumidification mechanism 10, and then the cooled air flow reaches the heating chamber 5. Generally, when the solar energy is sufficient, the control unit controls the heat pump mechanism 8 not to work. The control unit is generally a common microcontroller that can be bought in the market, and the blower 9 re-transmits the air flow in the heating chamber to the main air duct to realize the air circulation. If the solar energy is insufficient, the control unit will start the heat pump mechanism 8 to work, and the heat pump mechanism 8 will heat the air in the heating chamber 5 to ensure the air temperature in the main air duct 3.

The specific embodiments described herein merely illustrate the spirit of the invention. Those technical personnel that belong to the technical field of the invention may make various modifications or supplements to the specific embodiments described or substitute them in a similar manner, but they will not deviate from the spirit of the invention or go beyond the scope defined in the attached claims.

1. A multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump, the drying room comprises a drying chamber (1), a solar panel (2), a main air duct (3), a condensation chamber (4), a heating chamber (5) and a control unit, which is characterized in that, the solar panel (2) is connected with the main air duct (3) and can heat the air in the main air duct (3), the lower end of the drying chamber (1) is provided with a main air inlet (6), and the upper part of the side wall of the drying chamber (1) is provided with a main air inlet (7). The inlet of the main air duct (3) is connected with the outlet of the heating chamber (5), and the outlet of the main air duct (3) is connected with the main air inlet (6). The inlet of the condensation chamber (4) is connected with the main air outlet (7), and the outlet of the condensation chamber (4) is connected with the inlet of the heating chamber (5). The heating chamber (5) is provided with a heat pump mechanism (8) for heating air and a blower (9) for circulating air to the main air duct (3), and the condensation chamber (4) is provided with a dehumidification mechanism (10) for refrigeration and dehumidification of air. The control unit is connected with the heat pump mechanism (8) and the former can control the latter to work. Compared with the prior art, the device realizes the coupling heat supply mode of solar energy and heat pump heating, with precise control, high heat energy utilization rate, economical and practical advantages, etc. The invention can be applied in the fields of tobacco leaf curing, Chinese herbal medicine and economic crop dehydration and drying, and has the technical advantages of energy conservation and environmental protection.

2. A multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump as described in Claim 1, which is characterized in that, the solar panel (2) is half surrounded by the outside of the drying chamber (1), and the inner surface of the solar panel (2) and the outer surface of the wall panel of the drying chamber (1) constitute the main air duct (3). The main air duct (3) comprises an upper horizontal branch duct (11), a vertical branch duct (12) and a lower horizontal branch duct (13) that connected successively, and the lower horizontal branch duct (13) is located at the bottom of the drying chamber (1) and is connected with the main air inlet (6). The vertical branch duct (12) is located on the side of the drying chamber (1), and the upper horizontal branch duct (11) is located at the top of the drying chamber (1) and is connected with the heating chamber (5).

3. A multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump as described in Claim 2, which is

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characterized in that, the upper horizontal branch duct (11) is provided with a first partition (14), and the first partition (14) divides the upper horizontal branch duct (11) into mutually parallel solarthermic air duct (15) and heat pump air duct (16). The inlet end of the upper horizontal branch duct (11) is provided with a steering door (17), and the steering door (17) is hinged at the end of the first partition (14), which can select one to close the solarthermic air duct (15) or the heat pump air duct (16) by turning the steering door (17).

4. A multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump as described in Claim 3, which is characterized in that, the solarthermic air duct (15) is provided with a light sensation probe, the drying chamber (1) is provided with a temperature sensor, the light sensation probe and the temperature sensor are connected with the control unit. The steering door (17) is connected with a motor capable of driving its rotation, the motor is connected with the control unit, and the control unit can receive the electric signals detected by the light sensation probe and temperature sensor, and control the operation of the motor and the heat pump mechanism (8) according to the processing results.

5. A multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump as described in Claim 1 or 2 or 3 or 4, which is characterized in that, a regenerator (18) is provided at the intersection of the drying chamber (1), the condensation chamber (4) and the heating chamber (5). The regenerator (18) is provided with two intersecting and unconnected first flow channels (19) and the second flow channels (20), and the regenerator (18) can transfer heat between the first flow channel (19) and the second flow channel (20). The first flow channel (19) is connected with the drying chamber (1) and the condensation chamber (4), and the second flow channel (20) is connected with the condensation chamber (4) and the heating chamber (5).

6. A multifunctional automatic drying room for agricultural products with coupling heat supply of solar energy and heat pump as described in Claim 5, which is characterized in that, the first flow channel (19) and the second flow channel (20) are located between the two outlets of the condensation chamber (4) and are divided by a second partition (21). The second partition (21) is vertically distributed, the top of the second partition (21) is against the regenerator (18), and the bottom of the second partition (21) is against the dehumidification mechanism (10).

7. A multifunctional automatic drying room for agricultural products with

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coupling heat supply of solar energy and heat pump as described in Claim 1 or 2 or 3 or 4, which is characterized in that, the wall panels of the drying chamber (1), the heating chamber (5) and the condensation chamber (4) are all honeycomb panels.

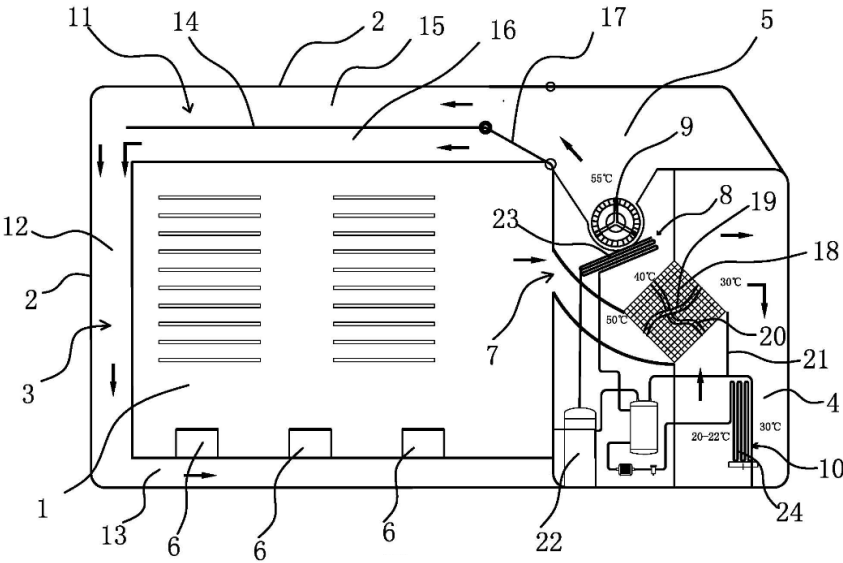


Figure 1