

Application status and development trend of air-source heat pump drying unit

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Abstract: In order to create a suitable environment and improve the quality of life of the people, the country has paid more attention to the problem of environmental pollution. The drying and drying process of materials accounts for a large part of the total energy consumption. Air source heat pump is an energy-saving device that consumes a small amount of high energy to improve the quality of low energy through thermal cycle, and has been widely used in many fields. The air-source heat pump drying unit can provide efficient drying technology, which is gradually applied in many fields such as production and manufacturing, grain processing, fruit and vegetable drying, etc. In this paper, the working principle of the air-source heat pump drying unit is briefly described, and then its application status in the fields of grain processing, fruit and vegetable planting, stadium reconstruction and so on is described. Finally, the development trend of the air-source heat pump drying unit is proposed from the perspective of technical process optimization.

1. Working principle of air source heat pump drying unit

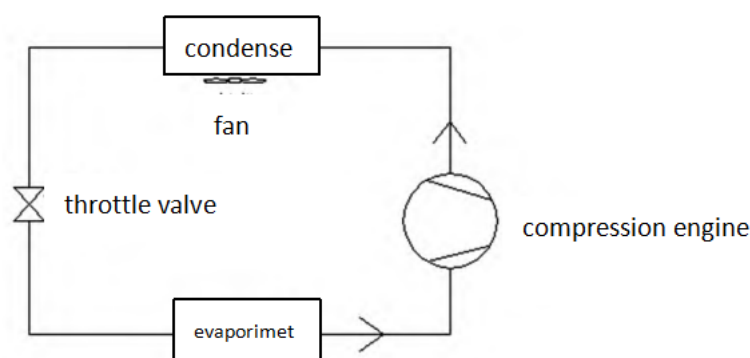


Figure 1: Schematic diagram of air source heat pump

The air-source heat pump drying unit is a kind of equipment that uses the inverse Carnot cycle principle to absorb heat from the environment and transfer the heat to the heating object to help the heating object warm up. Generally speaking, the mechanical components of the air-source heat pump drying unit are mainly composed of compressor, condenser, evaporator and expansion valve,

as shown in Figure 1. When the equipment is heating, it will work circularly in the evaporation-compression-condense-throttling state, transfer the heat in the low-temperature environment to the inside of the equipment, and then transfer the heat absorbed by itself to the object to be heated through the process of heat release. The air-source heat pump drying unit has the advantages of high heating efficiency, good heating and cleaning performance, good energy-saving effect, and the ability to achieve full automatic and accurate control. It is widely used in modern industrial production, grain processing, stadium reconstruction and other fields.

2. Application status of air source heat pump drying unit

2.1 Application in the field of grain processing

Drying is a key process in grain processing. The traditional manual drying method is time-consuming and labor-intensive, and it is difficult to achieve the effect of complete grain drying. In recent years, it has gradually become a new production idea to use the efficient heating performance of air-source heat pump drying unit to dry grain. Li Guangwei ^[1] and others compared the drying costs of grains with different heat sources, and found that the cost of coal drying and air source heat pump drying is equivalent, but the effect of heat pump drying is superior, and the cost of electric heating drying is the highest, which is not suitable for modern grain processing and production. In addition, the whole system using air source heat pump to dry grain adopts modular design, accurate refrigerant control flow and other new technologies, which can effectively ensure the energy efficiency and reliability of the equipment to remember the overall operation, and has the advantages of controllable cost, clean energy utilization, good raw grain drying quality, high heating efficiency, fully automatic operation, no need for special personnel to be on duty, convenient equipment installation, and convenient for rapid promotion, It is more suitable for large-scale promotion in the field of modern grain drying and processing.

2.2 Application in the field of fruit and vegetable planting

After the fruits and vegetables are planted and mature, the drying process also needs to be carried out. The natural drying or manual drying method used in the traditional mode also has disadvantages such as low efficiency and poor effect. The introduction of air-source heat pump drying unit to dry the fruits and vegetables can greatly improve the drying effect and quality. Dong Jianjun ^[2] and others selected the 15HP air source heat pump drying unit to dry German rice onions. The results showed that the air source heat pump drying unit had significant advantages in drying time, energy consumption and quality of German rice onions compared with the traditional natural drying, electric drying and other methods, and had important application value in optimizing the drying process of German rice onions. Ye Leilei ^[3] and others used the air-source heat pump drying unit to dry macadamia nuts. The results showed that after four stages of drying processing, macadamia nuts reached the drying standard, and the browning rate of nuts was 2.5%, the content of reducing sugar was 0.05%, and the comprehensive quality index of the product reached the best. In addition, the air-source heat pump drying unit can also dry and process fresh fruits and vegetables to produce preserved fruits, dried fruits and other non-staple foods, which is of great significance to improve the processing efficiency and quality of fruits and vegetables by-products.

2.3 Application in the field of venue renovation

Many modern large and medium-sized indoor sports venues need a large amount of clean hot water for cleaning, personal cleaning and other aspects. The traditional tap water circulation heating

and storage technology not only consumes a lot of energy, but also is difficult to ensure the cleanness of water quality. Using air-source heat pump drying unit to design the clean and circulating hot water system in the venue can change the drawbacks highlighted in the production of traditional hot water in the venue. Wang Sixiang^[4], according to the large amount of condensation heat in the indoor swimming pool and the large demand for sanitary hot water, adopted the air-source heat pump drying unit to absorb the large amount of condensation heat in the indoor swimming pool, and then recycled and cleaned, heated the circulating water source in the venue to produce a large amount of clean hot water. The results showed that: the transformation of the swimming pool hot water circulation system using the air-source heat pump drying unit, It can improve the energy efficiency of the hot water system in the venue, generate a large amount of clean hot water, and has high economic efficiency and energy saving effect. In addition, the air-source heat pump drying unit can also be used in the renovation of the hot water system of other venues such as badminton court, basketball court, football court, and so on, producing better renovation results.

3. Development trend of air source heat pump drying unit

At present, the air-source heat pump drying unit is more and more widely used in all walks of life, but it also has some technical bottlenecks. For example, the volume of the equipment's regenerator is relatively large, and the dehumidification effect is relatively poor, resulting in higher overall energy consumption. Therefore, in the future development, we should focus on solving the above problems. Specifically, on the one hand, gravity heat pipe can be considered as a heat transfer device, which can effectively reduce the volume of the regenerator and produce higher heat transfer efficiency; On the other hand, optimize the electric control system of the equipment unit. For example, introducing PID control algorithm into the dehumidification system of the equipment can accurately control the dehumidification effect and effectively solve the problem of poor dehumidification energy efficiency of the equipment; Or introduce micro-controller for programmed control to control the dehumidification process of the equipment, which can also greatly improve the dehumidification effect of the equipment. In addition, CFD software can also be introduced to simulate the drying and dehumidification effect of the equipment, and the system design can be optimized according to the simulation results. In short, through continuous technical improvement, the process performance of the air-source heat pump drying unit is continuously improved. The development of household appliances towards energy conservation and consumption reduction is the trend of the times and is also driven by policies. In the future, energy saving and consumption reducing heat pump products will play an increasingly prominent role in the low-carbon transformation of heating and cooling. On the one hand, the use of air source heat pump in industry can reduce costs and increase efficiency, and play an important role in reaching the carbon peak in 2030. On the other hand, the use of air source heat pump in the household sector can replace the existing air conditioning dehumidification and other functions, which can achieve a broader range of energy conservation and environmental protection and reduce various costs for families, Improve the comfort of residents' lives and large venues.

According to the data of BSRIA, the sales volume of air source heat pumps in 2013 was 1.004 million units, while it had increased to 1.395 million units in 2015. Under the vigorous implementation of the northern "coal to electricity" project, the sales volume of air source heat pumps in 2016 increased by about 45.8% compared with that in 2015, an increase of about 640000 units, and the overall sales volume reached 2.03 million units. In 2017, China's air source heat pump increased by 43.7% year on year, and its sales reached 2.92 million units. In 2018, the year-on-year growth was about 34.5%, and the total sales reached 3.93 million units, as shown in

Figure 2. The data of these five years shows that the market of air source heat pump has continued to develop with a growth rate of more than 20%.

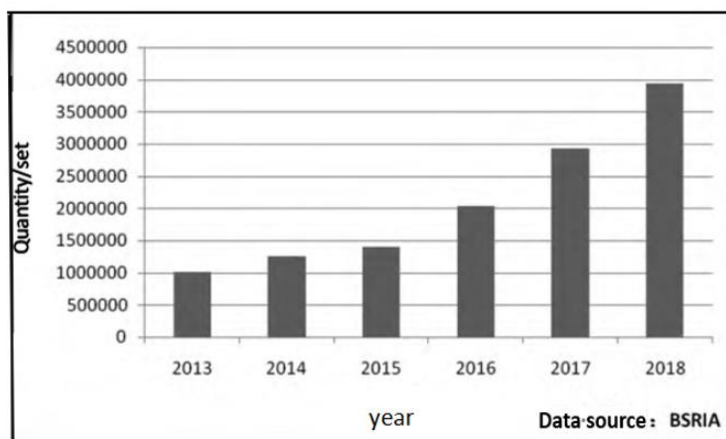


Figure 2: Sales statistics of air source heat pump over the years

Air source heat pump is one of the best ways to replace heating and drying equipment such as coal and fuel oil. With the increasing demand for energy consumption, automation and safety of products in various industries, the market demand for air source heat pump is still increasing. Air source heat pump is not only a traditional industry, but also a sunrise industry under the guidance of new technologies. The global market prospect is very broad [5].

4. Conclusion

The hot and humid environment in the drying room is not easy to be controlled, the temperature and humidity uniformity is poor, and the fresh air constantly replenished contains a large amount of oxygen, which causes oxidation and enzymatic reaction of the drying products, resulting in the destruction and loss of the color, aroma and nutrients of the dried materials, and thus the quality of the drying products cannot be guaranteed. Compared with the traditional hot air drying, the heat pump drying technology has the advantages of less energy consumption (1 kW can produce more than 5 kW of heat at most), no pollution to the environment, high drying quality, wide application range, safety and reliability. The heat pump drying technology has developed very rapidly in recent years, especially in the drying fields of agricultural products processing, medicine, tea and so on. With the continuous deepening of the application of air-source heat pump drying units in industrial production, product processing, venue renovation and other fields, the upgrading of equipment process performance and technology optimization should also be promoted. The production and development enterprises of air source heat pump drying units should solve the problems of low heat exchange efficiency, large volume and high dehumidification energy consumption of the equipment as soon as possible, and design and customize personalized product functions according to the needs of customers to promote the continuous development of the air source heat pump drying application industry.

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