Solar Air-Conditioning Refrigeration Technology and Its Research Progress

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Abstract: With the rapid development of society and economy, energy saving and environmental protection are particularly important, and solar energy is one of the most environmentally friendly energy sources. The biggest advantage of using solar energy for air-conditioning cooling is that it is highly compatible with the season. When the weather is the hottest, the cooling effect is more prominent, and the cooling capacity of the air-conditioning is greater. Diversity. Among these technologies, it is most scientific and reasonable to convert solar energy into thermal energy, and then realize cooling based on thermal energy. The advantage of this method is that it can realize the comprehensive utilization of air conditioning and its conversion efficiency is higher. However, the current solar air-conditioning refrigeration technology also faces many problems. This paper has researched solar refrigeration technology, and pointed out the need to improve solar refrigeration.

1. Introduction

Solar air conditioners are attracting more and more attention due to their superior season matching. Solar air conditioners generally use environmentally friendly refrigerants, and the ozone layer destruction factor (ODP) and greenhouse effect coefficient (GWP) are both zero, which fully meets the requirements of environmental protection. The current solar air-conditioning refrigeration technology can be roughly divided into two ways in principle: one is the conversion of solar energy into electricity, which is then used to drive compression refrigeration, and the way of generating electricity is divided into photovoltaic and photothermal The second is to directly use solar collectors to collect heat to promote cooling by heat. Among them, the air conditioning system driven by solar thermal conversion can generally not only be used for cooling in summer, but also can be easily heated and supplied with hot water throughout the year, which greatly reduces the overall economic cost of the system and is an ideal form of air conditioning systems in the future.

In order to further promote the steady development of solar air-conditioning refrigeration technology and achieve effective iteration and update of the technology, the article takes the development of solar air-conditioning refrigeration technology as the research core, focuses on the actual situation, and clarifies the necessity of the development of solar air-conditioning refrigeration technology. Based on this, From a multi-dimensional perspective, comprehensively explore the development direction and innovative mechanism of refrigeration technology, and effectively promote the improvement of solar air-conditioning technology content and practicality, and inject new vitality into the transformation and upgrading of the air-conditioning industry and the development of ecological environmental protection work.

2. Necessity of the Development of Solar Air-Conditioning Refrigeration Technology

As an important household appliance, air conditioners play a key role in improving the quality of life and quality of life. With the rapid increase in the number of air conditioners installed and the increase in the frequency of use, air conditioning has also brought about increases in energy consumption, heat islands, etc. Effects and other problems, if these problems are not effectively solved, it will lead to more serious ecological and environmental problems. The development of solar air-conditioning refrigeration technology has effectively satisfied the consumer demand in the air-conditioning market. In recent years, with the change in the concept of economic development in China, the traditional consumption model and production behavior have undergone extremely

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profound changes. Judging from the data provided by relevant departments, solar air-conditioning refrigeration technology has gradually matured consumer groups and realized consumption upgrades. Different from the traditional air-conditioning cooling mode, the solar air-conditioning refrigeration technology uses solar hot water as the main technical framework. The reasonable use of refrigeration equipment has realized the full connection between the solar water heater and the cooling function, forming a complete air-conditioning operation mode of the system, which greatly improves the air-conditioning. The economy of production and consumption reduces unnecessary waste of resources. Since solar air conditioners do not use refrigerants such as Freon, the ozone layer is not destroyed during the refrigeration process, which promotes the cleanliness of air conditioning operations, reduces the pressure on the ecological environment during air conditioning operation, and reduces the pressure on environmental protection. .

3. Application and Research Status of Solar Air Conditioning Refrigeration Technology

In recent years, many domestic and foreign scholars have conducted in-depth research on solar air conditioning refrigeration technology. There are two main ways of solar cooling. One is to first realize light-electric conversion, and then use electricity to drive conventional compressors for cooling. The principle is simple and easy to implement, but the cost is high; the second is to use the solar thermal energy as the driving force for cooling. High requirements, but low cost, no noise, no pollution, are the main ways of solar energy applications in air conditioning.

This article mainly reviews the research and application of solar absorption refrigeration, solar adsorption refrigeration, and solar jet refrigeration applied in the field of air conditioning.

Absorption refrigeration is based on the characteristics of the strong absorption of the refrigerant by the absorbent, which uses thermal energy to drive the solution for refrigeration. According to different absorbents, it can be divided into ammonia-water absorption refrigeration and lithium bromide-water absorption refrigeration. The introduction of solar energy into the absorption refrigeration system as the driving heat energy can greatly reduce the operating cost of the system and improve its operating performance. At present, most of the absorption solar air-conditioning systems researched and developed in China use the conventional closed cycle. Alizadeh proposed a three-effect compression-type absorption cooler driven by solar energy. This absorption refrigeration technology reduces the area of the collector. At a temperature of 140 ° C, the COP of the cooler is 1.5. In order to determine the heat transfer coefficient of the boiling mixed solution inside the tube in solar absorption refrigeration, Rivera et al. Proposed an intermittent absorption refrigeration system using ammonia-lithium nitrate as a mixed solution. This system consists of a generator-absorber and a condenser. Vacuum tube and evaporator, the test results show that when the system temperature is 120 ℃, the condensation temperature is 40 to 44 ℃, the system efficiency is between 0.15 to 0.4. Chen Yaping improved the heat recovery process of lithium bromide solution, and proposed a new 1.x-grade lithium bromide absorption refrigeration cycle suitable for solar energy and other low-temperature heat sources. This cycle is called 1.x lithium bromide absorption refrigeration cycle. Simulation calculations show that the performance index of the 1.x-level loop is significantly higher than that of the two-level loop. The 5kW absorption refrigeration unit designed by Li Xinmei is a combination of plate heat exchanger and shell and tube heat exchanger. After numerical calculation and simulation, the convection heat transfer coefficient of liquid can reach 2 ~ 10kW / (m2 • K).

Solar liquid dehumidification is to send ambient air or indoor return air into the dehumidifier, and make it contact with the dehumidification solution. Part of the water in the air is removed, and the dried air is humidified adiabatically to achieve the purpose of air conditioning; diluted dehumidification The solution is regenerated in the regenerator to complete a cycle. In the research of dehumidifier, based on the phase equilibrium theory, Ahmed deduced the thermodynamic formula for calculating the vapor pressure of the surface of the lithium chloride and calcium chloride solution, and compared it with the experimental value, which obtained a good agreement. Conde established mathematical formulas to calculate the surface vapor pressure, solubility, density,

surface tension and viscosity of lithium chloride solution and calcium chloride solution, which provided a theoretical basis for the physical properties of dehumidification solutions. Zhao Yun comprehensively analyzed and compared the dehumidifiers lithium bromide, lithium chloride, and calcium chloride solutions commonly used in liquid dehumidification systems from the aspects of vapor pressure, corrosiveness, and economics, and concluded that lithium chloride solutions are more suitable for solar liquid dehumidification air conditioners. Dehumidifier for the system. Sun Jian used classical thermodynamic theory to calculate the surface vapor pressure of calcium chloride, lithium chloride and their mixed solutions, which is very close to the experimental results. It is believed that this method can accurately estimate the surface vapor pressure of various dehumidifying solutions. In terms of dehumidifier, Wahab used triethylene glycol as a dehumidifier, and experimentally studied the effect of the filling density of wooden filler on the dehumidification capacity and dehumidification efficiency of the system. The results show that when using a high filling density, as the air flow rate, solution flow rate, and solution concentration increase, the system's dehumidification efficiency is lower and the filling density is smaller; as the solution or air temperature increases, the system's dehumidification efficiency is lower. High packing density. Although this adiabatic dehumidifier has a large heat and mass exchange area, the latent heat released during the dehumidification process is absorbed by the solution, which causes the solution temperature to increase, the surface vapor pressure to increase, and the moisture absorption capacity to decrease.

Adsorption refrigeration is based on the adsorption of solid adsorbents on refrigerants. Commonly used are molecular sieve-water, activated carbon-methanol adsorption refrigeration. Since solar adsorption refrigeration systems generally work under negative pressure, after a period of use, the refrigeration performance will deteriorate and eventually stop working. In order to avoid this phenomenon, Li Yuncang et al. Proposed the use of chemically stable glass as an adsorption bed and solar energy. Collector, the test results proved to be feasible. Wang Ruzhu and others produced an experimental prototype of a solar water heater-refrigerator compound machine. Using electric heater simulation experiments, the COP value of the refrigeration cycle was 0.4l. Zhang Xuejun et al. Proposed a new type of solar-driven continuous solid adsorption refrigeration system. Compared with the intermittent solar solid adsorption refrigeration system, it can achieve continuous refrigeration in sunlight, and the system has a high energy utilization rate. In order to solve the problem of refrigerant pressure drop in the traditional double-bed continuous adsorption refrigeration system, Liu Yanling et al. Proposed a new type of solar refrigeration system using silica gel-water as an adsorption working medium pair. The research results provide theoretical guidance for further experiments and improvement of system performance. Vasiliev and others trial-produced a solar-natural gas solid-adsorption heat pump that uses parabolic focused solar collectors to heat circulating water and drives a dual-adsorber regenerative adsorption refrigerator. When solar energy is insufficient, natural gas assists heating, which can achieve Continuous cooling. Based on the previous research, Sumathy put forward many methods to improve the performance of solar adsorption refrigeration subsystem. Anyanwu proposes a thermodynamic design method for solid-adsorption solar refrigeration. Activated carbon-methanol, activated carbon-ammonia water, and zeolite-water are used as working medium pairs. The calculation results show that zeolite-water working pairs are the best in air conditioning. When using traditional solar collectors, the maximum COP values of zeolite-water, activated carbon-ammonia, and activated carbon-methanol are 0.3, 0.19, and 0.16, respectively.

Solar adsorption refrigeration uses solar energy as the driving heat source, a porous solid as an adsorbent, and a gas as a refrigerant to form an adsorption refrigerant working pair. While the solid adsorbent adsorbs the gas adsorbent, the fluid The adsorbate continuously evaporates into a gas available for adsorption, and the evaporation process absorbs heat from the outside to achieve refrigeration. The dehumidification of the runner driven by solar energy has been deeply studied by many scholars at home and abroad. In terms of runners, Zhong Jinhua et al. Used the dynamic changes of two dehumidification indicators D and dehumidification performance coefficient DCOP to experimentally compare the dynamic dehumidification characteristics of silica gel and lithium

chloride runners before reaching steady state under the same conditions. The results show that under the same operating conditions, the non-steady-state transition time of the lithium chloride runner is longer than that of the silicone runner, and the D and DCOP of the lithium chloride runner are always higher than those of the silicone runner. Ding Yunfei conducted theoretical and experimental research on the heat and mass transfer performance of doped silica gel dehumidification wheels, and analyzed the effects of speed, desorption angle, and channel size on the performance of dehumidification wheels. For 0.2m thick runners, 10r / h and 90 ° The desorption angle is conducive to strengthening the heat and mass transfer performance of the dehumidification wheel. EsfandiariNia proposed a solar-driven dehumidification heat and mass transfer model of a runner. Through this model, the temperature and humidity of the air coming out of the dehumidifying runner can be predicted, so as to control the optimal speed of the runner.

The circulating pump in the jet refrigeration system is the only moving part. The system setting is simpler than the absorption type, the operation is stable, and the reliability is higher. However, its disadvantage is that the cooling efficiency is low. Fang Chengchao and others analyzed and researched the boost injection system, and the research showed that this boost injection or injection-compression hybrid system has good technical economy.

4. Application Prospects of Solar Air Conditioning Refrigeration Technology

With the world ’s increasingly tight energy sources and increasing air-conditioning energy consumption, the use of more energy-efficient air-conditioning systems is a common demand of mankind. The air-conditioning refrigeration system that uses solar energy as the driving heat source saves energy and does not use harmful substances such as Freon, which destroys the atmosphere. It is a veritable green air conditioner. It has great development potential in energy saving and environmental protection. Solar air-conditioning refrigeration systems are mostly based on solar collectors. On the one hand, due to the low efficiency of solar energy, high prices, and the impact of time, for relatively concentrated residential buildings, if the design of the building does not consider solar energy The installation of air conditioners and collectors will be greatly restricted; on the other hand, there are many forms of solar refrigeration, but from the current research status, there are some deficiencies in various forms of refrigeration systems, so they are limited. Widespread application of solar air-conditioning refrigeration technology. How to further improve the operating efficiency of the system and the combined operation of various refrigeration cycles are the key areas of future research. With the development of software and hardware systems, technical standards, and supporting equipment for the design and manufacture of solar air-conditioning systems, and relying on the development of the building market of green buildings, the research and application of solar energy in air-conditioning refrigeration will have great development.

5. Conclusion

In general, the organic combination of solar heat collection conversion and matching refrigeration and air conditioning methods and energy storage methods is the key to the future of solar refrigeration and air conditioning technology to be more efficient, low-cost, and large-scale applications, and it is also a period of time in the future. Focus of research and application in the technical field. A comprehensive review of the development of common solar air-conditioning refrigeration technology will help technicians to form a correct understanding at the thinking level. Based on this, a basic framework for the development of solar air-conditioning refrigeration technology will be gradually formed, which will provide a basis for subsequent technological innovation. The development provided the necessary theoretical support.

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