

Solar Direct-drive Type Central Air Conditioning

Yue Xingzuo

Wuhan institute of shipbuilding technology

wuhan china

84771162@qq.com

Abstract:Application of solar technology is a hot research field of control resources at home and abroad nowadays, using solar energy technology, high level is becoming one of the solutions of current environmental issues. Solar central air conditioning in line with energy saving, environmental protection concept of the social requirements. Research on solar energy central air conditioning at home and abroad, in this paper, the mechanism, the solar energy air conditioning factors and solutions of the problem. Integrated view, solar energy central air conditioner has the advantage of energy conservation, obviously, but it is still at the experimental stage, many technical problems are to be solved, at present, there are many limitations to use solar energy central air conditioner.

Keywords-Solar energy;central air conditioning;energy-saving;environmental protection;absorption refrigeration

I. INTRODUCTION

The solar energy air conditioning, is the use of solar energy, air conditioning equipment of lithium bromide absorption refrigerating machine using water as refrigerant. The no Freon chemical products, but also the operation does not need electricity to drive the compressor, reached no pollution and almost zero cost. Application of solar air conditioning coincided with the season. The highest temperature in summer, air conditioning load, need refrigeration capacity is the highest, while the sun radiation is strongest, also the largest solar energy output of the solar energy air conditioning, cold and provide the maximum. China's abundant solar energy resources, and the radiation of the sun strong time is long, so the solar energy air-conditioning is have a brilliant future.

However, the solar energy air conditioning products of high input, low utilization rate has become the stumbling block the development of solar air conditioning. But in energy saving, emission reduction urgent request, in the product concept of solar air conditioning superior, through the integration of solar energy technology, energy storage technology, constantly optimize the product performance, reducing the price of products, increase product competitiveness. Solar energy central air conditioning is bound to its unique advantage of the industry to benefit thousands of households.

II. THE BASIC WORKING PRINCIPLE

Solar direct drive type central air-conditioning system heat exchanger, the accumulator and the lithium bromide absorption type refrigerating machine is composed of three parts mainly consists of solar collector.

III. THE WORKING PRINCIPLE OF LITHIUM BROMIDE ABSORPTION TYPE REFRIGERATING MACHINE

Lithium bromide absorption chiller is used as working medium is performed by using the aqueous solution of lithium bromide. The low boiling water as refrigerant, high boiling point as the absorbent LiBr.

Main generator condenser, evaporator, absorber and an electric control part.

In the refrigeration process, when the lithium bromide aqueous solution by heat conducting oil heating in the generator, solution of water evaporation; water vapor entering the condenser, cooling water after cooling condensation; with the continuous vaporization of water, the concentration of the solution of the generator, rising,entering the absorber; when the condenser in the water through the throttle valve into the evaporator, rapid expansion and vaporization, and the vaporization process to absorb a large number of the evaporator refrigerant water heat, so as to achieve the purpose of cooling and refrigeration; in this process, low temperature water vapor entering the absorber of the lithium bromide solution, absorbed in the absorption,concentration gradually reduced, the solution pump back to the generator, to complete the cycle.

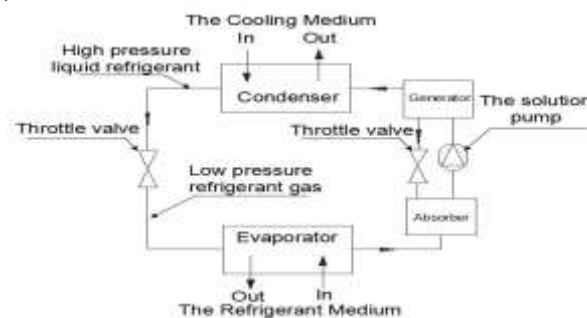


Figure 1 refrigeration process

A. The dilute solution and the concentrated solution circulation principle

The absorber absorbs the concentration of lithium bromide solution low pressure steam becomes small, low temperature, was sent to the boiling solution pump and refrigerant vapor, due to the higher pressure generator, so the pressure of the refrigerant vapor is higher, that is through the heating pump booster and steam, the steam pressure elevated.

The boiling solution to produce refrigerant vapor, concentration and temperature rise, but also has the ability

to absorb water vapor generator, because the pressure is much higher than the absorber pressure, therefore, to let the absorber of absorption of water vapour must through the throttle valve pressure.

In the absorber, the solution is the heat transfer through the cooling water spray, the tube bundle, because the solution on the absorption of water vapor to release great heat absorption, so it needs to be a lot of cooling water for cooling, experiment and theory show that the concentration of the solution, the higher temperature, lower, the ability to absorb water vapor is more strong, so, in practice, efforts should be made to improve concentration, reduce the temperature, but should pay attention to avoid the concentration is too high, low temperature and crystallization.

In addition, a dilute solution temperature is low, sent to the generator for energy to heat; and on the other hand, the higher temperature get solution, in the absorber cooling required to have strong absorption ability of water vapor, so, if can make the concentrated and dilute solutions of heat is good, it can improve the the coefficient of performance of the unit.

Therefore, in the actual lithium bromide absorption type refrigerating machine, usually with solution exchanger. In the solution heat exchanger, dilute solution flow in the tube, and the concentrated solution in the tube outside (shell) flow, so as to achieve the purpose of heat exchange.

B. The single effect lithium bromide absorption refrigerating machine structure layout

The single effect lithium bromide absorption refrigerating machine standard, usually with low pressure steam 0.1MPa or 75 °C hot water as driving heat source. It has the advantages of small volume, compact structure, simple operation, the use of low grade heat source, low cost, but the coefficient of performance is low, generally only about 0.7. Because it is the foundation of the lithium bromide absorption refrigerating machine, other units are based on the development of, therefore, this chapter focuses on the structure of single effect lithium bromide absorption refrigerating machine.

The principle of the absorption refrigerating machine from the lithium bromide, high pressure generator and the condenser, evaporator and absorber and the pressure is low, therefore, usually the generator and condenser in a space, and the absorber and the evaporator are arranged in a space.

Because the lithium bromide absorption type refrigerating machine work in the high vacuum condition, so the shell design it into a cylindrical structure. The high pressure section is disposed above, low pressure part arranged below, separated by a solution tank.

C. Performance of single effect lithium bromide absorption refrigerating machine

The performance of the lithium bromide absorption refrigerating machine is stable, the coefficient of performance (COP) depends on the design level, unit type, operation, steam pressure, temperature and flow rate

of cooling water, dirt, units within the vacuum level and many other factors.

Lithium bromide absorption type refrigerating machine in actual operation, often as a result of heating steam pressure (or temperature) fluctuations, seasonal climate changes and load changes, so that the refrigerator can not work under the design condition, for example by refrigerating machine working steam and cooling water consumption, the chiller coefficient of performance and other changes a series of. In addition, in the user load changes, cooling capacity should also be ready to make the change.

Because of the poor performance of the single effect lithium bromide absorption type refrigerating machine, the coefficient of performance (COP) of smaller, generally only about 0.7. Influence the performance of the following factors:

1) Influence of non condensable gas on the performance of refrigeration machine

Bromide absorption chiller is refrigeration equipment work under high vacuum condition, some units of the refrigeration performance instability or not up to one of the main reasons is that the vacuum of the unit design ability, no good solution. For the lithium bromide absorption type refrigerating machine, high vacuum degree is the essence of the non condensable gas turbine by pumping much reflection.

Sources of non condensable gas turbine system is as follows: the start-up of the unit, the unit in the air is not completely exhausted; air connections, welding, valve through a pipeline leak to the unit; in the unit, the hydrogen gas generated due to corrosion of metal materials of lithium bromide solution. The unit of memory in the non condensable gas, mainly affect the absorption process, the heat transfer, mass transfer weakened. The release of the external corrosion leakage into the refrigerator surface air refrigerator and internal metal hydrogen are non condensable gas. These gases are not setting, will not be absorbed by the lithium bromide solution. When the heat they adhere to the condenser tube surface, the thermal resistance increases, increases the condensing pressure, which increases pressure of generator, reduces the production of steam generator, the cooling capacity decreases. The non condensable gas exists in the absorber, reduces the absorption of water vapor in process of absorbing quality impetus, the mass transfer coefficient decreases, the mass transfer process of deterioration, refrigerating capacity decreased significantly. The non condensable gases accumulate more, refrigerating capacity drop more, sometimes to the point of not refrigeration.

2) Effect of solution circulating rate on the performance of refrigeration machine

For the heating steam pressure, rated temperature of cooling water and chilled water outlet temperature, lithium bromide absorption type refrigerating machine with circulating ratio solution and the corresponding, from the type can be seen, the recycle ratio, amount of the solution and the cooling capacity is proportional to dilute

into generator. If adjusted properly, there will be the following two situations.

(1) in dilute solution is too large to enter the generator of a dilute solution is too large, then the heating steam heat generator most used to improve the solution temperature, steam production is reduced, so that the equilibrium concentration of generator of the solution decreases, and the concentrated solution flow leads to the absorber increases, increasing the heat absorber increase the spray solution, temperature, and reduce the concentration of the spray solution, so that the absorption effect of the spray solution degradation, absorption ability. Production of steam to reduce cooling capacity decreased, strong solution concentration decreases the coefficient of performance decline.

(2) the dilute solution volume too small if entering the generator of a dilute solution is too small, the results are contrary to the above. But the increase of export concentration solution, the risk will produce concentrated solution crystallization. Once the crystallization occurs, the absorber effect will deteriorate, evaporator can't exert its effect of refrigeration, the refrigeration machine in the partial load operation, this is very bad. Therefore, whether it is appropriate to adjust the solution circulation, economic operation of lithium bromide absorption chiller is very important. "In addition, the absorber spray volume increased can properly improve the absorption effect of the absorber, but increased energy absorber pump. Conversely, if the absorber spray amount is too small, it will affect the absorption effect. So we must adjust spray volume to a suitable value. Results effect of evaporator and absorber spray amount of spray volume is similar.

D. Effect of surface active agent on the performance of refrigeration machine

In order to improve the lithium bromide absorption chiller heat transfer, mass transfer effect, improve the performance of the refrigerator, now widely added organic matter, surface active agent, adding 0.1% alcohol in lithium bromide solution, the refrigerating capacity can be increased by 10% ~ 15%. In the lithium bromide solution of common surfactants with iso-octyl alcohol or n-octanol at atmospheric pressure, they are colorless oily liquid irritant smell, almost insoluble in lithium bromide solution. In the two effect LiBr heating high pressure steam absorption type refrigerating machine, the heating temperature is higher, the octanol at higher temperatures can be used to decompose, fluorinated alcohol. Following their strengthening mechanism:

1) improve the absorption effect

Adding the surface active agent can improve the absorption effect. This is because adding octanol, surface tension of the solution decreases greatly, enhance the binding ability of solution and water vapor, which means that the absorption efficiency; in addition, adding octanol, partial pressure of water lithium bromide solution is reduced, absorption driving force increases, increases the absorption effect.

2) enhancement of heat transfer

Adding the surface active agent, condenser by film condensation becomes condenses into beads, improves the condensation effect, adding octanol after improved condensation surface effect. Because alcohol can make the tube heating surface completely wet, water vapor and copper containing alcohol heating surface contact, then form a layer of film, water vapor present bead in octanol film condensation. Heat transfer coefficient of dropwise condensation of condensable increased more than two times than the membrane, thus improving the heat transfer performance of the condenser. The addition of 0.1% ~ 0.3% in general has been able to meet the requirements.

Low density and octanol, level it is always floating in the absorber liquid bag. In order to make octanol as heat transfer solution spray into the absorber surface is provided with a flushing pipe, octanol, the absorber surface impact octanol, and make the solution, and then bring it to the absorber tube passes through the spray solution. Such as the shortage can be added.

E. Effect of water side fouling factor on the performance of refrigeration machine

Operation for a period of time after the lithium bromide absorption chiller, due to the influence of various factors, heat transfer tube wall gradually form a layer of scale, the thermal resistance increases, the heat transfer deterioration. When the pressure condenser and absorber pressure will increase, thus reducing the concentration difference, increase the solution circulation factor of F, resulting in refrigerating capacity drop. Fouling factor is that the size of thermal resistance of fouling due to dirt, bigger coefficient, thermal resistance is greater, the heat transfer effect is poor, the refrigeration quantity is small.

The new unit refrigerating capacity value of 8% ~ 10% than design, this is because the dirt coefficient of lithium bromide absorption refrigerating machine is equal to zero. But in order to ensure that in the long run, the refrigerating capacity can meet the design requirements, in the operation should pay attention to during the water quality analysis, if the water quality is poor, should take timely measures such as water treatment, the impurity of water of suitable chemical treatment, and regular cleaning of the heat transfer surface by mechanical or chemical methods. In addition, the refrigeration machine in the design, should according to the water quality of water were appropriate for the calculation of heat transfer coefficient of dirt. Fouling factor can be found in various books and manuals. Usually in water is good, desirable 0.0001m °C /W, if the water quality is very poor, dirt coefficient even up to 0.0004 ~ 0.0006m °C /W.

According to the characteristics of the variable condition, the user can according to the specific conditions of their choosing proper refrigeration machine; to determine and choose the regulation, control scheme of refrigerator, the refrigeration machine work in the most reasonable circumstances. This kind of regulation and control should be automatic, it not only can reduce the labor intensity of operators, but also can accurately ensure refrigerating machine runs in specified conditions, so as to

reduce the operation cost, prevent the occurrence of accidents.

IV. COLLECTOR

The collector is a solar driven core type solar air collector, quality is directly related to the success or failure of the solar air-conditioning, solar thermal products, vacuum tube solar collector was recently selected solar air conditioner.

A. Structure of vacuum tube solar collector

Inner outer tube, inner tube wall with a mercury coating, outer wall heat absorption coating, the outer tube and inner tube is a vacuum layer; the outer tube is a transparent glass, inside and outside the tube is made of high borosilicate glass high hardness; one end of a import and export, the other end is closed.

B. Characteristics of vacuum tube solar energy

Vacuum tube solar energy principle is endothermic coating the inner tube of the sunlight absorption, water tube heating, and water tank or even boxes for the exchange,improve water temperature. As a heat collecting plate in the endothermic also heat dissipation, while the heat transfer only three ways: radiation, conduction, convection.Three kinds of radiation heat transfer in vacuum tube solar are very small, mercury coated tube to prevent heat radiation; the center of an outer pipe vacuum layer to prevent heat conduction; as for the heat convection with the vacuum tube solar, almost zero. The thermal efficiency is up to 93.5%.

Vacuum tube solar life: because of its material is of high borosilicate glass, and the inner and outer coating in vacuum environment is not oxidized, without external circumstances of life over 20 years.

C. Effect of various environment

Small radiator, heat preservation effect is good, strong frost resistance (have a good performance in the Antarctic); vacuum tube to the typhoon resistance is small, the ability of resisting typhoon intensity; vacuum tube is a circular shape by external impact force is small, hail.

V. ACCUMULATOR

The accumulator is solar direct drive type central air conditioning energy storage equipment, is affiliated equipment solar direct drive type central air conditioning, it can solve the problem of uneven solar energy in the supply and demand.

The heat accumulator, seems to have encountered technical bottlenecks, soaking time can not be guaranteed. Solar direct drive type central air conditioning on the accumulator has higher levels of demand, the high-efficiency stacked accumulator, the insulation principle is to reduce the heat transfer temperature and reduce the heat radiation.

The design of double insulation, there are two cavities in the structure, the inner cavity medium for molten salt phase change, external cavity medium for heat conducting oil,both inside and outside the cavity between the use of phenolic foam, phenolic foam is a kind of refractory, damp proof, heat insulation, thermal insulation, non-toxic, anti new material pressure, light, heat insulation performance the fire temperature can reach 450 °C. And avoid using glass wool insulation, outer surface painted black, arranged in a solar direct local, using the natural heat preservation.

VI. SUMMARY

Integrated view, solar energy central air conditioning is still in the experimental stage,many technical problems are to be solved, at present, there are many limitations to use solar energy central air conditioning, aiming at the present situation and some problems need to be solved:

- 1, how to further improve the utilization of solar energy
- 2, optimize the system, improve the refrigeration machine of COP
- 3, how to reduce the unit cost.

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