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# CURRENT STATUS AND DEVELOPMENT OF CONTEMPORARY HIGH TEMPERATURE HEAT PUMP TECHNOLOGY

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# ТЕКУЩЕЕ СОСТОЯНИЕ И РАЗВИТИЕ СОВРЕМЕННОЙ ВЫСОКОТЕМПЕРАТУРНОЙ ТЕПЛОВОЙ НАСОСНОЙ ТЕХНИКИ

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*Abstract.* With the continuous deepening of the concept of energy saving and emission reduction, heat pumps have been widely applied to life. With the improvement of heat quality, the corresponding condensation temperature of heat pump devices is required to be high. Therefore, high temperature heat pumps have become a hot topic, looking for a A high-temperature heat pump working fluid is an effective way to develop a high-temperature heat pump device. Exploring a new heat pump cycle mechanism is also an effective way to generate a high-temperature heat pump device. This paper combs the research status of high temperature heat pump in the field at home and abroad and analyzes the existing high temperature heat pump working medium and high temperature heat pump circulation mechanism, mainly expounds the principle of the existing high temperature heat pump technology.

*Аннотация.* Благодаря непрерывному углублению концепции энергосбережения и сокращения выбросов, тепловые насосы широко применяются в жизни. При улучшении качества тепла необходимо обеспечить соответствующую температуру конденсации тепловых насосов. Поэтому высокотемпературные тепловые насосы стали горячей темой, и поиск рабочей жидкости высокотемпературного теплового насоса является эффективным способом разработки высокотемпературного теплового насоса. Изучение нового механизма цикла теплового насоса также является эффективным способом создания высокотемпературного теплового насоса. В статье приводится статус исследования высокотемпературного теплового насоса в полевых условиях как внутри страны, так и за рубежом и анализируется существующий высокотемпературный тепловой насос и высокотемпературный механизм циркуляции теплового насоса, в основном излагается принцип существующей технологии высокотемпературного теплового насоса.

*Keywords:* heat pump working fluid, high temperature heat pump cycle, high efficiency and energy saving.

*Ключевые слова:* рабочая жидкость теплового насоса, цикл высокотемпературного теплового насоса, высокая эффективность и энергосбережение.

*Introduction*

As an energy-efficient device, heat pump has been widely used in daily life. According to the different external heating temperature of the heat pump system, the heat pump system can be divided into two types, namely the normal temperature heat pump and the high temperature heat pump [1]. The condensing temperature of the existing heat pump devices is mostly between 45 and 55 °C. With the improvement of the heat quality, the heat pump technology can no longer meet the requirements of high heat temperature. Therefore, an important development direction of high temperature heat pump technology [2]

After a long period of development, high-temperature heat pump technology has not only achieved great breakthroughs in high-temperature heat pump working fluids but also in circulation mechanism. Many high-temperature heat pump technologies have been successfully used in industrial and domestic fields, such as “GEA high-temperature heat pump”. "Technology, "Kobe Steel High Temperature Heat Pump" technology, more advanced technology is invented and applied, and the high temperature heat pump market will be further large.

*High temperature heat pump working fluid*

As the carrier of heat transfer, heat pump working fluid (refrigerant) plays an extremely important role in the circulation of heat pump system. Reasonable selection of working fluid can help realize economic, safe, environmentally friendly and stable operation of heat pump unit under high temperature conditions. . The high temperature heat pump requires the corresponding condensing temperature of the refrigerant in the condensing to be higher. In addition to the conventional requirements, the following conditions should also be met:

1) Appropriate standard boiling point temperature (NBP), critical temperature (Tc), critical pressure (pc) in the working range;

2) Appropriate critical volume (vc), critical compression factor (Zc) [2];

3) The unit cooling capacity q0 and the unit volume cooling capacity qv are relatively large;

4) The COP is high, and the indicators for evaluating the economics of the heat pump;

5) The saturated gas and liquid line should be as steep as possible to make the condensation process closer to the constant temperature exothermic process;

6) ODP (potential value of atmospheric ozone destruction) and small GWP (global warming potential);

7) Wide range of sources and easy to obtain.

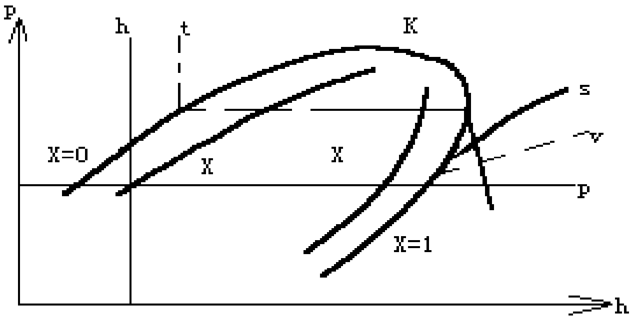


Figure 1 Critical point k of the working fluid in the heat pump cycle

In recent years, high-temperature heat pump refrigeration has always been a hot topic, and the development and search for a high-temperature heat pump is a necessary condition for high-temperature heat pump cycle.

For the moment, it is divided into the following types by temperature:

1) 50~80 °C, R22, R134a, R404A, R410A, R407C;

2) 80~110 °C, M1, R114, CF3I, R143;

3) above 110 ° C, R245fa, R1234ze, R245ca, R236ca, R254, M8, M9;

4) Water H2O.

*Heat pump cycle classification*

At present, the circulation mode for high-temperature heat pumps is mainly divided into the following three categories: compression cycle (mechanical compression, thermal compression), absorption cycle (first type absorption heat pump, second type absorption heat pump), mixing cycle (Kalina Absorption compression cycle, solar/chemical energy assisted circulation).

*Compressed loop*

Compressed circulation is the most common heat pump circulation method. It is usually composed of evaporator, compressor, condenser, throttle valve, etc. The principle is: low-pressure refrigerant liquid absorbs heat from the environment itself in the evaporator. , into a low temperature and low pressure working gas, into the compressor is compressed into a high temperature and high pressure working gas, condensation in the condenser to become a high pressure working fluid, and then throttled back to evaporation through the throttle valve The heat pump cycle is completed.

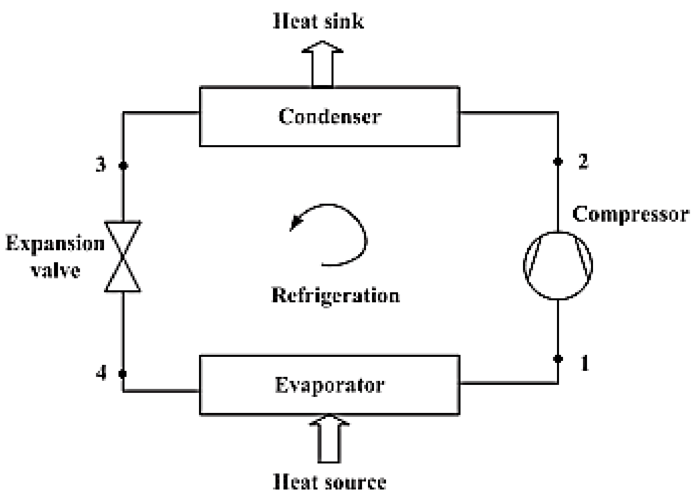


Figure 2. Compressed heat pump cycle diagram

*Absorption heat pump*

Absorption heat pumps are mainly divided into two categories: the first type of absorption heat pump (heater) and the second type of absorption heat pump (heater). The absorption heat pump is composed of a solution circulation part and a working medium circulation part. At present, the main working fluids are: an aqueous ammonia solution and a lithium bromide aqueous solution.

The heat source in the absorption heat pump replaces the compressor, and is mainly composed of an evaporator, an absorber, a generator, a condenser, a throttle valve, a regenerator, a solution pump and the like. The working medium evaporates in the evaporator to absorb heat as steam, and enters the absorber to be absorbed by the concentrated solution. The concentrated solution becomes a dilute solution, which is then sent to the generator by the solution pump. After the heat source is heated, the working medium escapes from the dilute solution and escapes. The working fluid vapor enters the condenser to condense and release heat into the working fluid, and is throttled and throttled back to the evaporator through the throttle valve to complete the heat pump cycle of the working medium.

The absorber and condenser in the system are exothermic parts. According to the exothermic temperature and the purpose of use, the absorption heat pump is divided into the first and second types of absorption heat pumps. Usually the first type of absorption heat pump has a COP greater than 1, while the second type of absorption heat pump has a COP of only 0.4 to 0.7.

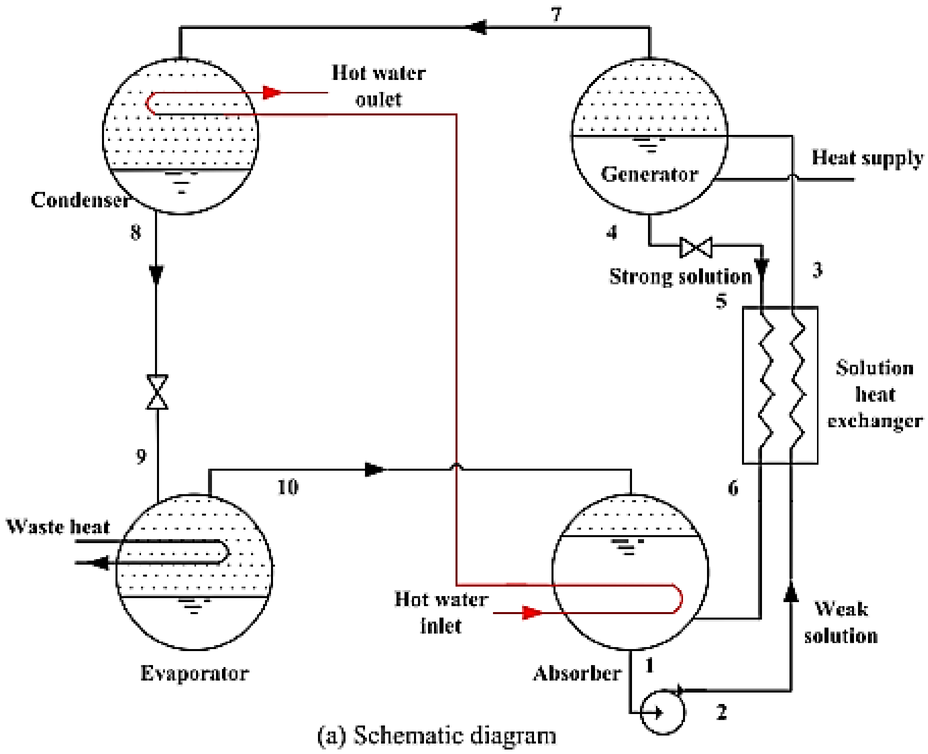


Figure 3. Schematic diagram of the first type of absorption heat pump cycle

*High temperature heat pump technology*

*Primary throttle quasi-secondary scroll compressor heat pump cycle*

Introducing a scroll compressor with an auxiliary air inlet to realize a primary throttle quasi-secondary heat pump system of the economizer to improve the heating capacity and condensation temperature of the air source heat pump, and the intercooler adopts a serpentine coil type instead of flashing Hair style [3].

Before entering the economizer (intercooler), part of the refrigerating medium at the outlet of the condenser is throttled and depressurized (4-5 process), and enters the unconserved working medium in the economizer and the serpentine coil to exchange heat. Saturated steam (5-8 process); the refrigerant in the coil realizes the supercooling effect (4-6 process), and then through the throttling and depressurization (6-7 process), the evaporation heat in the evaporator becomes work The gas (7-1 process), the compressor is compressed (1-2 process), using the technology of “interstage enhancement”, 5 throttling and endothermic saturated steam for qi and gas (8-2) ', 2-2' process), the superheated steam at the 2' point after the gas is increased and then compressed into high temperature and high pressure refrigerant gas in the compressor (2-3 process), and finally condensed and released in the condenser (3-4 process), completed the heat pump cycle of the working fluid [4].

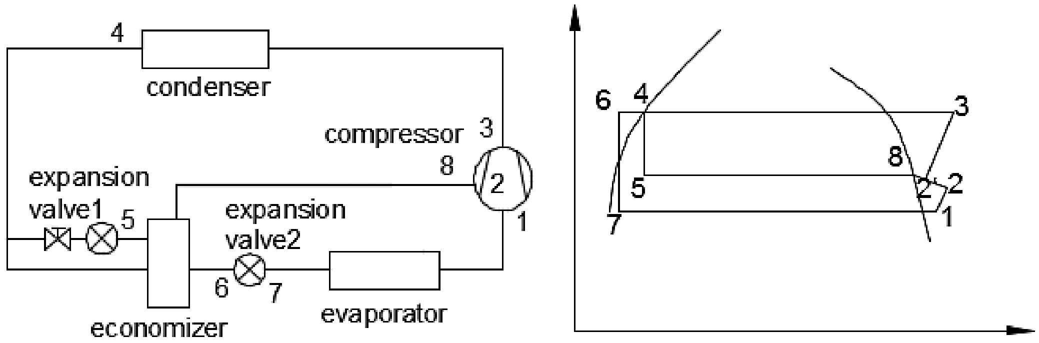


Figure 4. Primary throttle secondary turbo compressor heat pump cycle

*Cascade heat pump cycle*

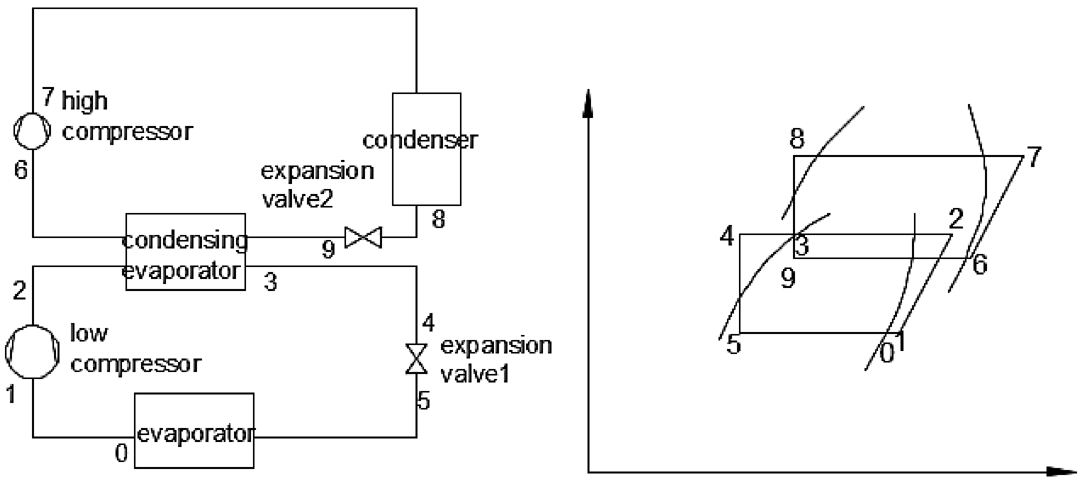


Figure 5. Schematic diagram of cascade heat pump cycle

The commonly used two-stage cascade heat pump device is composed of a low temperature stage and a high temperature stage. The low temperature stage uses a medium and low temperature refrigerant, and the high temperature stage uses a high temperature refrigerant to form a cycle of two single stage heat pump systems. The two systems are connected by a condensing evaporator, in which the high-temperature high-temperature refrigerant evaporates, so that the low-temperature stage low-temperature refrigerant condenses and releases heat, and finally the low-temperature heat source heat is transferred through the two-stage cascade heat pump system. To high temperature [5].

*Conclusions and prospects*

Through the above summary analysis, it can be found that the current research work on high-temperature heat pumps mainly focuses on the discussion of suitable working fluids and circulation mechanisms. In this respect, certain results have been achieved and engineering applications have been made. The author believes that when using high-temperature heat pump device to supply heat, the cooling capacity generated by the evaporation end cannot be used well. If the cold heat generated by the high-temperature heat pump system is used well, the refrigeration and heating can be utilized at the same time. A hot and cold heat pump device is used at the same time, and its energy efficiency will be very strong (the coefficient of performance is the sum of the heat pump coefficient and the cooling coefficient). The combination of high-temperature heat pump working fluid and related heat pump circulation mechanism has led to the development of new high-temperature heat pump devices for use in high-temperature heat pump areas for waste heat recovery and high-grade heat supply.

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