Evaporation and desalination using a solar concentrator in an agricultural complex

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Abstract. The purpose of the article is to study boiling and distilling water using solar concentrator, the actual application and profitability of using such a method of liquid evaporation. The use of various modern types of technologies makes it possible to purify water as efficiently as possible, while avoiding the decomposition of compounds. The different configurations of boiling by means of solar concentrator allow meeting different forms of application. Such configuration changes include different types of lenses, as well as different shapes and sizes of the solar concentrator itself, the use of mirror arrays that can be configured in such a way as to direct sunlight to one point to achieve high temperatures.

1 Introduction

The technological method of water distillation, in comparison with other numerous types of water purification, has the greatest advantage over other relatively similar methods, which consist in high throughput of hydrocyclones and centrifuges. The distillation of water consists in the distillation of liquid, which includes the process of evaporation of liquid and further cooling of steam and its condensation in the form of fine droplets. With such evaporation, the liquid is separated from the solids. Therefore, this process is an effective way to purify water from various types of impurities. The steam obtained by evaporation of water passing through the evaporation apparatus is cleaned on the irrigated column. The liquid, in turn, condenses in a condenser heat exchanger, and the condensate itself is collected in a condensation tank. Water that does not correspond to the proper degree of purification is supplied by pumps to special filters. Cationite or anionite filters are usually used. Then the water that has already been purified and meets the operating parameters is sent for reuse. One of the most effective methods of purification under certain conditions under which it is necessary to achieve maximum purification, namely, to reach the boiling point of the desired compound, but at the same time to avoid decomposition of this compound itself.

Solar concentrators are a type of technology used to boil water by focusing incoming sunlight into a single point. This heating point can be used to heat water to temperatures high enough to cause evaporation and subsequent boiling. Solar concentrators can be used in many

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applications, including hot water supply for domestic and communal needs, providing process heat for specific industrial purposes [1, 2].

When using a solar concentrator for boiling water, it is necessary to minimize the scattering of sunlight. This means that the most effective method of heating water using a concentrator is in clear sunny weather. In addition, the higher the angle at which sunlight falls on the concentrator, the higher temperatures can be achieved [3, 4].

Solar concentrators come in various shapes and sizes, and Fresnel lenses and mirror arrays are the most common types. A Fresnel lens is a plastic lens that can be used to change the direction of sunlight to a single point, providing more intense heating. Mirror arrays, in turn, use an array of mirrors capable of directing sunlight to a single point to achieve high temperatures [5, 6].

2 Materials and methods. The principle of operation of the technological scheme

The most common way to use the concentrated boiling process using solar energy is the production of distilled water that shows in fig.1 and fig.2. In arid or remote areas, solar concentrators can be used to evaporate water, receiving only pure distilled water at the outlet. This distilled water can then be used for agricultural needs or as drinking water.

Solar concentrators can also be used to heat liquids to sufficiently high temperatures in order to separate their components. This method is actively used in the chemical industry for various needs, for example, such as the production of polyols or polyurethane foam.

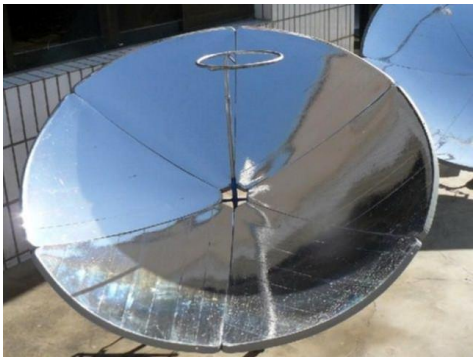

Fig. 1. The solar concentrator.

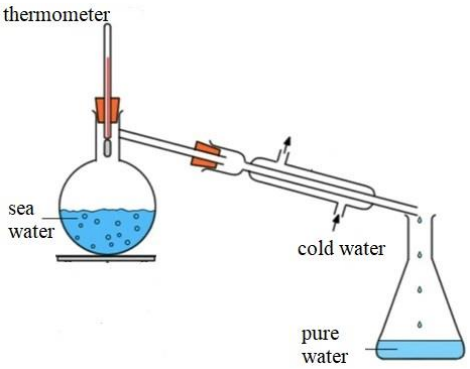

Fig. 2. The scheme of desalination.

The best way to obtain distillate from a solar concentrator is to use a fractional distillation unit. In installations of this type, the concentrate must be heated in a certain way to separate its components, and then the distillate is collected. This process can be carried out using either a desktop fractional distillation unit or a large-scale industrial fractional distillation unit, depending on the conditions and needs [7, 8].

This distillation method, created using a solar concentrator, can be an effective way to obtain high-quality distillate, since the concentrator can be used to increase the efficiency and volume of the product at the outlet during the distillation process. In addition, the concentrator can be used to remove impurities from the distillate, contributing to a cleaner and better product [9, 10].

3 Results. Practical significance

The work as part of the energy technology complex is shown in figure 3.

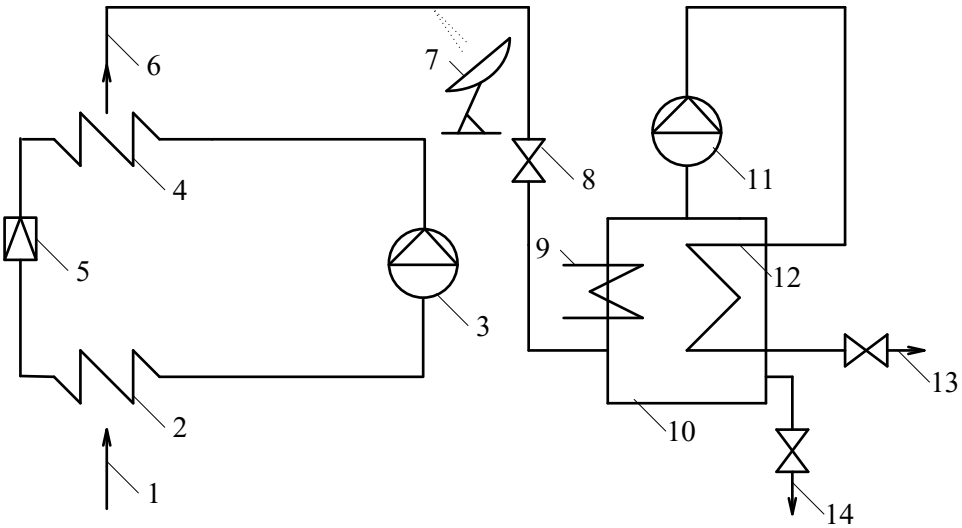

Fig. 3. Operation of the solar concentrator in the energy complex for desalination of water (designations further in the text).

Figure 3 shows an energy complex based on a heat pump. The composition of the heat includes an evaporator 2, a compressor 3, a condenser 4, a throttle valve 5. Water or air 1 is source of heat. Water 6 is heated in a condenser and heated by a solar concentrator. Through the valve 8, water is supplied to the container 10, which is under discharge. The water in the tank is heated by an electric heater 9. The discharge is created by a compressor or fan 11. The steam condenses and gives heat to the heated water in the tank 10. Salt water 14 is removed from the container periodically. Condensate 13 formed from steam is sent to the consumer.

The presented scheme is quite interesting from the point of view of a combination of heat sources. For the first time, a heat pump is used as the basic source of thermal energy for water desalination schemes. In addition, a solar concentrator in certain operating modes can significantly heat the original sea water. The built-in heater in the desalination tank is needed for the operation of the energy complex at night in the absence of solar radiation.

We note the advantages of the developed complex, namely the autonomy of work on the sea coasts, in countries with a shortage of fresh water. The energy complex uses renewable energy sources, which has a positive effect on environmental protection.

In addition, I would like to note the need to install gate valves or valves 8, 13 and 14 in the diagram of Figure 3. Valve 8 is necessary for uniform heating of sea water at the inlet to the evaporator and metered supply. Valves 13 and 14 can be set to operate the evaporator intermittently or continuously depending on the time of day. For example, at night, a long evaporation period is required because the temperatures are not so high. Conversely, during the daytime, the evaporator can be set to work continuously, since a solar concentrator makes a large contribution to the heating of sea water. Temperatures during this period can be so high that automatic adjustment of the focus of the solar concentrator mirrors is required. This will require a tracking system for the sun's rays, depending on the intensity of their fall.

4 Discussion

Another method of distilling water is a method using a fan or compressor. This method is one of the simplest and most effective for water purification. First of all, the air is sucked into the fan or compressor and, as it passes through the blades, it is adiabatically compressed and heated. Next, the air enters the condensation chamber and is cooled by a condenser. Since the volume of air decreases during compression, its temperature and humidity increase, resulting in the formation of steam. Then this condensate is collected and then passes through a series of filters. Filters remove various impurities from the water, leaving only water vapor. Then this steam passes through a cooling chamber, which additionally cools it and allows the condensed moisture to collect in a container [11, 12].

Before starting the water distillation process, it is important to make sure that the fan or compressor is operating at maximum efficiency, as this affects the amount of steam produced at the outlet. In addition, it is important to pre-cool the air passed through the fan or compressor in order to ensure sufficient condensation intensity. After the air is passed through the fan or compressor and condensed, the steam will pass through the cooling chamber. Depending on the design features of the chamber, this process can be facilitated by the supply of cold water to the chamber, which will lead to accelerated and better condensation of steam. Similarly, for greater efficiency, the chamber must be insulated to maintain the desired temperature and humidity levels. Insulation is carried out in order to reduce the amount of condensate formed in the chamber [13, 14].

The process of distilling water using a fan or compressor is one of the simplest and most effective methods of water purification. In general, this method is necessary and critically important in the field of thermal power engineering, since its application allows increasing the steam parameters necessary for efficient energy production [15, 16].

It should be noted that the most unusual configurations and evaporation schemes are increasingly finding their place in engineering sciences and their application in practice. These configuration changes include different types of lenses, as well as different shapes and sizes of the solar concentrator itself, which can be adjusted to direct sunlight to a single point to achieve high temperatures [17, 18].

Instead of sea water, the plant can use industrially contaminated water or contaminated furnace water. This technology is quite versatile, like all desalination technologies using heating plants [19, 20].

5 Conclusion

The use of solar concentrators can be considered a sustainable way of boiling water in many applications, including energy and agriculture. Using solar energy instead of traditional energy sources, it is possible to achieve boiling water at low resource costs and relatively low maintenance costs. Also, one of the main positive aspects of using such a method, in addition to low resource costs and fairly high efficiency of processes, is the minimal negative impact on the environment, which significantly distinguishes this method from the already existing traditional methods used in modern energy and industry in general [21, 22]. The application of the developed scheme is possible both in countries with a hot climate and in countries with a shortage of fresh water. For example, for the countries of North Africa, such an installation would make an invaluable contribution to the development of agriculture, since with large volumes of fresh water production; plans for irrigation of coastal zones can be developed. For the countries of the Persian Gulf, where mostly desert terrain prevails, such developments would allow the population to receive an autonomous source of fresh water on a permanent basis [23, 24]. For the countries of Southeast Asia, such installations could not only desalinate seawater, but also become additional sources of purification of polluted rivers, which would

solve the problems of the population living in conditions of constant flooding of rivers and flooding of coastal areas.

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