Saline water treatment technology for irrigation and water conservancy

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Abstract. In this paper, according to the special environmental characteristics of South Xinjiang, the circulation heating pipe is designed and its hydraulic characteristics are analyzed by hydraulic numerical calculation, which lays the foundation for field test. According to the characteristics of high heat collection, low heat dissipation and easy installation, the material, single tube structure and general layout of the circulation drying tube are designed.

1. Introduction
The shortage of fresh water resources in arid areas has become a serious problem faced by many countries, which may even lead to wars. In terms of agricultural irrigation in southern Xinjiang, it is necessary to consider the resource-based utilization of salt and alkali water desalination emission reduction, which can be realized by using desalination technology for reference\textsuperscript{[1]}. There is a lot of research on desalination technology at home and abroad. The main technologies include distillation, freezing, RO and NF separation, electrodialysis, ion exchange and adsorption. Due to the high cost of seawater desalination, large-scale application of seawater desalination technology is obviously not feasible economically for the vast area of South Xinjiang\textsuperscript{[2-6]}. Moreover, the discharge of concentrated salt water from the desalination will cause serious damage to the soil.

The whole physical evaporation technology is used in the desalination system of circulating heat collection and salt water based on solar energy, which is developed by our research group. Its principle is as follows: the surface salt and alkali water solution obtains enough temperature and evaporates to form clouds, and the clouds will form salt free rain when they are cold under certain conditions (light water can be used)\textsuperscript{[7-10]}. That is to replace the original thermal energy (electricity, fossil fuel and other resources) with solar energy to provide power for the water salt separation of salt and alkali water to promote the separation of salt and fresh water, and finally obtain condensed fresh water. The heating device is shown in Figure 1.
2. **Hydrodynamics calculation**

According to the local lighting conditions in Xinjiang, the maximum radiation amount in a day can reach 1000W/m², and the continuous lighting duration in a day can reach 10 hours, then the lighting radiation energy of the device used in the project in a day can be \[11-17\]:

\[
\frac{1000W}{m^2} \times 10 \text{hour} \times 60 \text{min} \times 60 \text{s} = 3.6 \times 10^7 J/m^2
\]

(1)

That is, we can get \(3.6 \times 10^7 J\) energy per square meter.

Calculate the floor area of the circulating concentrating hot salty fresh water separator according to 100m² (the site used for the operation of the unit in Xinjiang is 120m², and 20m² is reserved for the erection of other units in the project), so that we can calculate the radiation heat that the whole project site can receive:

\[
3.6 \times \frac{10^7 J}{m^2} \times 100m^2 = 3.6 \times 10^9 J
\]

(2)

That is, the whole site can get \(3.6 \times 10^9 J\) energy.

According to the heat absorption equation of salt water:

\[
Q = CM\Delta T
\]

(3)

where, \(Q\) is the heat absorbed, \(C\) is the specific heat capacity of salt water, \(M\) is the quality of salt water, and \(\Delta T\) is the temperature rise of salt water.

Because the specific heat capacity of water is \(4.2 \times 10^3 J/(kg \degree C)\), the temperature of salt water rises from 10 °C (the temperature of water extracted from the local salt drainage ditch in Xinjiang) to 100 °C (the critical temperature required for the boiling evaporation of salt water, for the geographical characteristics of the plateau in Xinjiang, the boiling temperature of salt water may be lower than 100 °C). So \(\Delta T\) is 90 °C.

So, \(M=3.6 \times 10^9/4.2 \times 10^3/90=9523.8kg=9.524t\).

So theoretically, about 9.524 tons of salt water can be evaporated to form fresh water.

Arrange the drying pipe and heat exchange pipe according to the length of 10m×10m width, then the project occupies 100m² of the site, and use the length of 2m as a unit for splicing. The arrangement of pipes and pipes in the longitudinal direction shall be as compact as possible to save space. If the interval between the longitudinal adjacent pipes is 5cm, 142 rows (1000cm/5cm=200) can be arranged in the longitudinal direction.

Each row has 10m long pipes (2m / piece×5 pieces = 10m).
Then total length = 10m / row × (200 + 1) row = 2010 m.
Then we can calculate the flow velocity in the pipeline.
Because 9.524 tons of salt water, i.e. 9.524m\(^3\) of water, should be treated in one day. It is proposed to use 20mm inner diameter pipe for passing salt water, and the water area is 0.000314m\(^2\), then we can calculate the flow velocity in the pipe:
Quantity velocity per day=\(\frac{9.524}{36000} = 0.000264556 \text{m/s}\).
The velocity in the pipe=\(\frac{0.0002646}{0.000314} = 0.8425 \text{m/s}\).
Therefore, we use pumps to pump water and keep the flow rate in the pipeline at about 0.8425m/s.

3. Conclusions
In view of the shortage of water resources and the serious problem of soil salinization in South Xinjiang, this research group adopts the whole physical method to study the water salt separation technology of condensation water formed by solar photothermal evaporation and extraction of crystal salt from saturated salt water. A new method of extracting distilled water and sodium chloride crystal salt by concentrating solar energy is proposed. This project provides new ideas and scientific basis for the economic and effective utilization of salt water and condensate water resources and the improvement of saline alkali land in southern Xinjiang, and realizes the harmless discharge while the utilization of water resources and the improvement of saline alkali land. This paper is one of the important supporting achievements of this project, aiming to study the mechanism of gas-liquid separation.

Salt and alkali water desalination technology is similar to the current desalination technology. At present, desalination technology and equipment have been mature, and three key technologies of desalination have been basically solved. According to China's 12th Five Year Plan, by the end of the 12th Five Year Plan, the desalination equipment will have a desalination capacity of 2.6 million tons/day; in terms of the utilization of concentrated seawater resources, in terms of technology research and development and large-scale application of projects, it has become an indispensable part of the desalination technology system, and will become a bright spot in the field of desalination in the next few years.

The dry water in saline alkali land basically belongs to the category of brackish water. Its salt content is lower than that of seawater, but its composition is different. Through long-term scientific research and engineering practice, it has been proved that it is highly effective and feasible to use membrane technology similar to seawater desalination for treatment, in technical development and large-scale engineering application. Southern Xinjiang has a vast area and abundant solar energy resources. Using mature thermal desalination technology for reference, it is not only efficient and feasible, but also its cost will be greatly reduced.

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