Integrated system developed for ice storage cooling and seawater desalination

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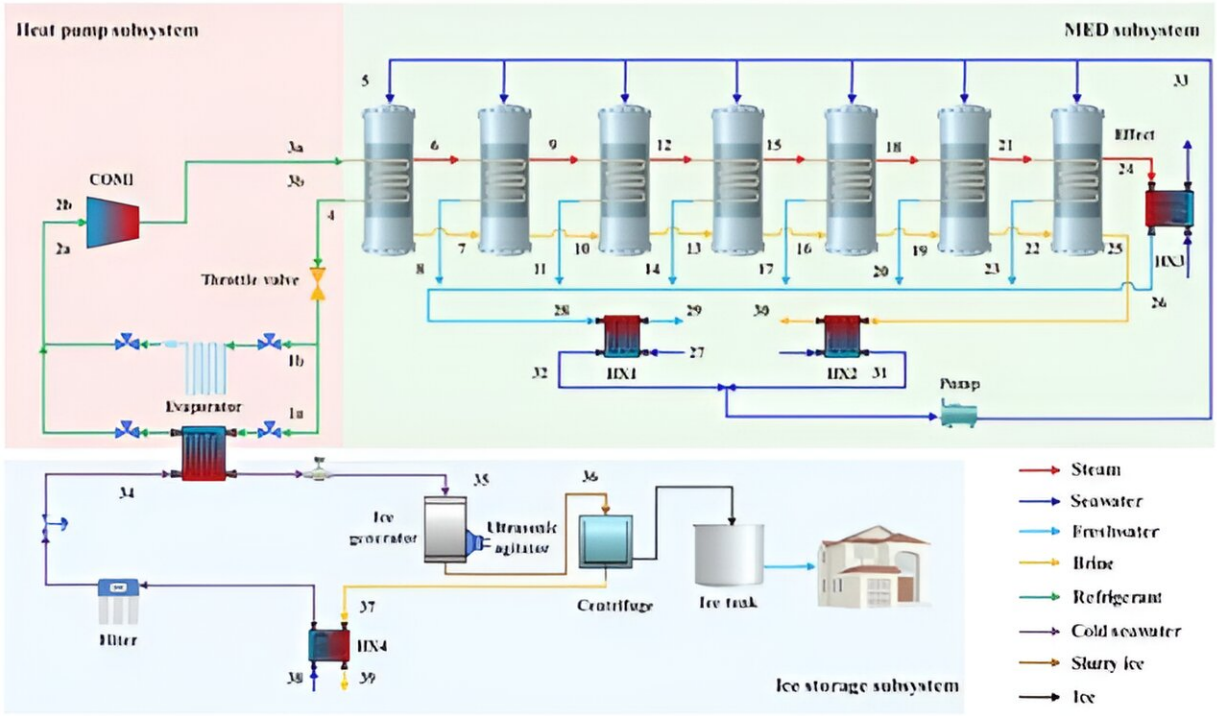

The integration of desalination and ice storage processes not only addresses the issue of high energy consumption but also maximizes the utilization of energy resources. Credit: Dr. Chen's group

Conventional methods of seawater desalination include multi-effect desalination (MED), reverse osmosis (RO), and freezing desalination (FD). Some of these methods consume a lot of energy, while others

produce relatively poor water quality. Therefore, there is potential for improvement in these conventional desalination methods.

In recent years, the energy consumption of buildings has been continuously increasing, with cooling energy consumption accounting for a significant portion of the overall energy usage. Ice storage technology plays a crucial role in addressing this issue.

The process of ice melting in ice storage can be coupled with the ice-making process in freezing desalination of seawater. Simultaneously, by utilizing heat pump technology, it is possible to achieve both ice-making and heating processes, thereby coupling freezing desalination, ice storage, and multi-effect evaporation. This integration enhances the economic efficiency of the system.

In a study published in *Energy*, Dr. Chen Longxiang's group from Fujian Institute of Research on the Structure of Matter of the Chinese Academy of Sciences aims to achieve clean and efficient energy utilization by addressing high energy consumption during desalination and ice storage processes.

Researchers took advantage of the price differentials during peak and off-peak hours to implement a multi-stage energy utilization system, where ice is produced and stored during nighttime and melted during daytime to provide cooling. During off-peak hours, ice is produced using low price surplus electricity and stored for later use. During peak hours the stored ice is melted to release cooling, reducing the utilization of expensive electricity consumed by air conditioning systems. The integration of desalination and ice storage processes not only addresses the issue of high energy consumption but also maximizes the utilization of energy resources.

The researchers developed a coupled system that integrates ice storage,

freezing desalination, and multi-effect evaporation of seawater using a heat pump system. The evaporator of the heat pump system provides cooling energy to prepare supercooled water, which is then translated into slush ice by using ultrasonic methods. The slurry ice undergoes centrifugal desalination treatment in a centrifuge device. The desalinated ice enters the ice storage system to provide cooling for buildings and serves as a freshwater supply after melting.

Furthermore, the temperature on the condenser side of the heat pump system is approximately between 60°C and 70°C, which is very close to the first-effect evaporation temperature in multi-effect desalination. The first-effect evaporator of the multi-effect evaporation system also serves as the condenser of the heat pump system. The secondary steam generated from this process provides energy for subsequent stages of seawater evaporation and desalination, leading to the production of high-quality freshwater.

The new coupled system is environmentally superior to traditional systems, unit product CO_2 emission (UPCE) intensity of only 15.50 kg/$, which is a reduction of 7.68% compared to traditional systems. It represents an attractive solution offering advantages in terms of thermodynamics, economics, and environmental impact.

This study proposes a new coupled system that combines ice storage cooling and seawater desalination, offering a potential solution for areas with simultaneous cooling and freshwater supply needs.

More information: Longxiang Chen et al, Thermodynamic and economic analysis of an integration system of multi-effect desalination (MED) with ice storage based on a heat pump, *Energy* (2023). DOI: 10.1016/j.energy.2023.129064

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