UNIVERSITY OF LJUBLJANA
Faculty of Mechanical Engineering

Vljudno vabljeni na predavanje, ki bo v petek 3.10.2025 ob 11.00 v Leskovarjevi sobi.

Efficient solar distillation and crystallization for hypersaline treatment

Prof. Dr. Zhenyuan Xu

Professor in Mechanical Engineering
Shanghai Jiao Tong University, Shanghai, China
xuzhy@sjtu.edu.cn

Abstract: Solar-powered distillation is a key technology for distributed low-carbon freshwater supply. However, the inherent contradiction between the low energy density of solar power and the high evaporation enthalpy of water, combined with limited regulation methods in passive distillation processes, results in constrained heat and mass transfer, leading to bottlenecks such as high system heat loss and poor salt resistance. This presentation will introduce our exploration in enhancing the energy efficiency and salt tolerance of solar distillation through the regulation of heat and mass transfer, including the following aspects: revealing the synergistic mechanism of vapor–condensation gap distance on vapor diffusion and ineffective conductive heat transfer through the air layer under low heat flux conditions, which led to a 100% improvement in distillation efficiency through optimization; elucidating the mechanism by which temperature and concentration gradients in confined saline thin layers enhance natural convection, significantly improving the salt tolerance of the distillation process through intensified thermal-saline convection and reducing water production costs by an order of magnitude; proposing a hierarchical porous self-assembly strategy coupled with crystal crawling and weathering, which achieves a balance between passive solution transport, rapid vapor diffusion, and stable heat transfer by constructing a hierarchical porous salt-crystal evaporator, enabling a breakthrough in stable and efficient salt crystallization.

Refs.:

[1] J. Yu, ..., Z. Xu. **Energy & Environmental Science** (2025), 18, 454 - 467.
[2] J. Gao, ..., Z. Xu. **Joule** (2023), 7, 2274-2290.
[3] Z. Xu, et al. **Energy & Environmental Science** (2020), 13, 830-839.

Bio: Professor Zhenyuan Xu is a Professor at the Institute of Refrigeration and Cryogenics, School of Mechanical Engineering, Shanghai Jiao Tong University. His key expertise is in heat pump, heat storage and thermal desalination. He has published more than 70 peer-reviewed papers in Joule, Energy Environ. Sci., Nat. Commun. and Energy with more than 4800 citations. His new designs on solar desalination were featured as Top MIT Research Stories in 2020/2023, the Best Inventions of 2023 by Time Magazine, and earned the UAE Global Water Award-Youth, Cell Press China Best Paper Award. His contributions in heat pump and heat storage were awarded the first prize of Mechanical Industry Science and Technology Award, and James Joule Award of International Institute of Refrigeration. He serves as the committee members of the China Association of Refrigeration and China Association of Desalination and Water Reuse.

PRIMOŽ POREDOŠ
Digitally signed by PRIMOŽ POREDOŠ
Date: 2025.09.25 09:17:20 +02'00'