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This project aimed to develop a high-performance interfacial evaporation technology suitable for seawater evaporation. Because it involved multi-physics simulations such as solar radiation and humidity variations, COMSOL simulation software was used. The overall project process and content are summarized in **High-Performance Solar Interfacial Evaporation Technology.pdf**.This document aims to explain in detail the steps and trade-offs involved in the process, as well as the challenges that remained unresolved at the time and the current solutions. I hope to delve deeper into this topic in the future. (For the main ideas and software operation methods, please refer to Reference 1-6).

1.Project Introduction

The strategy for improving high-performance interfacial evaporation technology is mainly divided into two parts: one is to enhance the absorption of solar radiation energy, and the other is to enhance the ability of porous media to transport seawater.

High-performance interfacial evaporation is driven by absorbed sunlight, so under the same lighting conditions, increasing the irradiated area is one approach. The traditional approach is to form the interfacial material into a thin cube (this ensures that most channels in the porous material can effectively transport seawater). However, considering the change in effective irradiation area under solar radiation, I designed the interfacial material into a spherical shell shape, which effectively solves this problem. However, this raises another issue: the transport method of seawater within the porous material. In interfacial evaporation technology, water transport in porous materials is explained by Darcy's law, but the general application scenario is a linear transport path. However, with my design, the transport path becomes a curved upward curve, which required exploring the underlying formula. (At the time, due to laboratory limitations, there were no relevant materials available for verification, and no relevant theoretical derivation or support. Therefore, I only explored the feasibility of this idea and simulated the corresponding temperature and humidity changes.)

2. Simulation Ideas

In order to reduce the amount of calculation, I chose to use a two-dimensional symmetry plane for analysis, supplemented by a three-dimensional result diagram. There were some problems during the simulation. I wanted to simulate the changes in sunlight throughout the 24 hours of the day, including changes in solar radiation energy and angle, but this function can only be selected in COMSOL during three-dimensional analysis. In two-dimensional analysis, only radiation can be used to approximate solar radiation. Therefore, the trend of the simulation results is relatively reasonable, but the specific changes are not very obvious. For example, the changes at the top and bottom of the spherical shell are not very ideal. In addition, the results are too linearly distributed. The temperature changes of the entire porous material are displayed as uniform layer-by-layer changes. The actual results will definitely be different. So at that time, I tried to use LAMMPS software for molecular dynamics simulation, but I did not have actual materials, could not know the specific material structure, and could not perform process simulation.

3. Current Optimization Ideas

If conditions permit, I think μCT can be used for image reconstruction, and then LAMMPS software can be used for analytical dynamics simulation. The image reconstruction model can also be used for COMSOL simulation, which can make the simulation more accurate. Of course, you can also develop a high-performance solver similar to LETHE to analyze the heating of porous materials and the transport process of seawater in the pores of porous materials. The simulation level is simulated in this way. If conditions permit, I think it is possible to construct experiments for analysis, such as using temperature probes, high-definition cameras, laboratory scales and other equipment to observe and record the mass of seawater evaporation, changes in the temperature field, and the trend of water evaporation.

Of course, there is another point to note, that is, salt will precipitate after the seawater evaporates. I designed the salt into a spherical shell shape to take advantage of the gravity factor so that the accumulated salt can be discharged by itself and will not hinder the further evaporation of seawater.

4. Summary and enthusiasm for the UNFoLD lab

This is the result of my master's degree. Although immature, it's a significant milestone for me and I've benefited greatly from it. I was drawn to joining the lab by the dynamic video of vortex formation featured on the UNFoLD Lab homepage. The intuitive experimental conditions were very appealing (this is what I've always strived for: to clearly present the results of a project through a visual video). I'm constantly learning and challenging myself, and I truly enjoy these fascinating experiments. Of course, my years of scientific experience tell me that behind these videos are countless nights of painstaking research. I hope to hone my theoretical application and problem-solving skills through practical projects. If I'm fortunate enough to join the lab, I believe the UNFoLD Lab will inspire new insights and enable me to achieve fruitful research results.