Enhancing performance of solar distillers using functional materials

Ammar Elsheikh[1,2, a *] and Manabu Fujii[1,b]

[1]Tokyo Institute of Technology, Meguro-Ku, Tokyo, 152-8552, Japan
[2] Faculty of Engineering, Tanta University, Tanta, Egypt
[a]elsheikh.a.aa@m.titech.ac.jp, [b]fujii.m.ah@m.titech.ac.jp

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SHORT SUMMARY

The rapid increase in freshwater and energy demand motivated researchers to develop eco-friendly desalination technologies operated with renewable energy sources. Solar distillers have been extensively studied in the literature as simple solar-powered water desalination devices. However, solar distillers suffer from their low efficiency. The utilization of functional materials such as micro/nano-particles, phase change materials, and porous materials may help in enhancing the performance of solar distillers. In the present review, the recent developments for augmenting solar evaporation by functional materials were discussed. The reviewed literature indicated that performance enhancement is highly affected by materials type and size, particle concentration, material structure, and thermophysical properties of the materials.

EXTENDED ABSTRACT

Water and energy shortages are the two main critical challenges faced by the human being and severely affect the economic development of different countries [1]. 97% of the available water on the earth is found in the seas and oceans with high salinity (3000–35,000 ppm). This salty water is not suitable for human consumption. In addition, 2% of the water is in the ice form found in the polar region and only 1% is freshwater found in the rivers, lakes, and underground [2]. Thus, it is highly desirable to convert salty water into drinkable water via eco-friendly technologies. Solar distillers are low-cost eco-friendly desalination devices that could be used to obtain drinkable water by direct utilization of solar energy. However, these devices suffer from their low water yield and are highly affected by the intermittent nature of solar radiation. Numerous experimental investigations have been carried out to augment the water yield of solar distillers by integrating them with other thermal devices such as solar collectors, photovoltaic modules, and condensers [3]. The use of these devices increases the cost of water production, maintenance requirements, and area use. Thus, the development of new functional materials, including nanomaterials, phase change materials, and porous materials, to enhance the evaporation process inside the solar distillers and solve the problem of the intermittent nature of solar energy has received great attention in recent years.

Phase change materials are used underneath the basin of the solar distiller or in another thermal storage device that is connected to the solar distiller. They are utilized to store energy absorbed during sunshine and release it during cloudy hours or after sunset via consequence heating and cooling processes. There are two main types of energy storage devices employed in solar distillers, chemical and thermal. Thermal energy storage devices outperformed chemical ones due their low cost. Thermal energy is stored in the form of latent and sensible heat. The common used sensible heat storage materials used in solar distillers are stones, steel wool fibers, and sand-filled cotton bags [4].

Nanoparticles have been also used to enhance the evaporation process due to their outstanding thermophysical properties as they have extremely high surface area compared to their volume along with low specific heat, high thermal conductivity, and high absorptivity [5]. They effectively absorb solar energy, convert it into heat, and dissipate it into water. They were reported as efficient materials to enhance the water yield of solar distillers [6]. In the present review, the recent developments for augmenting the performance of solar distillers using functional materials are discussed.

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