Solar desalination by nanofluids

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KEYWORDS

Nanofluids, Desalination, Solar energy, Nanoscience, Solar desalination

SUMMARY

With rapid population growth and pollution of freshwater resources, governments must prioritize the provision of clean drinking water and achieve sustainable development goals. By developing technology for desalination to conserve energy, the use of sustainable renewable solar energy has taken on an eloquent role in society. Solar desalination has benefited from using nanofluids to increase productivity in many ways. The current review study aims to assess the potential for employing nanofluids of various types and concentrations to increase the yielded fresh water of desalinated water using solar energy.

EXTENDED ABSTRACT

Due to its distinctive qualities that enhance performance and boost the productivity of producing drinking water using solar energy, nanotechnology has lately emerged and has gotten involved in many fields, piquing the curiosity of many academic researchers [1]. The Argonne National Laboratory (ANL) of the United States introduces the term "nanofluid" [2]. In order to create nanofluids, solid nanoparticle auxiliaries are dispersed in widely used base fluids such as oil, water, glycol, and refrigerants [3]. Typically, these auxiliaries are formed of oxides, metals, or carbon nanotubes [4].

As can be seen in Fig. 1, nanofluids have recently been the subject of applied studies that attracts the most attention due to their promising features.

Depending on the type of nanoparticles utilized, their size, and the ratio of the colloidal abeyance, nanofluids may exhibit much higher heat transfer properties than traditional fluids [5]. Compared to normal liquids, nanofluids have a better ability to take part in molecular interactions with liquids, which helps to increase physical characteristics parameters, including thermal conductivity, viscosity, specific heat, and density [6-8]. There are several ways to categorize nanomaterials, including by morphology, size, phase compositions, nature, and provenance as seen in Fig. 2 [9]. Nanomaterials are used in a variety of energy-related fields, such as solar thermal collectors [10] and solar air conditioning [11], solar desalination [12], heat exchangers [13], electronics cooling [14], minimal quality lubrication [15], aerospace [16], nuclear reactors [17], automotive cooling [18].

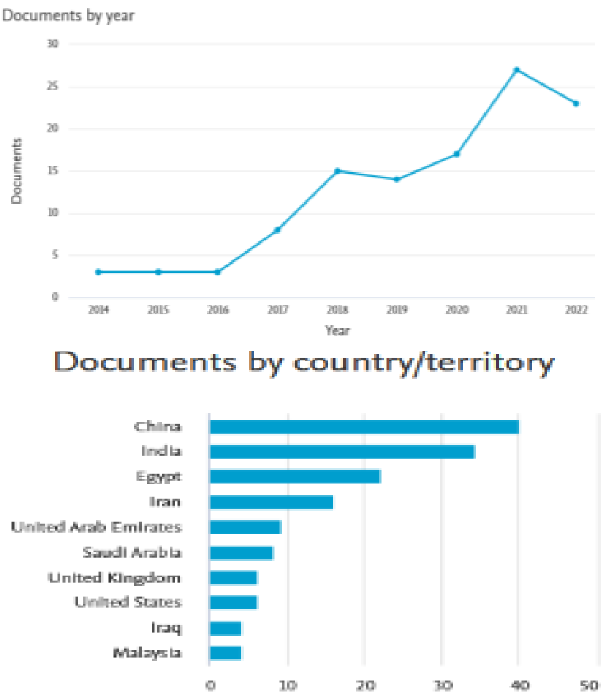

Figure 1 Published topic articles of desalination nanofluids over the years with documents by country

This amazing advancement in nanotechnology research is a tool for improving transferred heat in working fluids because it creates a contemporary route for enhancing the heating and cooling processes. Despite the numerous uses for nanoparticles, there are some major issues that pose a danger to their continued usage [19], including:

- Toxicity and stability over time.
- High costs of preparing nanofluids.
- Harmful effect on the environment.
- Provides medium for metal erosion / corrosion.

Owing to its usage as a sustainable renewable resource, solar energy is known for both its low cost and its negative environmental repercussions, such as the release of greenhouse gases, carbon dioxide emissions, and climate change [20-21].

Research efforts worldwide have begun to use solar energy to desalinate seawater at the lowest possible costs [22] while exploiting the unique properties of nanomaterials to promote obtaining larger quantities of desalinated water using solar energy [23]. Fig. 3 shows the use of different nanomaterials in solar water desalination [24-37].

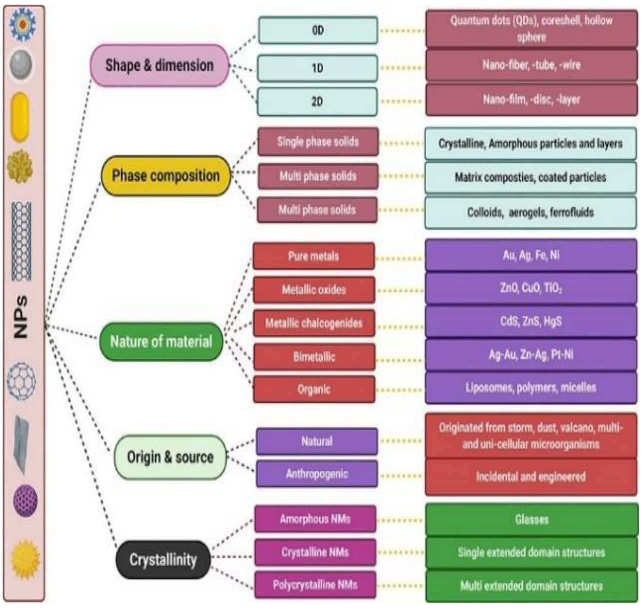

Figure 2 Classification of nanomaterials [9].

Chen et al. [38] dispersed Fe_3O_4 nanoparticles after modifying with multi-wall carbon nanotube nanoparticles with concentrations of 0 to 0.04 wt% in saline water. In saline water, surfactants were used to sustain the nanofluids. The idea of modifying magnetic properties was hinted by the research of Wang and Shao et al. [39, 40]. It was found that the created nanofluids increased the rate of solar energy usage, supplying greater heat energy for saline water evaporation, as the evaporation efficiency reached 76.65% while increasing the concentration of nanofluids to 0.04 wt%. The effectiveness of employing copper oxide and graphite in a solar still basin productivity at various concentrations was investigated by Sharshir et al. [41–42]. The cover glass's outside surface was also given a film cooling treatment at the same time. In comparison to solar still without nanofluids, the findings revealed an increase in the solar still yield of 53.9 and 44.9 percent when utilizing graphite and copper oxide, respectively.

The use of nanofluids in solar thermal desalination systems is growing every day, however there are still numerous issues and difficulties that the concerned researchers must overcome the differences in the findings of many studies and the poverty of knowledge of the tools underlying the characteristics of nanofluids. As a result, these difficulties prevent the employment of nanometric materials in solar thermal energy desalination from being improved.

Conclusions

This extended article presented a careful review of improving the productivity of desalinated water using nanomaterials for their unique properties. Among the research studies, some challenges impede the use of nanoparticles on a larger scale and need to be reconsidered, such as nanoparticle agglomeration, stability, and sedimentation, in addition to the high cost of producing nanomaterials with high properties.

Figure 3 Nanomaterials with solar desalination [24-37].

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