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A review of wind and geothermal energy applications of the water desalination in Iran and the world

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Abstract

Renewable energy is a suitable replacement for fossil fuels and has many applications. One of its noticeable applications is desalination which is vital regarding the current water crisis. Accordingly, renewable sources are used in the desalination of alternative to fossil fuels. Wind and geothermal power are two high-potential renewable energies combined with desalination units. However, due to some challenges, they have not developed sufficiently. Iran is one of the wealthiest countries in this type of energy and has much potential for using these technologies, which have not been applied yet. The research aims to consider the achievements of the combination of wind and geothermal energy with desalination. Also, environmental challenges and proper solutions are analyzed. In addition, offshore wind power plants, micro wind turbines, bladeless turbines, triboelectric nanogenerators, and submarine geothermal resources are concluded. In addition, nanotechnology has a significant role in enhancing these systems. Nanocomposites lead to wear reduction of the blades. Nanofluids increase the amount of absorbed heat in geothermal power plants and also reduce the earthquake risk. Graphene and the combination of zeolite and alumina increase the amount of separated salt in reverse osmosis-based desalination.

Keywords: Renewable Energy, Wind Energy, Geothermal Energy, Desalination, and Nanotechnology

1. Introduction

Nowadays, fossil fuels provide approximately 80 percent of the world's energy needs. Using these fuels has caused loads of destructive effects. Eighty-nine percent of the world's carbon dioxide emissions in 2018 were related to fossil fuels and industry. The release of greenhouse gasses causes global warming to the detriment of the Earth [1]. Consequently, the replacement of these harmful fuels with renewable energy is essential.

Besides, the water crisis is growing in many countries, especially the middle east and the north of Africa. Water per capita is reported to be less than 1500 m3/year. One of the most suitable solutions is desalination. Typically, desalination unit energy is provided by fossil fuels. This technology has developed considerably recently. However, there are some problems in its way. High energy consumption and costly desalinated water production are two main issues.

Combining desalination units and renewable energy is a promising way to solve the existing problems. The most convenient form of renewable energy combined with desalination is solar energy. Wind energy and geothermal power are the second and third most convenient energies, respectively [2]. Despite the potential of these resources, there are challenges in combining them with desalination [3, 4]. Recently, nanotechnology has played a significant role in enhancing wind and geothermal energy harvesters, and desalination technologies [5, 6]. Recognition of the challenges and proper solutions in wind-based and geothermal-based desalination can mitigate the present water shortage.

This paper reviews, the current condition of wind and geothermal power combined with desalination. In addition, the potential of using these technologies in Iran is considered. Moreover, environmental challenges and solutions are discussed. Finally, the role of nanotechnology in the advancement of these systems is explained briefly.

2. Results and Discussion

Applications of renewable energy are apparent in modern life. Wind energy is a high-potential form of renewable energy that has developed rapidly [7]. Also, geothermal power is advantageous, supplying energy continuously. Therefore, it is a reliable energy source for consumers [4]. Wind-based and geothermal-based desalination is primarily operated on small scales [2, 8]. According to the state-of-the-art, wind power can produce 14000 m^3 of desalinated water per day, which costs 2.09 to 2.11 dollars/m^3. Geothermal energy has produced 80 m^3 desalinated water per day using 1440 m3 geothermal water [2].

According to the critical condition of water in Iran and the amount of available wind and geothermal energy in the country, the combination of these

technologies is widely recommended by researchers to overcome the water crisis.

Considering the studies, RO-based (reverse osmosis) desalination using wind energy in Iran can produce 20,000,000,000 m3/day.

Geothermal-based desalination using the RO process in Iran can produce around 111,000 m^3/day [9].

Despite the undeniable potential, some environmental challenges occur due to these systems. Some of the challenges and solutions are given below:

Offshore wind power plants, energy-saving systems, and a combination of wind energy and other renewable energies can be used, as a solution to the intermittent wind-based power production [2, 3, 10].

Bladeless wind turbines can be used to prevent harmful effects on animal habitats [3].

Micro wind power plants and triboelectric nanogenerators can be used to solve visual impacts, noise disturbance, land use, and safety hazards [3, 11]

The submarine geothermal resources use is beneficial solving problems such as land use, noise disturbance, visual impact, and salty water release from geothermal power units [4, 12]

Some of the nanomaterials used in wind energy harvesters, geothermal power plants, and desalination systems, especially RO-based desalination, are summarized in table1.

Table 1 Application of nanomaterials in enhancing wind-based and geothermal-based desalination

Application	Material	Result	Reference
Wind turbine	Nanocomposite materials and the addition of short carbon fibers and graphite	Wear reduction of blades	[13]
Wind turbine	Super hydrophobic nanocomposite coating doped with titanium powder	Freezing prevention	[13]
Wind turbine	Combination of epoxy and graphene oxide nanocomposites	Lightning effects reduction	[5]
Triboelectric nanogenerator	Indium tin oxide and a polytetrafluoroethylene thin film	System efficiency increase	[5]
Wind turbine	Carbon nanotubes	Wear reduction of blades	[13]
Geothermal energy	Nanofluids	Heat absorption increase	[14]
Geothermal power plant	SiO2-coated surfaces	System protection	[5]
Geothermal power plant	Nano-ZrO2–TiO2 coatings	Deterioration reduction	[5]
Geothermal power plant	Cagey solution made of carbon molecules	Earthquake risk reduction	[15]
Membrane in desalination	Vertically aligned carbon nanotubes	15 percent fouling resistance	[16]
Membrane in desalination	Silicon/Cellulose Acetate/polyethylene glycol nanocomposite	Hydrophilicity of membranes increase	[16]
Desalination	Combination of zeolite and alumina	97 to 99 percent salt separation	[16]
RO-based desalination of sea water	Pillared graphene	100 percent salt separation	[16]

3. Conclusions

The water crisis is an acute threat these days, and desalination is a suitable solution. Renewable energy-based desalination can reduce the cost of desalinated water. Wind and geothermal power meet the needs of desalination units. However, some challenges are in their way. Analyzing the disadvantages of these technologies and their solutions is a significant factor in enhancing desalination processes using wind and geothermal energies. Applying mentioned solutions requires accurate economic analysis.

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