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# Geothermal source potential for water desalination – Current status and future perspective

Veera Gnaneswar Gude

*Department of Civil and Environmental Engineering, Mississippi State University, Mississippi State, MS 39762, USA*

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ABSTRACT

Direct use and power generation based on geothermal sources are growing at a steadfast pace around the world. Although available abundantly in many parts of the world, geothermal energy sources have been under-utilized in desalination applications. Geothermal sources have the potential to serve as excellent heat sources for thermal desalination processes. Since thermal desalination processes require large quantities of heat sources, geothermal based energy source represents a feasible, sustainable, and an environmentally friendly option. The advantage with geothermal source is that it can act as a heat source and a storage medium for process energy utilization. If these water sources have high dissolved solids, then they can serve as feed water for the desalination process. Since external energy consumption is minimized except for the mechanical energy requirements, geothermal enabled desalination processes could have less environmental impacts when compared to other nonrenewable energy driven desalination processes. Cogeneration schemes for simultaneous water and power production are also possible with geothermal sources as well as poly generation with multiple process benefits involving cooling and heating applications. This paper provides the present state-of-the-art of geothermal desalination with discussion on the benefits of geothermal desalination over other renewable and nonrenewable energy driven desalination configurations. Present status of the worldwide geothermal desalination and the potential for future developments in this technological area were discussed in detail with case studies for Australia, Caribbean Islands, Central America (Coasta Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama), India, Israel, the Kingdom of Saudi Arabia, UAE, USA, and Sub-Saharan Africa.


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*E-mail addresses:* gude@cee.msstate.edu, gudevg@gmail.com

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## 1. Introduction

Providing clean water for human consumption has become a major challenge at local, regional, national and global levels [1]. This is mainly due to increasing demand prompted by population growth and urbanization [2]. Over the last century, global population has tripled while water demand per capita has doubled, resulting in a six-fold increase in water withdrawals. This suggests that not only has the number of water users increased globally, but individual consumption rate has also increased due to high living standards. For example, Energy Information Administration (EIA) reports a population increase of 70 million in USA alone by 2030. The direct domestic water demand and indirect industrial, agricultural, and environmental water demand needed to sustain this growth is expected to place serious strains on currently available water resources. At the same time, this growth in population is expected to increase the electricity demand by approximately 50% [3], which will place additional demands on available water sources in USA. For example, thermoelectric power plants accounted for 48% of the total water withdrawal in the US in the year 2000. The consumptive use of water for electricity production could more than double from 3.3 billion gallons per day in 1995 to 7.3 billion gallons per day in 2030 [4]. Although this consumptive use is not high compared to the total US consumption of 100 billion gallons/day, large volumes of water are to be dedicated to thermoelectric power plant operation.

Although 71% of the earth's surface is covered with water, the oceans hold over 95% of this water, all of which is salt water not suitable for drinking purpose, while the remainder (about 2.5%) is fresh water in rivers, lakes, and underground, and polar ice caps, which is expected to supply most needs for human and related consumption. On the other hand, freshwater demand is expected to rise sharply at global level. About 3 million people, i.e., 40% of the current world population do not have access to clean and safe drinking water [5]. In addition, 90% of infectious diseases are caused by consumption of unsafe water. Moreover, the World Resources Institute predicts that by 2025, at least 3.5 billion people will experience water shortages [6]. Global agencies (including WHO, UNDP, UNICEF, etc.) expect that 24 of the least developed countries, many of them along coastal areas without access to freshwater and electricity, need to more than double their efforts to reach the Millennium Development Goals (MDGs) for basic health, sanitation, and welfare. Seawater can serve as an excellent water source in many of these countries which also indicates the need for development of sustainable technologies for water production.

The relation between water and energy source production and utilization is inseparable (Fig. 1). Provision of clean water inevitably requires energy, which is currently being provided essentially by nonrenewable fossil fuels. It has been estimated that production of 1 $m^3$ of potable water by desalination requires an equivalent of about 0.03 tons of oil [7]. Extraction and refining of fossil fuels and production of energy not only places additional demands on water, but also results in pollution of water sources and air (greenhouse gas emissions). Thus, the projected global demand for clean water supplies for the future will significantly accelerate not only depletion of fossil fuel reserves but also concomitant environmental damage and emission of greenhouse gases [8]. This situation provides the basis for renewable energy