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# Applications of Geothermal Energy for Desalination: A Review Technological Advancement and Water Security

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## Abstract

Geothermal energy, harnessed through the Earth's thermal resources, emerges as an enduring and sustainable remedy to tackle the urgent concern of water scarcity through desalination. By harnessing the innate thermal reservoirs within the planet, geothermal energy provides a distinctive avenue for generating heat and electricity, particularly when synergistically aligned with desalination procedures. To understand the insights of the implications of geothermal energy for desalination, we conducted a comprehensive literature review analysis. Main objectives of the review are to (i.) disseminate insights into geothermal-driven desalination, (ii.) explore potentialities and obstacles of geothermal-driven desalination, and (iii.) evaluate forthcoming environmental, socio-economic predicaments associated with this approach. We selected 50 peer reviewed scholarly communications published using Google Scholar from 2000 to 2022, focusing on impactful English-language publications within esteemed scientific journals. We found multi-effect evaporation/distillation (MED); multi-stage flash distillation (MSF); thermal vapor compression (TVC) and mechanical vapor compression (MVC). Membrane processes include electrodialysis (ED), reverse osmosis (RO), and membrane desalination are the common techniques used across mainly in Australia, USA, UAE, Sub-Saharan and African nations, and Japan. The integration of innovative designs of these methods can enhance the efficacy and cost-efficiency of geothermal desalination systems. Furthermore, critical environmental, social, and economic concerns linked to geothermal-driven desalination were identified. We noted that high-capacity factor for stable heat supply, independent of seasonal changes, ideal temperatures (70-90° C) for low-temperature desalination, cost-effectiveness with simultaneous power and water production, environmentally friendly with no emissions, versatile to meet energy demand across scales are some of main advantages of selection of geothermal energy for desalination. Some studies showed that geothermal energy for desalination is practical and effective, especially in areas facing water scarcity, strengthening water security. However, challenges persist, necessitating inventive solutions encompassing the pursuit of robust materials designed for high-temperature operation and streamlining energy conversion and integration processes. Other foreseen difficulties include the potential environmental impacts on geothermal reservoirs and the necessity for careful resource management to maintain a fair socio-economic equilibrium. Thus, the future research direction should be mainly focus on harnessing geothermal heat to drive the process, significantly reducing energy consumption and mitigating carbon emissions to potentially be employed across the world.

***Keywords**:* Carbon emission mitigation, Desalination, Energy conservation, Geothermal Energy, Water security