Desalination of Sea Water to Drinking Water Using Ultrasonic Sound Technique

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***Abstract*—Due to the lack of drinking water people have been forced to obtain fresh and renewable water sources. For this reason, desalination systems are being developed around the world. Ultrasonic sound technology is one of the most recent technologies in the desalination industry which improves the evaporation and distillation processes by increasing the mass and heat transfer that causes are reduction in energy consumption. This technology can help to maintain the health and safety of people because of avoiding the use of chemical material. In this study, an ultrasonic desalting system was evaluated in terms of salinity and the amount of produced water.It was found that the salinity of incoming water had the highest impact on the produced water salinity level. By raising the temperature of incoming hot air the level of salinity decreased while by increasing the power of ultrasound the amount of produced water increased. The value of optimal experimental variables was obtained for the desalination system's operation for one hour, which yielded 200.737 ml water with a salinity level of 545 ppm.In addition to that, the economic analysis of this system was also investigated and it was proved that the operational and energy costs of this system were lower than those of the conventional methods such as RO and MSF. The salinity level in produced water by the desalination system was analyzed and the results matched with the WHO guidelines for drinking water quality.**

Keywords: Desalination systems; Ultrasonic sound technique;etc.,

I. Introduction

Water is a necessity for life and an essential need for human beings. Therefore, the quality of consumed water has an immense influence on human beings. Life on earth ,economics, security, politics, sustainable development and the health of societies can be affected by water crisis that has been rising rapidly around the world, which is considered to be a severe warning to various nations [1]. In addition to the growth of industrial activities and contamination by micro-fluids, agricultural consumption, and not.observing the correct pattern of usage in most developing countries, alteration in people's lifestyle, the persistence or even reduction of available water resources on earth and the continuing rise in the world's population increase the necessity of safe water consumption [2,3]. On the basis of this evidence, human beings need to purify and desalinate saline water on earth as a new and renewable source of safe and drinking water.

In order to provide sustainable water supplies, desalination systems can be used in many areas due to the minimal distance of about three-quarters of the world's population from the sea . Up to now, various methods have been developed for desalinating saline water, amongst which membrane and thermal methods have been further developed [4,5]. High energy consumption, which increases cost and pollution, is the most significant problem in desalination systems. In order to overcome this issue, renewable energy sources are being used to provide energy for these systems. However in most cases the efficiency and working capacity of desalination systems have barely been improved [6–8].Application of ultrasound is one of the most recent technologies for improving water purification and desalination. This technology improves the evaporation and distillation processes by enhancing mass and heat transfer. Therefore, the application of ultrasound technology empowers desalination systems in order to use renewable energy sources which improves the economic and environmental conditions.

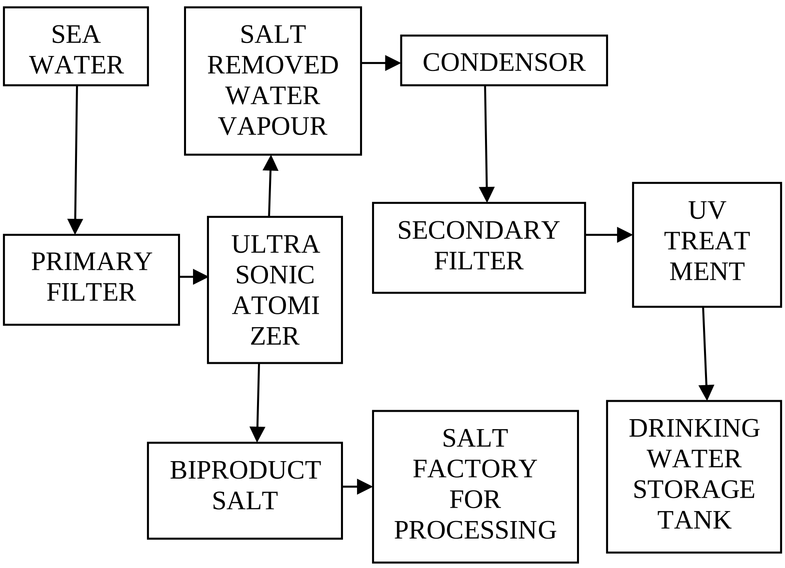
Ultrasound waves cause cavitation phenomena in liquids. Collapsing cavitation bubbles cause sono-chemical extinction of pollutants during the aqueous phase [9]. Symmetrically or asymmetrically implosion can occur when the solid particles are in the proximity of cavitation bubbles. Microscopic turbulence and/or thinning of the solid liquid film are the result of shock waves which are made by symmetric cavitation, in any case they pervade to the surrounding solids. Increasing the rate of mass transfer among the reactions and/or producing it through the film can be made by a phenomenon known as microstreaming. It cannot be a symmetrically collapse if solid particles are in close vicinity to the bubbles. Foundation of solvent micro jets which bombard the solid surface and cause pitting and erosion are made by asymmetric cavitation [10]. When the bubbles explode, a strong oxidation agent is produced. The use of this technology can break down many complex organic compounds into simpler compounds during cavitation.

Therefore, the purpose of this study is the process of atomizing saline water by ultrasound, and desalinating it with hot water exposal to determine the amount of produced water and its salinity content with the ultrasonic desalination system.

II. BACKGROUND AND RELATED WORKS

Ultrasonic desalination involves the use of high-frequency sound waves to disrupt the structure of saline water, facilitating the separation of salt and water molecules. "Ultrasonic Desalination of Seawater" by X. Zhang et al. (2019): This study investigates the use of ultrasonic waves for desalination, focusing on the mechanism of salt removal and the efficiency of the process." Experimental Study on Desalination of Seawater Using Ultrasonic Waves" by A. Kumar et al. (2021): The study presents experimental results on the desalination of seawater using ultrasonic waves, evaluating factors such as energy consumption and salt removal efficiency.These related works demonstrate the growing interest in utilizing ultrasonic technology for desalination purposes, highlighting its potential benefits such as increased energy efficiency, reduced fouling, and improved overall performance. Further research in this area could lead to the development of more cost-effective and sustainable desalination solutions.

III . BLOCK DIAGRAM



Seawater is pre-treated to remove any suspended solids or large particles. Pre-treated seawater is then pumped into an ultrasonic atomizer The ultrasonic atomizer uses high-frequency sound waves to break up the seawater into tiny droplets. The droplets are then evaporated, leaving behind the salt crystals. The steam is then condensed back into liquid water, which is now free of salt. The desalinated water is then collected and stored.

In this project, three phase setups are involved,

1. Primary Filtering to filter out the sea waste, garbages, plastics, etc. Secondary filtering to settle the dusty sand particles.
2. Primary treatment using ultrasonic sound waves to desalinate the sea water.
3. Secondary treatment using Ultraviolet rays in order to kill the micro bacteria present in the water.

Figure. ultrasonic water atomizer used in the experiments.

Direct current voltage and the current of the ultrasonic water atomizer were adjusted to be 48 V and 5 A, respectively, producing an oscillation frequency of 1.7 MHz in order to produce 5 kg/h of atomized water. In the case of using an ultrasonic atomizer, the atomized feed water output is assumed to be saturated vapor, where the enthalpy of the output water vapor,hvap,outis determined by both the inletfeed water temperature and the atmospheric pressure. According to this, the model of the ultrasonicatomizer is the same as the model of the spraying system.

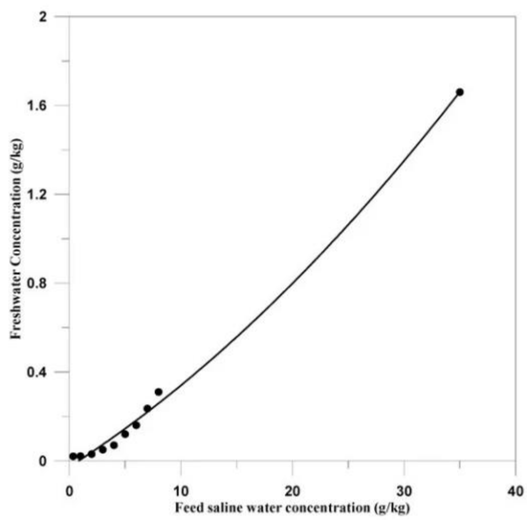
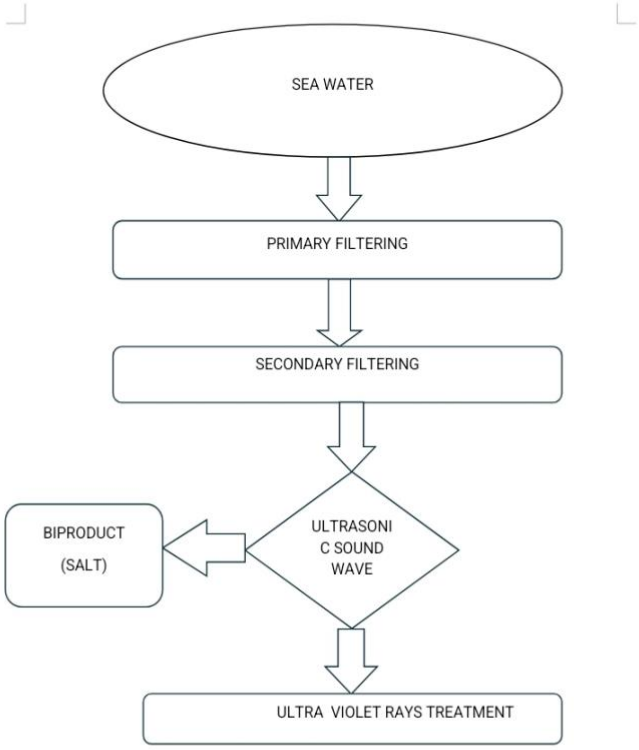


Figure. Productivity concentration using the ultrasonic water atomizer.(A Novel Humidification Technique Used in Water Desalination Systems Based on the Humidification–Dehumidification Process)

By evaluating the performance of the desalination system, the specific productivity can be considered to be an essential parameter that defines the amount of freshwater, which can be produced by consuming one unit of energy.

IV.DESIGN PROCESS



V.METHODOLOGY

Ultrasonic desalination is a developing desalination technique that utilizes ultrasound waves to separate salt from seawater. It is considered as an emerging technology with the potential to offer several advantages over traditional methods like reverse osmosis (RO).An Ultrasonic desalination is a process of converting liquid into a fine mist using high-frequency sound waves to remove salt crystals from seawater. This technology has potential to be more energy-efficient and cost-effective than traditional methods.One of the main advantages of ultrasonic desalination is that it can operate at much lower temperatures than traditional thermal desalination methods. This means that it can be powered by renewable energy sources, such as solar or wind power. Ultrasonic desalination produces very little wastewater. In traditional thermal desalination methods, up to 70% of the seawater intake is discharged as wastewater. However, in ultrasonic desalination, almost all of the seawater intake is converted into fresh water.Optionally, perform post-treatment processes such as activated carbon adsorption, pH adjustment, and disinfection to further improve the quality of the desalinated water and ensure its safety for drinking. Implement monitoring and control systems to regulate key parameters such as ultrasonic power, temperature, pressure, and flow rate.Monitor the efficiency of the desalination process by measuring salt concentration, water quality parameters, and energy consumption. Scale up the ultrasonic desalination system as needed to meet the desired water production capacity and application requirements.

VI.ECONOMIC ANALYSIS

Economic analysis of a system in order to evaluate the cost effectiveness and also definition of the unit cost of the produced fresh water is required during any research. In recent years, desalination costs have reduced due to low equipment pricing, lower energy consumption and improved system designs. Costs for purchasing equipment,auxiliary equipment, land, construction, management and installation are capital costs which has been reduced in recent years. Annual costs include energy, labor, chemicals and spare parts Full details of the annual costs relating to each system are not yet available because they are difficult to calculate. The required components of desalination system are Ultrasonic Piezoelectric Transducer 1.77MHz Crystal oscillator - MCRS010000F183000RR, UV Light,Filter,Solar panel ,Salt Water Storage Tank,Accessories. The cost estimation of these components the piezoelectric Transducer is approximately Rs 4500 the crystal oscillator is cost approximately Rs 3000 and other accessories cost will be Rs 6500. The the total manufacturing cost approximately Rs 14,000. Include costs for equipment such as ultrasonic transducers, desalination chambers, control systems, pre- and post-treatment units, and infrastructure.Consider expenses related to engineering design, permitting, land acquisition (if applicable), and project management. Calculate the cost per unit volume of drinking water produced by the ultrasonic desalination system, factoring in both capital and operating costs.Compare the water production costs with alternative sources of freshwater, such as traditional desalination methods, groundwater extraction, or surface water treatment. Consider economies of scale and efficiency improvements over time as the technology matures and production volumes increase.

VII.RESULTS AND DISCUSSIONS

Ultrasonic desalination is still a relatively new technology, but it has the potential to revolutionize the way we produce drinking water from seawater.

VIII.CONCLUSION

Desalination of seawater to drinking water using ultrasonic sound technique would likely highlight its potential as a promising method for desalination due to its ability to efficiently remove salt particles from seawater. However, it may also mention challenges such as energy consumption and scalability, which need to be addressed for widespread implementation. Further research and development are necessary to optimize the process and make it economically viable for large-scale applications.Ultrasonic sound can enhance mass and heat transfer, leading to faster evaporation and potentially lower energy consumption compared to traditional methods. The ultrasonic sound process itself could be powered by renewable sources, reducing the environmental. Ultrasonic sound avoids the use of chemicals in the desalination. The ideal frequency, power levels, and design for ultrasonic desalination systems are still under investigation. Overall, ultrasonic desalination shows promise as a future method for producing clean drinking water from seawater. However, more development is needed before it can widely compete with existing desalination technologies.

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X.REFERENCES

[1] H.T. El-Dessouky, H.M. Ettouney, Fundamentals of Salt Water
Desalination, Elsevier, 2002.

[2] J.-y. Lu, X. Du, G. Lipscomb, Cleaning membranes with focused ultrasound beams for drinking water treatment, in: IUS, IEEE, 2009, pp. 1195–1198.

[3] M. Doosti, R. Kargar, M. Sayadi, Water treatment using ultra-sonic assistance: A review, Proc. Int. Acad. Ecol. Environ. Sci., 2(2) (2012) 96.

[4] G. Tiwari, A.K. Tiwari, Solar distillation practice for water desalination systems, Anshan Pub, 2008.

[5] P.V. Kumar, A. Kumar, O. Prakash, A.K. Kaviti, Solar stills system design: A review, Renew. Sustain. Energy Rev., 51 (2015) 153–181.

[6]Valdemir,leonardobandeira, Use of High-Frequency Ultrasound Waves for Boiler Water Desalination Treatment,UNICAP-ICAM,2022.

[7] Muhammad qasim, Faisal W.Khudhur,Ultrasound-assisted forward desalination osmosis using inorganic drawsolutes,American University of sharjah,2019.

[8]Nashua A.H.Fetyan,Tamer Mohamed Salem attia,Water purification using ultrasound waves application and challenges,Arab Journal,2020.

[9]Behnam Hosseingholilou,AhmadBanakar,Design and evaluation of a novel ultrasonic desalination system byresponse surface methodology, Tarbaitmodares university, 2019.

[10]Lingyunzhang,Huadong,Temperature Response in the Process of Ultrasonic Seawater Desalination,Anesth pain Med,2016.

[11] Larsen, M.A.D.; Petrovic, S.; Engström, R.E.; Drews, M.; Liersch, M.; Karlsson, K.B.; Howells, M. Challenges of data availability:Analysing the water-energy nexus in electricity Generation. Energy Strategy Rev. 2019

[12]Martínez Moya, S.; BoludaBotella, N. Review of techniques to reduce and prevent carbonate scale. Prospecting in water treatment by magnetism and electromagnetism. Water 2021,

[13]Asadi, N.; Soleimanimehr, H.; Alinia-ziazi, A. An investigation on boiler feed water treatment using reverse osmosis and ion exchange by WAVE software. J. Appl. Res. Water Wastewater 2021, 8, 124–128.

[14]Wang, Z.H.; Liu, X.-Y.; Zhang, H.-Q.; Wang, Y.; Xu, Y.-F.; Peng, B.-L.; Liu, Y. Modeling of kinetic characteristics of alkaline-surfactant-polymer-strengthened foams decay under ultrasonic standing wave. Pet. Sci. 2022, in press.

[15] Hiratsuka, A.; Pathak, D. Application of ultrasonic waves for the improvement of water treatment. J. Water Resour. Prot. 2013,5, 604–610.