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Review on Hourly Yield for Square Pyramid Solar Still

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A B S T R A C T

A basic necessity of all human beings, animals, agriculture, and industrial applications is the availability of pure drinking water in adequate quantity and of acceptable quality. Drinking water of sufficient quality and dependability is essential for all residents, as well as agriculture and industrial purposes. Solar desalination is a non-traditional technique of removing salt and other impurities from saline water to produce pure drinking water that makes use of the sun's freely accessible energy. Solar desalination is an effective approach for obtaining potable water from brackish/wastewater in hot climates and/or isolated areas when water and energy are scarce. In recent years, there has been a lot of attention paid to the creation of new solar still designs in order to overcome the limits of conventional single basin single slope solar stills.One of the results of such a development is the pyramid solar system. The current study examines the evolution of the pyramid solar still as well as different strategies for improving its performance. According to a study of studies conducted by several experts, pyramid solar stills are more efficient and cost effective than traditional single slope single basin stills. As a result, the review article will aid researchers in comprehending the principles of pyramid sun still, as well as the necessity, advancements, and difficulties in pyramid solar still, in order to increase its thermal performance and make it more and more cost effective. This conversion is still accomplished with the use of a solar gadget. However, Solar's main drawback is its poor productivity, which is why many experts are working on continual technical advancements and study.Pyramid sun stills are one of these enhancements to the traditional old design of solar stills in order to boost production. This technical analysis discusses the various configurations and advancements in pyramid solar stills in depth. The different modification and manufacturing techniques for pyramid solar stills are also described in this study.

Keywords:Solar Energy, Renewable Energy, Desalination, Solar Still, Pyramid Solar still,Environment

1. Introduction

Freshwater needs are increasing day by day as a result of industrialization, motorization, and rising human living standards. Because of their scarcity, naturally accessible freshwater reserves are incapable of satisfying freshwater needs. According to the United Nations Organization, almost 1800 million people throughout the world may face acute water scarcity by 2025(Nayi 2017)(Nayi and Modi 2018). Only if civilization discovers new ways to generate freshwater will this issue be resolved. Fortunately, desalination technology, which is based on the natural hydrological cycle, has the potential to solve this problem, although it uses more energy and has certain bad effects on the environment.The world's population is rapidly growing, and industrialization is increasing the need for clean, pure water. Deforestation, on the other hand, results in less rainfall. As a result, there is a mismatch between demand and availability of pure water, with water accessibility for today and the future being a key problem for academics. One of the most significant processes for converting saline or dirty water to drinkable water is desalination. Figure 1 depicts a thorough categorization of desalination processes. The majority of desalination methods shown in Figure 1 use conventional fuel, which has negative effects on the environment, nature, and human health (Nayi 2017)(Nayi and Modi 2018)(Fath 1998)(Sharon and Reddy 2015).

2. Literature Review

This segment was meant for a clearer comprehension of the research currently being carried out and how much progress is under way. Within this paper, it is obvious about my research which operates on the previous one continuously. This reveals the value of the job, which links the research with past which future jobs. Few studies have experimentally and theoretically calculated the yield losses and also calculated hourly solar yield. The goal of this analysis is to include the listing and full descriptions of all recognized research in this field and to compare the outcome.

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K. H. Nayi Study a comprehensive technological analysis of the solar pyramid's design and development to explain the production plan for improvement. In the outcome optimized the optimum output and profitability measured at various dependent conditions, part materials, observing heat loss analysis focused on the 2nd rule of quality. Most work focuses on the simulation of water vapor using different tools and analyzes the impact of their geometry and other parameters on productivity(Nayi 2017).

Robbi Rahim et. Al Current work analysis reveals the tubes were drained, along with wind, yet to raise yield. The 1-meter square basin area used for the tests and 14 drained tubes were placed at the bottom of the still. Often included in the present research is calcium stones as safe heat storage medium. Three types of experiments were carried out, namely traditional solar still, solar still with evacuated tubes and solar still with evacuated tubes and calcium stones in Patan District, Gujarat, during January to June 2019. Groundwater was used as feed water in studies already ongoing. It was analyzed that utilizing solar still with evacuated tubes and solar still with evacuated tubes and calcium stones the total yield was improved by 113.52 per cent and 104.68 per cent. In current research, the payback period was also calculated, and it was 237 for solar still with evacuated tubes and calcium stones. Ultimately, it was found that the calcium stones are strong safe heat storage medium in order to reduce the quantity of water and absorb the heat during the daytime tests(Panchal et al. 2020).

K. Fahmy et al This article provides both an empirical analysis and thermal and economic contrasts of two still structures of the solar system: the pyramid and the one slope. To simulate the two configurations and check their thermal efficiency it developed a mathematical model. Aswan City meteorological statistics were used, and the average cumulative energy obtained was determined for each still basin. For the whole year, the main performance metrics like still productivity and efficiency are provided(Fatha, Fahmy, and Ha 2003).

H. J. Kennady et. al. These research poses a few significant factors that still impact a triangular solar pyramid 's results. The experimental work was undertaken also to determine the influence of depth of water on the performance of the triangular solar pyramid. From this study it is concluded that the coefficients of convective andevaporative heat transfer are important in the creation of solar distillation systems, and the effect of temperature differential between the evaporative and condensing surfaces is also necessary in optimizing the operating temperatures range. Solar condensation region is nearly superior to that of the evaporating field. While the experimental findings have revealed that the influence of water depth in the solar also affects the freshwater output. However, experimental outdoor experiments were performed to research the impact of changes of wind strength to cool the glass cover down. It was observed that raising the wind speed from 1.5 m / s to 3 m / s and 4.5 m / s respectively has the benefit of growing the overall output by 8 and 15.5 percent(Sathyamurthy et al. 2014).

L. Liu et. al. Solar-powered diaphragm distillation technology analysis, computational simulation program performance calculation and mathematical modeling compared. Increases in efficiency as the field to minimize the flow rate improves the ability of the heat exchangers(Ding et al. 2005).

H. N. Singh et. al. Different types of solar stills have been developed including design, modeling, and associated summary. Different solar power systems still focus on specific phenomena and parameters affecting production performance(Tiwari, Singh, and Tripathi 2003).

D. Singh et al. The current examination is given to building up a warm model of changed multi–wick bowl type twofold slant sun oriented still (MMWBDSSS). Investigative articulations of temperatures of water, glass covers, dividers, and wick, prompt proficiencyand distillate yield have been inferred. The exploratory approval of warm model has been completed and a reasonable understanding has been identified between hypothetical outcomes and trial perceptions. Based on yearly vitality and exergy, the vitality lattices, to be specific, the vitality recompense time (EPBT); life cycle change proficiency (LCCE); In the environment states of Prayagraj, U.P., India, the element for vitality growth, antieconomic and exergoeconomic investigation was also assessed for sun-oriented still with jute and dark cotton wicks. On the vitality premise, CO2 emanation relieved per year was seen as 7.82 and 8.690 tons; and separately 0.1550 and 0.1980 tons on the exergy premise with jute and dark cotton wicks at 10mm depth of water. The exergoeconomics limit was seen as 62.30 Wh / Rs. And 79.10 Wh / Rs, too. For the sun still driven by jute and dark cotton wicks at 10 mm water depth, individually for four percent loan fee and fifty years frame life(Pal et al. 2018)(Agrawal, Rana, and Srivastava 2017).

A. Yadav et al. have been viewing the specific thermal desalination models and chosen indirect method for medium and wide, whereas the direct method is ideal for limited output. Different materials accessible locally can also boost efficiency at low solar expense, they can be conveniently and efficiently produced. This requires less and is perfect to destroy both pollutants, bacteria and waterborne viruses(M. and Yadav 2017).

Pascale Compain Solar MED and MSF, although apparently normal and enticing alternatives, cannot be regarded as established technologies. More and more advances in desalination technologies are expected to make these approaches successful in competition with traditional, integrated RO systems at power plants. Somewhere the answer resides in mixture: heat source mixture and cycle combination. Recent advances include desalination systems like MSF paired with opposite osmosis, the heat supply being a thermal power station, which can be pictured in conjunction with solar energy. There will also be a need for fresh water, but desalination techniques need to be scaled up to become safer, more effective and more virtuous(Compain 2012).

Qian Chen et. al. Owing to the geographic correlation of high solar supply and extreme water shortages, solar desalination provides a viable alternative to the rising global water market. A conceptual model for the planned large-scale solar-powered desalination device is first developed and tested with laboratory pilot. Afterwards, under the environmentconditions of Makkah, Saudi Arabia, the system 's long-term effectiveness and energy quality is analyzed. The solar desalination network suggested is capable of delivering a continuous water supply of 20 kg / day for solar collector area per square meter, and the benefit can be further improved by maximizing the interactions between the three subsystems, i.e. solar collector capacity, storage tank temperature and heat loss, and desalination device energy efficiency. The annual efficiency is maximized with a collector region of 360 m2, where the feed flow rate is 1.7 kg / s and the fuel storage tank diameter is 1.9 m. (Luft 1981)(Heidary et al. 2018).

2.1. Solar Desalination

While populations across the world continue to rise and as current freshwater reservoirs begin to decrease due to usage and emissions, demand for freshwater is increasingly growing. Marine waters are an infinite supply of water because about 98 per cent of all global water is available in oceans; thus, desalination of seawater is the rational solution to satisfying the increasing demand for fresh water. The need for electricity is now increasingly growing owing to the rapid industrialization of the planet. In much of the planet, fossil fuels remain the dominant energy sources; nevertheless, their stocks dwindle, output increases and usage affect the atmosphere. Cosmic powers constantly replenish green energy supplies so they can be used to generate safe so usable types of energy with reduced environmental effects(Sharon and Reddy 2015)(Abutayeh et al. 2014)(Altarawneh et al. 2017).

Developing an economically efficient and environmentally sustainable desalination device entails lowering electricity demand by utilizing clean resources to power its operation; in turn, choosing the correct desalination method includes a range of technical criteria by understanding of its design limitations. Significant economic and social changes are taking place around scarce water and energy supplies, while maintaining the availability of fresh water and the usage of green energy sources can help to prevent destructive wars, sustain sustainable lifestyles and stop the global warming and the pollution. The most commonly employed forms of desalination are well known and described in the literature. Momentous quantities of energy are needed in all desalination processes; hence it is crucial to establish feasible desalination processes to will energy demand as well as utilize renewable energy. Various desalination systems powered by renewable energy have been built during the pastseveral years; but, owing to the large capital costs associated with the usage of renewable technology, these have not yet been successfully deployed. Solar radiation is a very desirable source of energy since it is distributed at no cost; however, it has no major detrimental impact on the climate. A great deal of research and development has been done to use this free type of energy to establish more effective renewable processes such as desalination of water and production of electricity. The component of solar radiation in the US. The Solar energy is intermittent and will therefore need storage, but optimizing its usage alongside improving energy-efficient technologies will significantly diversify energy supplies, save the atmosphere and the social costs levied. Solar desalination is basically a small-scale duplication of the normal hydrological process that generates groundwater, the main freshwater source in the world. Scholarly studies and industry observations have demonstrated that thermal desalination schemes are best adapted to large-scale installations than mechanical desalination schemes. Solar energy is ideally adapted to power thermal desalination processes as it can be implemented directly without creating errors in energy conversion; moreover, current thermal desalination plants can be quickly retrofitted to accommodate solar radiation(Ullah and Rasul 2019)(Vishwanath Kumar et al. 2015)(Chen et al. 2020).

3. Type of Desalination System

Solar distillation devices are known as the passive solar stills and the active mode solar stills. In the case of active solar stills, for quicker evaporation an extra-thermal energy via external mode is still pumped into passive solar tank. External mode can be the concentrator panel for the collector. There are two forms of desalination system one isothermal system in which the desalination cycle needs heat for some water, and another is membrane device. Two types of primary and indirect systems are based on a liquid desalination method (Chen et al. 2020)(Li et al. 2018).

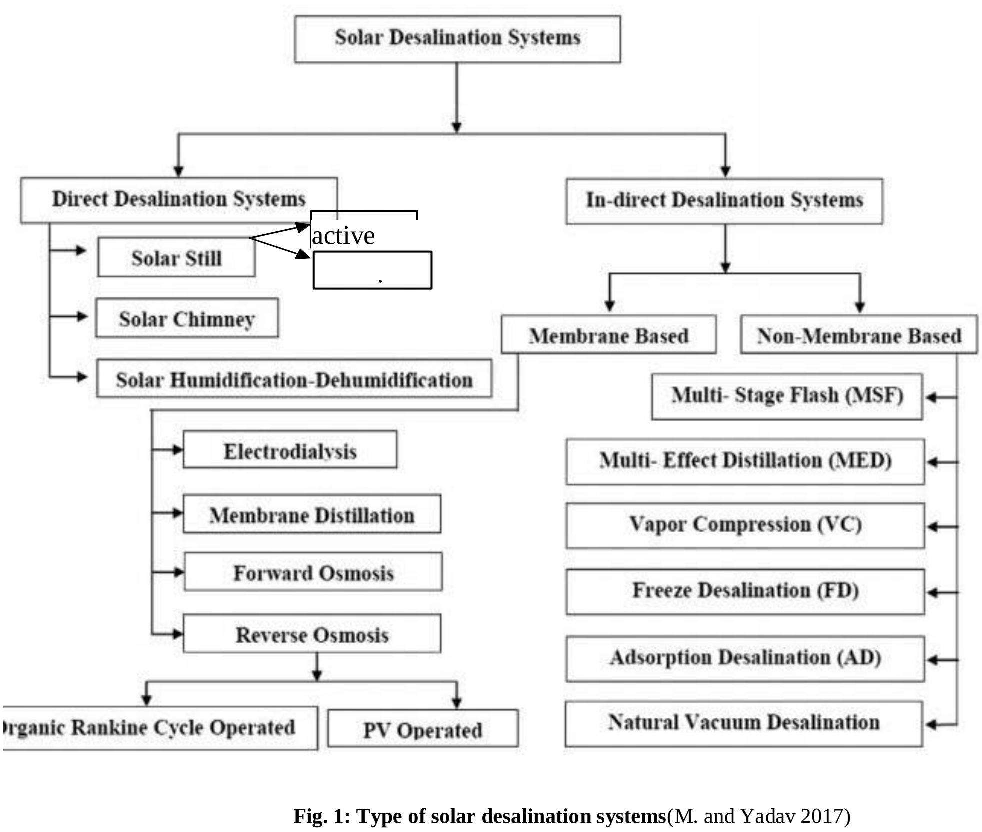

Fig. 1: Type of solar desalination systems(M. and Yadav 2017)

4. Direct desalination system

4.1. Solar still system

The first human-made, water desalination tool, dated from the 19th century, is now the light. A solar is always an airtight, cramped basin covered with a tilted glass panel shown in the fig. 2. The basin of saline (or brackish) water to heat up water and cause evaporation. At the inner side of the glazing the water vapor condenses. It is easy in nature and service primarily for the limited potential of water supply in a remote region. This is an airtight sloping clear glass shell, and for optimum radiation absorption the basin is painted black color(Altarawneh et al. 2017)(Chen et al. 2020).

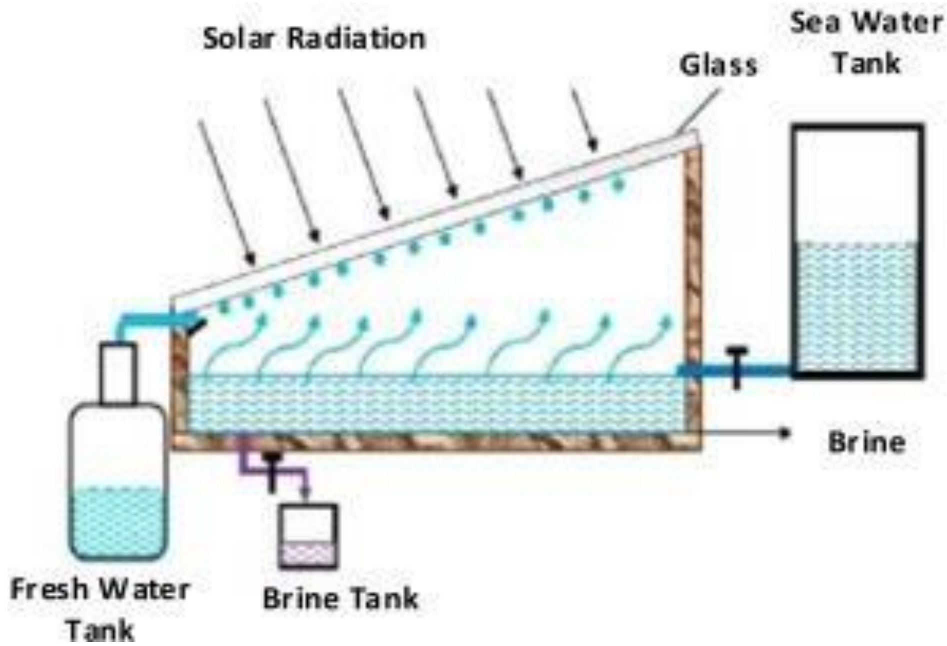

Fig. 2: Schematic diagram of solar still (Altarawneh et al. 2017)

4.2. Humidification and dehumidification system

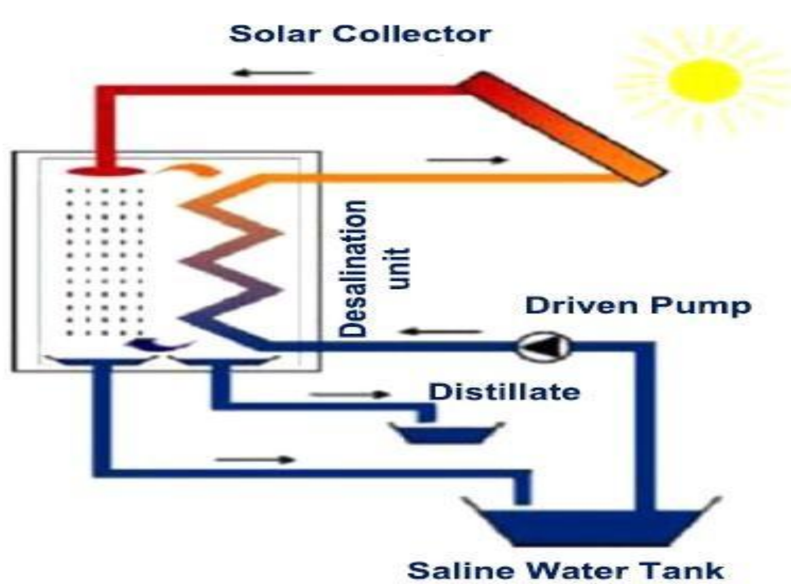

Fig. 3: Humidification and dehumidification system(Narayan et al. 2010)

Humidification – dehumidification desalination requires specific components for each of the thermal's process, requiring each component to be confided independently and enabling much greater accuracy in thermodynamic cycle setup to vaporize water into the air and finally to condense the vapors. The benefit of Humidification – dehumidification over solar is also considerably higher GOR, resulting in a substantially higher GOR. More commonly, humidification – dehumidification systems are considered to have a benefit over many other methods. This makes Humidification–dehumidification more appropriate for implementation in the developed world where there could be minimal financial resources and technological assistance. The main disadvantage of the Humidification – dehumidification method is that the thermal energy demands are always fairly large compared to other technologies [26].

4.3. Solar chimney system

In this solar chimney system thermal energy transformed into kinetic energy and turned into electric power. Collector type plastic and glass are used to trap heat greenhouse and makes temperature differential through the chimney between outdoor air and indoor air. The turbines spin and produce electricity, due to varying pressure or kinetic energy.

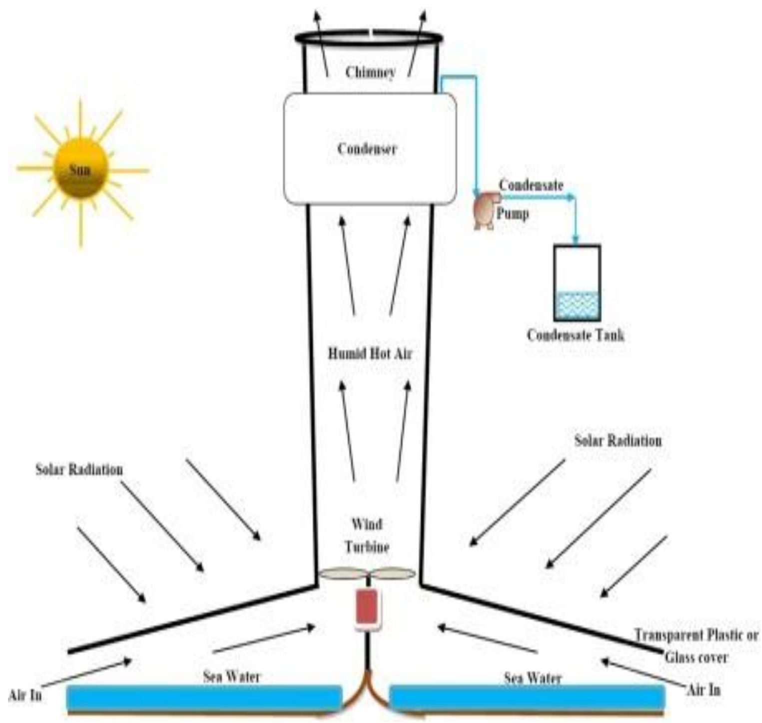

Fig. 4: Solar chimney(Sharon and Reddy 2015)

5. Indirect desalination system

5.1. Nonmembrane Indirect solar desalination system

5.1.1 Multistage flash Indirect desalination system

Seawater desalination is increasingly becoming an essential source of potable water in many areas of the world for long-term human survival. The multi-stage flash method (MSF) provides drinking water even more effectively than any other device of all seawater desalination systems. Given its comparatively high expense, an MSF plant's modular construction is an apparent advantage for an project that will satisfy a range of output demands. An additional benefit of an MSF system is its capacity to couple it as the heat supply to an energy generation facility, rendering the cycle extremely essential for water and power output.[27][28]

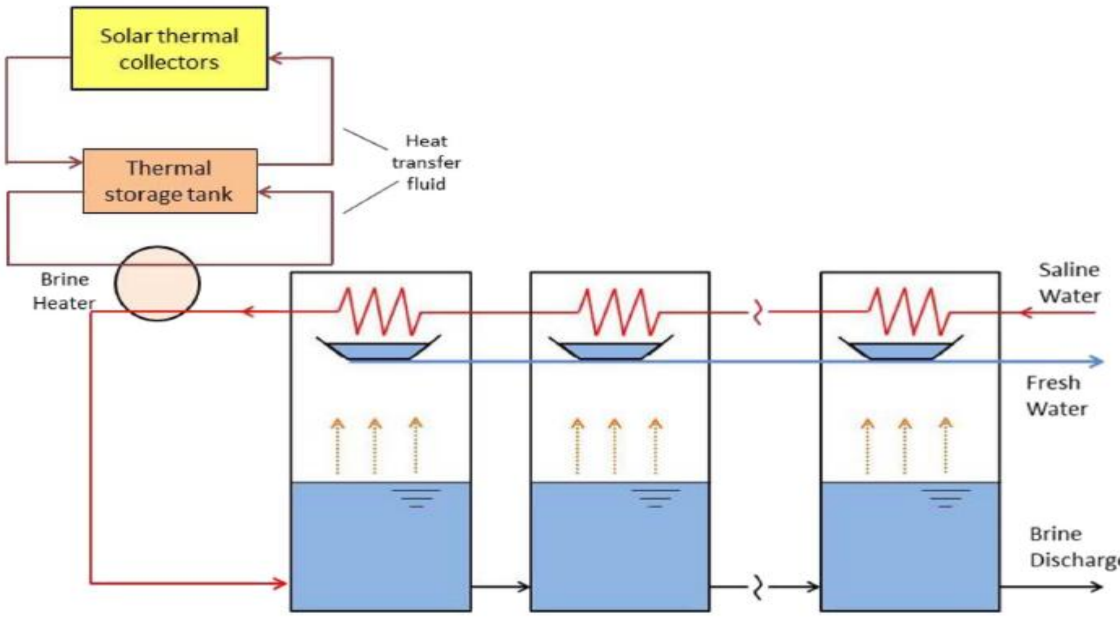

Fig. 5: Multi-stage flash method (Al-Shayji, Al-Wadyei, and Elkamel 2005)

5.1.2 Multieffect Indirect desalination system

Through this water flows through the cell and provides ambient energy at small pressure to the first effect and this impact is transformed by latent heat through vaporization. It ismostly more thermally efficient for large-scale plants and operated at 55-120oC low brine temperatures. This prevents issues with the scaling and corrosion.[27]

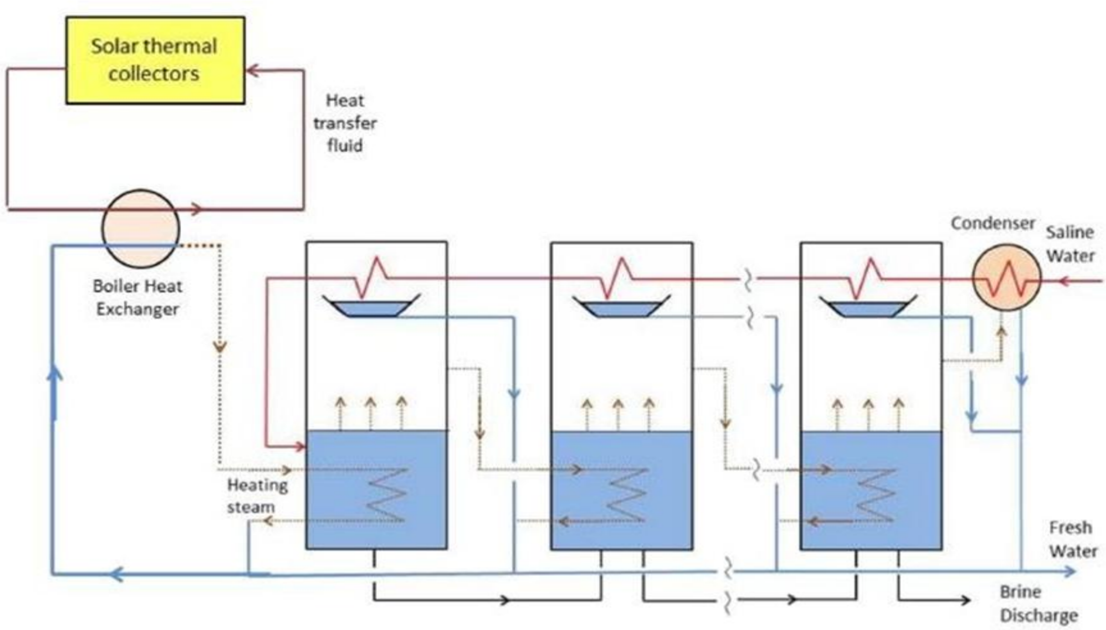

Fig. 6: Multi-effect desalination system (Compain 2012)

5.1.3 Vapor compression indirect desalination system

Since vapor compression increases both vapor pressure and vapor temperature, additional vapor may be generated using the latent heat rejected during condensation. The compression effect of water vapor can be accomplished using two processes. The first technique employs a steam-motivated ejector device at manometric pressure from an external source to collect vapor from the desalination phase. Eject compression or thermocompression is known as type. Using the second form, water vapor is compressed by a mechanical system which is in most cases electrically operated. This form is called

Mechanical Compression of Vapors. Two different versions of the Mechanical Compression of Vapors process are available: vapor compression and vacuum vapor compression. Vapor compression designates the systems in which the systems in whichevaporation occurs at sub atmospheric pressure. Anything like a gas engine physically powers the force. As vapor is produced it is moved to a condenser exchange heat that returns the vapor to water. When the heat lost through condensation is transferred to the residual feedstock, the resultant fresh water is relocated to storage(Chen et al. 2020).

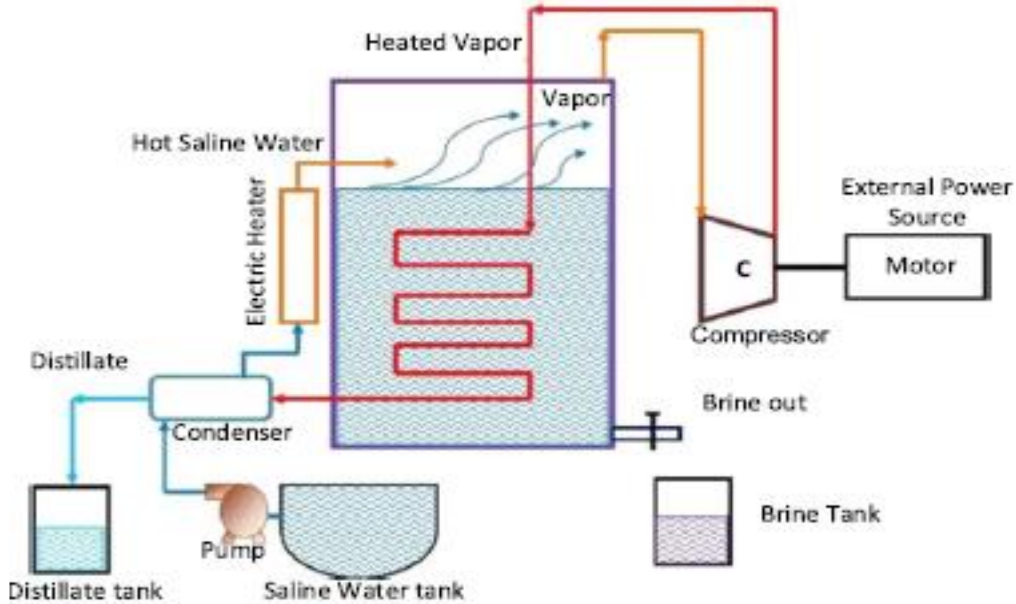

Fig. 7: Vapor compression indirect desalination system (M. and Yadav 2017)

5.1.4 Freezing indirect desalination system

Desalination by freezing methods is based on the premise that ice crystals formed in physical chemistry are made of practically pure water when the temperature of salt water is lowered to its freezing point and further heat is removed. In addition, by the definition of all crystals, impurities are removed from the frameworks of the crystals as they expand. For conjunction with distillation, the freezing cycle requires the phase transformation of water from liquid to concrete. It requires separation of the ice crystals from the brine, polishing of the ice crystals to remove the adhering salts on the surface of the crystals, and freezing of the ice to produce fresh water. Then, ice crystals of liquid water emerged on the surface of this seawater to cool under freezing level. Depending on the refrigerant mixing process, they are different forms. FD is also able to improve yield and high discharge from the brine(Bae et al. 2015).

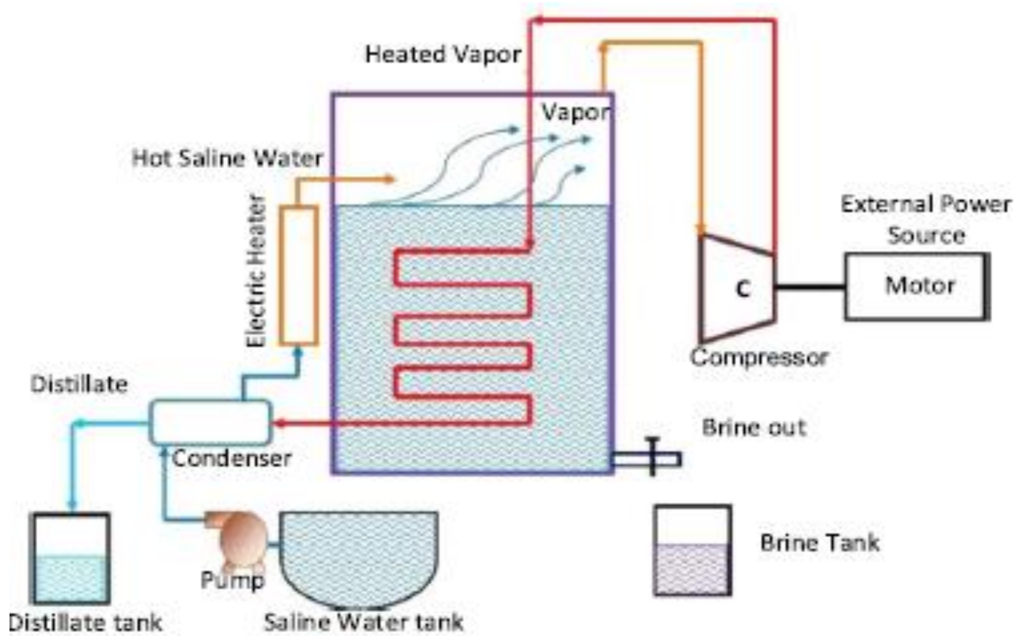

Fig. 7: Vapor compression indirect desalination system(M. and Yadav 2017)

5.1.5 Freezing indirect desalination system

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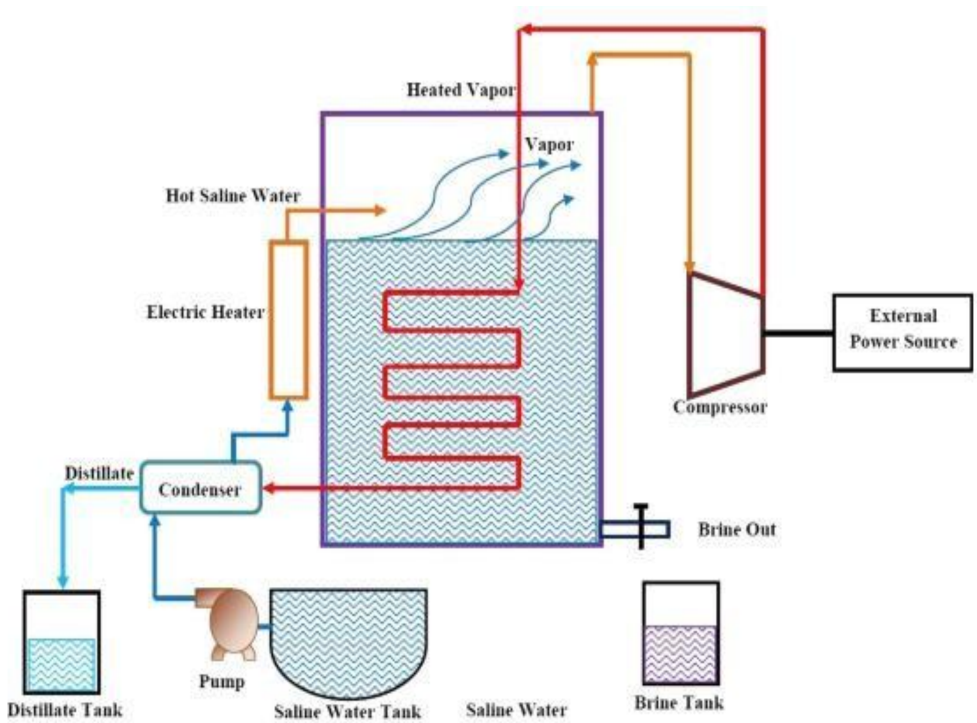

Fig. 8: Freezing indirect desalination system (M. and Yadav 2017)

5.1.6 Absorption indirect desalination system

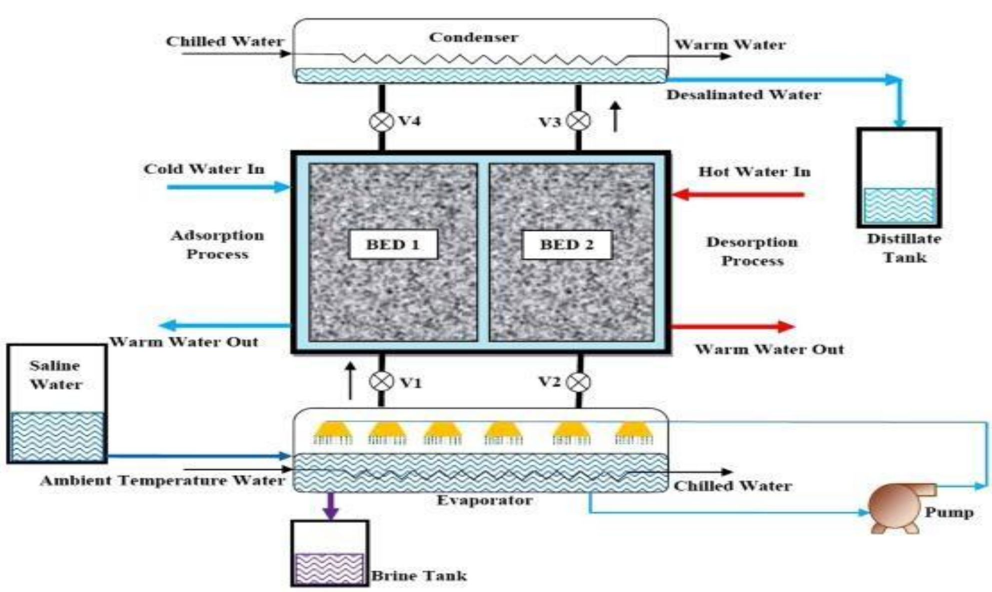

Fig. 9: Absorption desalination(Sharon and Reddy 2015)

Desalination by freezing methods is based on the premise that ice crystals formed in physical chemistry are made of practically pure water when the temperature of salt water islowered to its freezing point and further heat is removed. In addition, by the definition of all crystals, impurities are removed from the frameworks of the crystals as they expand. For conjunction with distillation, the freezing cycle requires the phase transformation of water from liquid to concrete. It requires separation of the ice crystals from the brine, polishing of the ice crystals to remove the adhering salts on the surface of the crystals, and freezing of the ice to produce fresh water. [29].

5.1.7 Natural vacuum indirect desalination system

Fresh water vapors may be created from salt water at low ambient temperatures in desalination systems if the vacuum pump generates the required pressure needing more energy. This electrical energy usage may be decreased or avoided by providing ventilation through the force of gravity by requiring water to collapse under gravity and therefore generating vacuum on the surface. Freshwater created by lowering the operating temperature is supplied with a vacuum by means of a vacuum pump which increases the power consumption. By using force of gravity to build a vacuum mouth, electrical energy may be substituted by a natural phenomenon to create a vacuum(Sathyamurthy, Harris Samuel, and Nagarajan 2016).

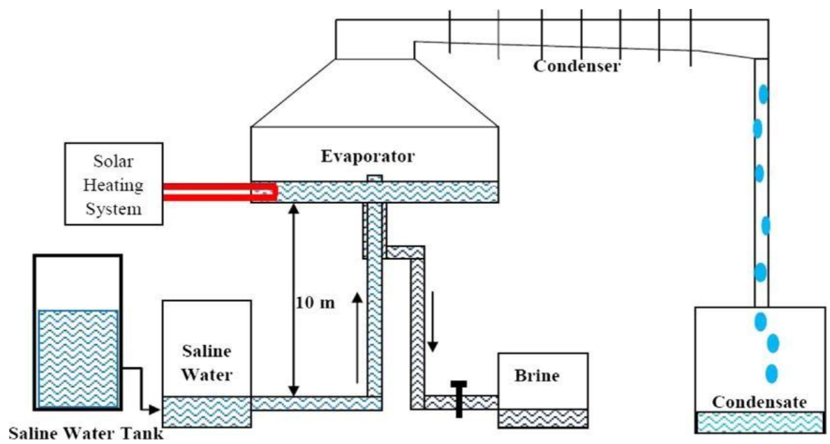

Fig. 10: Natural vacuum desalination systems (Sharon and Reddy 2015)

5.1.8 Solar thermal indirect desalination system

The growing need for desalination to expand the availability of water, along with worries regarding the environmental implications of driving desalination utilizing fossil fuel, hassparked significant interest in the production of desalination systems driven by renewable energy. Over the past few years there has been a tremendous interest in develops integrated solar-thermal desalination systems, especially systems that are activated by solar-driven interfacial evaporation. Based on a Rankine loop, a solar cycle running at a higher-pressure pump provides the mechanical energy. It is often utilized, and used to minimize the expense hybrid device at mechanical strength and higher pressure generated from the expander (Compain 2012)(Bae et al. 2015)(Elimelech and Phillip 2011)(Ghaffour et al. 2015).

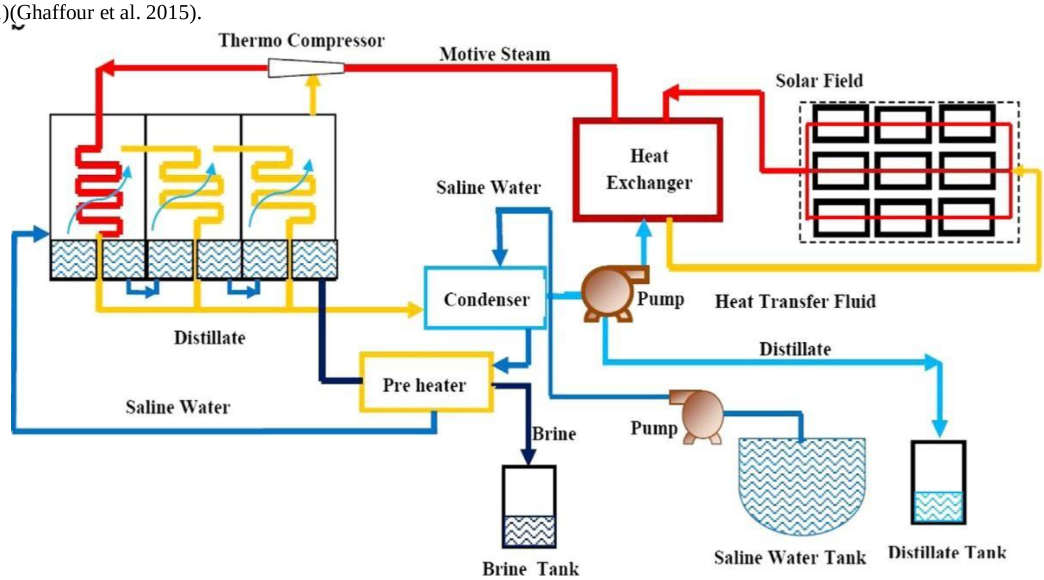

Fig. 11: Solar thermal desalination (Compain 2012)

5.2. Membrane solar desalination system

2.3.2.2.1 Reverse osmosis solar desalination system

Osmosis is a common process where water is transferred through a membrane from a solution with a lower to a higher concentration. Water flow may be reversed if the lower concentration side applies a pressure that is greater than the osmotic level. In reverse osmosis desalination systems, seawater pressure is increased above the usual osmotic pressure of 2.5 MPa but kept below the level of the membrane equilibrium, usually 6 to 8 MPa, forcing the freshwater side of liquid water across membrane pores. To mitigate the osmotic pressure of feed water, the most effective desalination due to low simple usage of energy (2-5 kW / m3) and 65 percent worldwide is supplied with high demand salty water(M. and Yadav 2017).

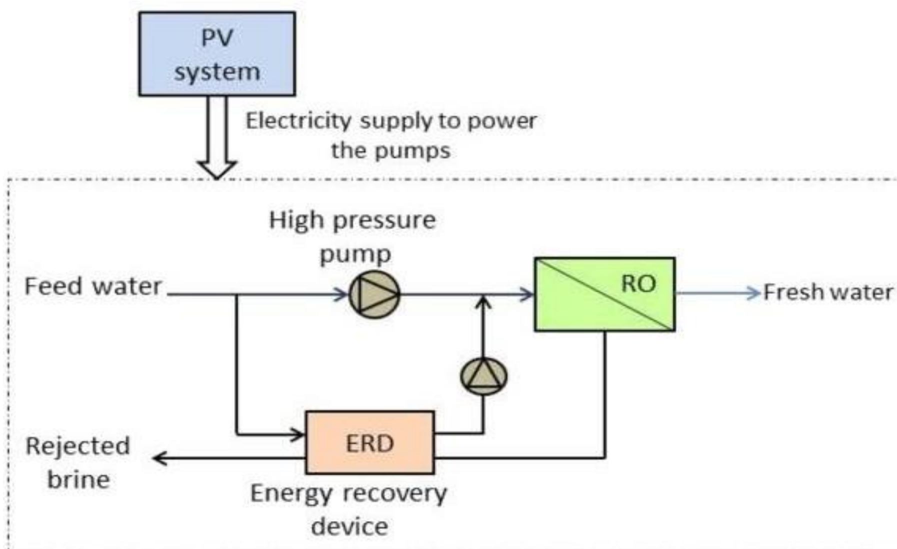

Fig. 12: Reverse osmosis solar desalination system(M. and Yadav 2017)

2.3.2.2.2 Electro-dialysis solar desalination system

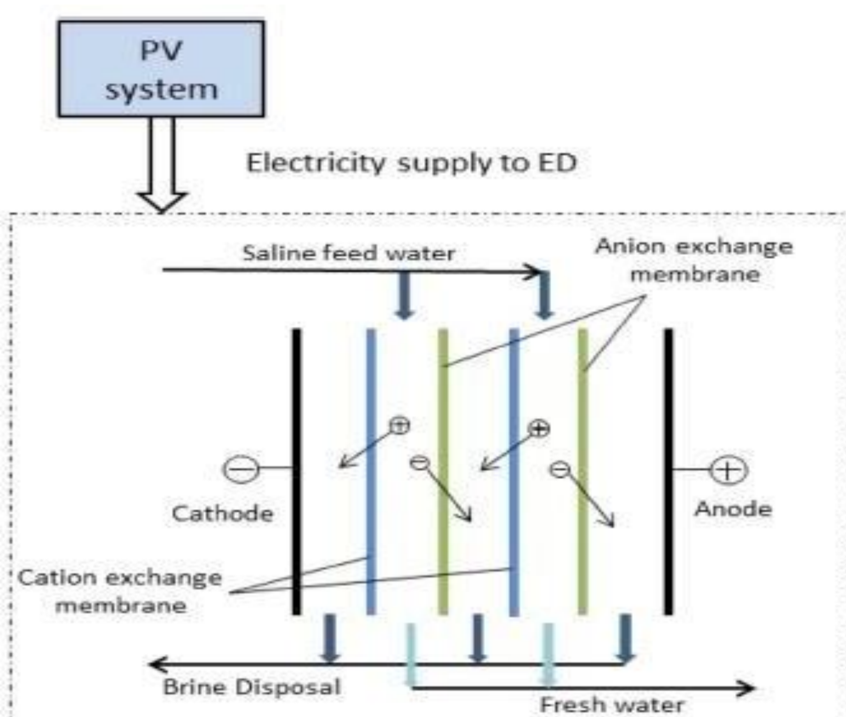

Fig. 13:Electro-dialysis solar desalination system (Zhang et al. 2018)

Thanks to its high running costs and costly ion exchange membranes, Electro-dialysis solar desalination system is an electrically powered desalination device appropriate primarily for brackish water. Saline water is moved to an electrodialysis stack consisting of alternating layers of cationic and anionic ion exchange membranes in an electric system. See Fig. 13 for an Electro-dialysis solar desalination system diagram. Such saline water-in is circulated into an Electro-dialysis solar desalination system stack where anions and cations pass in the opposite direction where there is potential overlap. The electron shares bonds between them, distinguishing them from sea water and ions. It's more economical regardless of the ion exchange membrane extension, weak electrodes and low life cycle(Chen et al. 2020)(Zhang et al. 2018).

2.3.2.2.3 Membrane solar desalination system

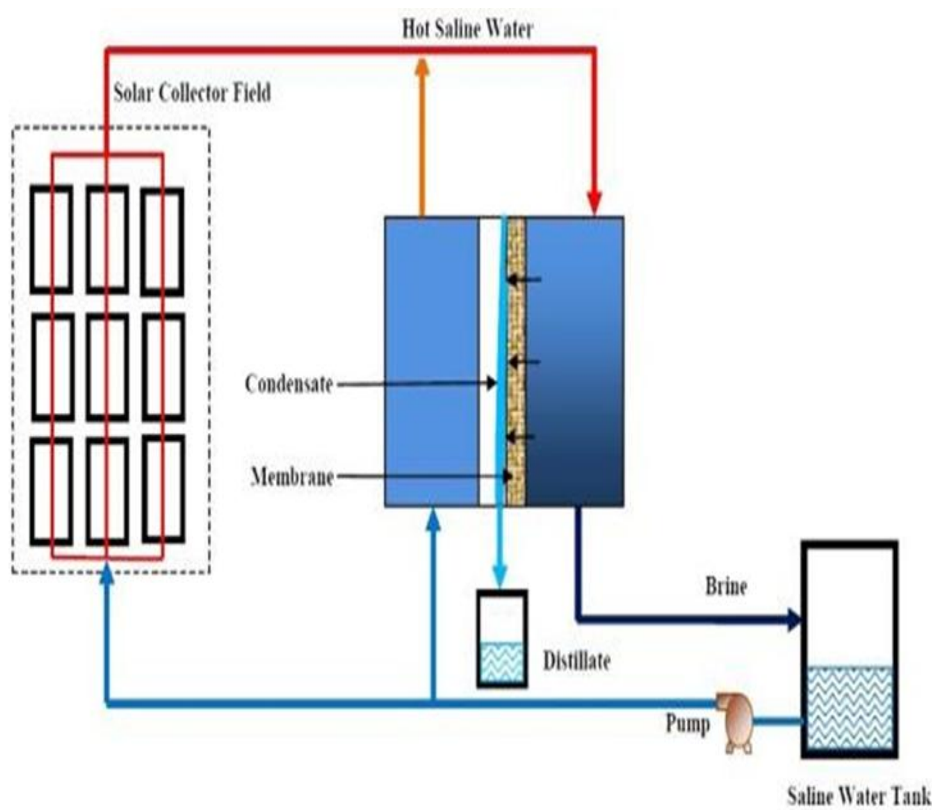

Fig. 14: Schematic diagram of Membrane solar desalination system (M. and Yadav 2017)

Membrane solar desalination system requires both the thermal and the mechanical energies; hence it is analogous to moving solar-assisted membrane desalination device solar desalination, as seen in Fig. 14, which can use lower-grade solar or solar collector fuel and PV or power grid capacity. Membrane solar desalination deviceis a separation process that uses hydrophobic microporous membranes to prevent the passage of seawater via membrane pores and then enable the transfer of emitted vapor to the other side. Membrane solar desalination system is a thermally controlled mechanism in which the vapor pressure gradient is the guiding factor for conveying mass across the membrane. Four simple configurations exist for the. Solar desalination method for the membranes: immediate contact, air difference, sweeping vapor and vacuum(M. and Yadav 2017)(Fath et al. 2008).

2.3.2.2.4 Forward osmosis solar desalination system

Forward osmosis (FO) is an osmotic process that utilizes a semi-permeable membrane such as reverse osmosis (RO) to impact water separation from solutes dissolved. The driving force for this separation is an osmotic pressure gradient, and a broad concentration "shift" fluid is required to induce a net inflow of water through the membrane into the drawing fluid, thereby distinguishing the feed water from its solutes. In contrast, the method of reverse osmosis uses hydraulic pressure as the driving force of separation which helps to resolve the gradient of osmotic pressure which would otherwise sustain water flux from the permeate to feed. Thus, reverse osmosis needs slightly more resources relative to forward osmosis(Compain 2012)(Fath et al. 2008).

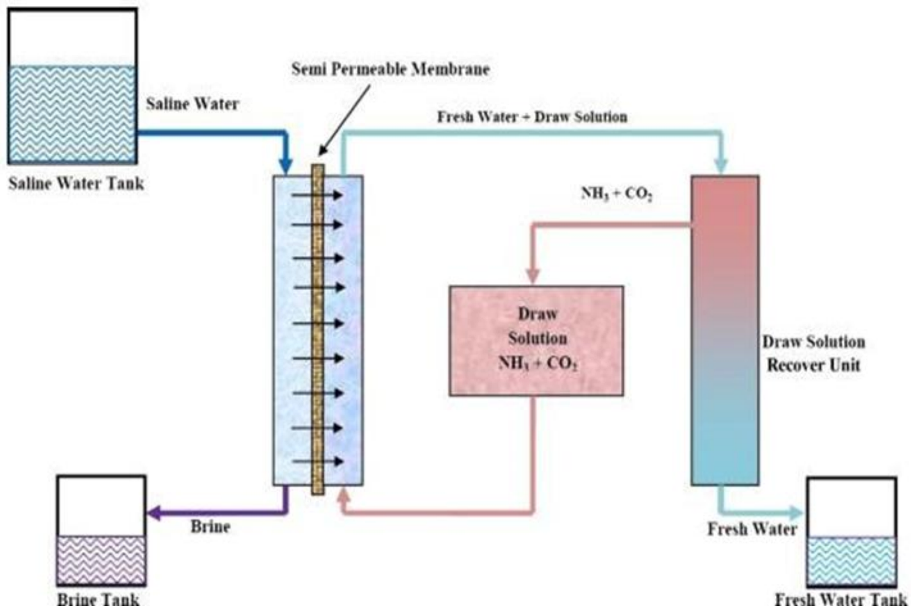

Fig. 15: Forward osmosis solar desalination system (Compain 2012)

5.3. Types of solar still based on geometry

There are many types of solar still are given(Nayi 2017)

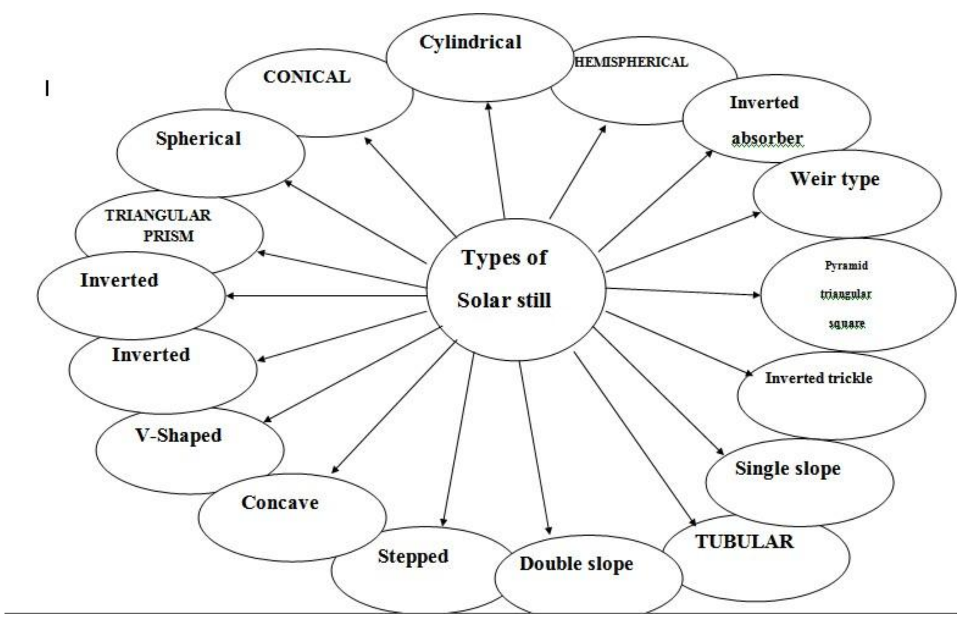

Fig. 16: Type of solar still based on geometry(Nayi 2017)

5.4. Square pyramid solar still

Only the standard solar pyramid resides in a single basin filled with salt water. The basin is constructed of an iron, aluminum or copper galvanized surface coated in black matte paint to optimize the efficient solar radiation. The basin is filled with thermocol, glass cloth, or wood to reduce damages. The bath is enclosed in a 30 ° and 4 mm long inclined glass shell. The glass mask is bent at which it opts for full solar exposure proportional to the angle of latitude. The solar radiation penetrates into the glass cover and is consumed by the tank, the temperatures of the pool grow and water is heated in salt water by the heat conduction. Air evaporated and came into touch with glass due to the breeze blowing in humid atmosphere and the capillary activity of water produced in the distillation trough. The distilled distillate water is clean drinking water and contaminant-free. The optimum output glass inclination at various water temperatures is almost equivalent to latitude angle with natural and saline water use active mode and passive mode cases to measure the overall hourly yield at the same size parameter. In this project estimated hourly yield of square solar pyramid also technically and even measured yield loss experimentally. The yield output is measured, which for square solar pyramid is only about 30.9 percent. In this shows also various parameters depending on yield of square solar pyramid still with plotting graphs at different water depth and water salinity condition. Specific work is ongoing for various water depths and inclinations for single and double slopes, but in this project, we still have to do both of these on solar pyramid to demonstrate their results(Nayi and Modi 2018),(Altarawneh et al. 2020), (Han, Waks, and Shapiro 2020).

6. Conclusion

Solar still shows to be the greatest choice for meeting the rising need for drinkable water in a world of competition and energy problems since it uses renewable, limitless, pollution-free, and cost-free solar energy. Many studies have been conducted in this sector in order to maintain an inventive and efficient revolution. One of them is still the pyramid solar.The current study contains a thorough examination of pyramid-shaped solar stills. The following conclusion may be drawn from the complete examination of the pyramid solar still:Energy and exergy efficiency are both higher at lower saline water depths, with the billet form of latent heat storage material proving to be more efficient.The tracking system is still required for pyramid solar, but the shadowing impact of the side wall is reduced. Water depth, glass cover temperature, ambient air velocity, intake saline water temperature, water vapor movement inside the solar still, and materials of various components (Basin, Insulation, and Transparent cover) all have a major impact on the still's performance. As a result, all parameters must be tuned for the best results. The performance of a pyramid sun still is affected by the quantity and quality of saline water (in terms of depth of water) in the same way that a conventional solar still is affected.The pyramid solar still had the lowest cost of distillate output at 0.031 $/liter, indicating that it is the most viable alternative to traditional sun stills.When the water level is increased in a triangular pyramid solar still, the convective and evaporative heat transfer coefficients decrease throughout the sunlight hours. By distributing wick material over the slanted surface of a pyramid solar still, an average daily still efficiency of up to 50.25 percent may be achieved. Inside the pyramid solar still, forced convection, produced by a tiny DC fan, greatly increases the evaporation rate, resulting in increased daily production. Forced convection in a pyramid solar still has been shown to increase daily production by up to 25%.Many researchers were focused on improving the efficiency and productivity of stills, but they neglected to examine the economic aspects of the advancements in order to determine the eventual cost of drinkable water. As a result, an exergo-economic study of pyramid solar is still required. In a pyramid solar still with forced convective heat transfer, daily distillate output rises as the Reynolds number and wind velocity rise.The inclination angle of the glass cover in the pyramid solar still should be kept equal to local latitude for the greatest yield each day.

References

Abutayeh, Mohammad, Chennan Li, D. Yogi Goswami, and Elias K. Stefanakos. 2014. *Solar Desalination*. Vol. 9781118208.

Agrawal, Abhay, R. S. Rana, and Pankaj K. Srivastava. 2017. “Heat Transfer Coefficients and Productivity of a Single Slope Single Basin Solar Still in Indian Climatic Condition: Experimental and Theoretical Comparison.” *Resource-Efficient Technologies* 3(4):466–82. doi: 10.1016/j.reffit.2017.05.003.

Al-Shayji, K. A., S. Al-Wadyei, and A. Elkamel. 2005. “Modelling and Optimization of a Multistage Flash Desalination Process.” *Engineering Optimization* 37(6):591–607. doi: 10.1080/03052150412331335801.

Altarawneh, Ibrahem, Mohammad Batiha, Saleh Rawadieh, Mohammad Alnaief, and Muafag Tarawneh. 2020. “Solar Desalination under Concentrated Solar Flux and Reduced Pressure Conditions.” *Solar Energy* 206(February):983–96. doi: 10.1016/j.solener.2020.06.058.

Altarawneh, Ibrahem, Saleh Rawadieh, Mohammad Batiha, Leema Al-Makhadmeh, Sultan Alrowwad, and Muafag Tarawneh. 2017. “Experimental and Numerical Performance Analysis and Optimization of Single Slope, Double Slope and Pyramidal Shaped Solar Stills.” *Desalination* 423(February):124–34. doi: 10.1016/j.desal.2017.09.023.

Bae, Kyuyoung, Gumin Kang, Suehyun K. Cho, Wounjhang Park, Kyoungsik Kim, and Willie J. Padilla. 2015. “Flexible Thin-Film Black Gold Membranes with Ultrabroadband Plasmonic Nanofocusing for Efficient Solar Vapour Generation.” *Nature Communications* 6. doi: 10.1038/ncomms10103.

Chen, Qian, Raid Alrowais, Muhammad Burhan, Doskhan Ybyraiymkul, Muhammad Wakil Shahzad, Yong Li, and Kim Choon Ng. 2020. “A Self-Sustainable Solar Desalination System Using Direct Spray Technology.” *Energy* 205:118037. doi: 10.1016/j.energy.2020.118037.

Compain, Pascale. 2012. “Solar Energy for Water Desalination.” *Procedia Engineering* 46(0):220–27. doi: 10.1016/j.proeng.2012.09.468.

Ding, Zhongwei, Liying Liu, Mohamed S. El-Bourawi, and Runyu Ma. 2005. “Analysis of a Solar-Powered Membrane Distillation System.” *Desalination* 172(1):27–40. doi: 10.1016/j.desal.2004.06.195.

Elimelech, Menachem, and William A. Phillip. 2011. “The Future of Seawater Desalination: Energy, Technology, and the Environment.” *Science* 333(6043):712–17. doi: 10.1126/science.1200488.

Fath, Hassan E. S. 1998. “Solar Distillation: A Promising Alternative for Water Provision with Free Energy, Simple Technology and a Clean Environment.” *Desalination* 116(1):45–56. doi: 10.1016/S0011-9164(98)00056-3.

Fath, Hassan E. S., Samy M. Elsherbiny, Alaa A. Hassan, Matthias Rommel, Marcel Wieghaus, Joachim Koschikowski, and Mostafa Vatansever. 2008. “PV and Thermally Driven Small-Scale, Stand-Alone Solar Desalination Systems with Very Low Maintenance Needs.” *Desalination* 225(1–3):58–69. doi: 10.1016/j.desal.2006.11.029.

Fatha, H. E. S., K. Fahmy, and A. Ha. 2003. "Thermal-Economic Analysis and Comparison between Pyramid- Shaped and Single-Slope Solar Still Configurations." 159.

Ghaffour, Noreddine, Jochen Bundschuh, Hacene Mahmoudi, and Mattheus F. A. Goosen. 2015. "Renewable Energy-Driven Desalination Technologies: A Comprehensive Review on Challenges and Potential Applications of Integrated Systems." *Desalination* 356:94–114. doi: 10.1016/j.desal.2014.10.024.

Han, Chang Mu, Edo Waks, and Benjamin Shapiro. 2020. "Mathematical Modeling and Experimental Validation for Expression Microdissection." *Applied Optics* 59(20):5870–80. doi: 10.1364/AO.395864.

Heidary, B., T. Tavakoli Hashjin, B. Ghobadian, and R. Roshandel. 2018. "Optimal Integration of Small Scale Hybrid Solar Wind RO-MSF Desalination System." *Renewable Energy Focus* 27(00):120–34. doi: 10.1016/j.ref.2018.05.003.

Li, Shuang Fei, Zhen Hua Liu, Zhi Xiong Shao, Hong shen Xiao, and Ning Xia. 2018. "Performance Study on a Passive Solar Seawater Desalination System Using Multi-Effect Heat Recovery." *Applied Energy* 213(November 2017):343–52. doi: 10.1016/j.apenergy.2018.01.064.

Luft, Werner. 1981. "Solar Energy Water Desalination in the United States and Saudi Arabia." *Proceedings of the Intersociety Energy Conversion Engineering Conference* 2:1800–1803.

M., Chandrashekara, and Avadhesh Yadav. 2017. "Water Desalination System Using Solar Heat: A Review." *Renewable and Sustainable Energy Reviews* 67:1308–30. doi: 10.1016/j.rser.2016.08.058.

Narayan, G. Prakash, Mostafa H. Sharqawy, Edward K. Summers, John H. Lienhard, Syed M. Zubair, and M. A. Antar. 2010. "The Potential of Solar-Driven Humidification-Dehumidification Desalination for Small-Scale Decentralized Water Production." *Renewable and Sustainable Energy Reviews* 14(4):1187–1201. doi: 10.1016/j.rser.2009.11.014.

Nayi, Kuldeep H. 2017. "A DETAILED TECHNICAL REVIEW ON SQUARE PYRAMID SOLAR STILL." (2):3759–66.

Nayi, Kuldeep H., and Kalpesh V. Modi. 2018. "Pyramid Solar Still: A Comprehensive Review." *Renewable and Sustainable Energy Reviews* 81(July 2017):136–48. doi: 10.1016/j.rser.2017.07.004.

Pal, Piyush, Rahul Dev, Dhananjay Singh, and Amimul Ahsan. 2018. "Energy Matrices, Exergoeconomic and Enviroeconomic Analysis of Modified Multi–Wick Basin Type Double Slope Solar Still." *Desalination* 447:55–73. doi: 10.1016/j.desal.2018.09.006.

Panchal, Hitesh, Sanil S. Hishan, Robbi Rahim, and Kishor Kumar Sadasivuni. 2020. "Solar Still with Evacuated Tubes and Calcium Stones to Enhance the Yield: An Experimental Investigation." *Process Safety and Environmental Protection* 142:150–55. doi: 10.1016/j.psep.2020.06.023.

Sathyamurthy, Ravishankar, D. G. Harris Samuel, and P. K. Nagarajan. 2016. "Theoretical Analysis of Inclined Solar Still with Baffle Plates for Improving the Fresh Water Yield." *Process Safety and Environmental Protection* 101:93–107. doi: 10.1016/j.psep.2015.08.010.

Sathyamurthy, Ravishankar, Hyacinth J. Kennady, P. K. Nagarajan, and Amimul Ahsan. 2014. "Factors Affecting the Performance of Triangular Pyramid Solar Still." *Desalination* 344:383–90. doi: 10.1016/j.desal.2014.04.005.

Sharon, H., and K. S. Reddy. 2015. "A Review of Solar Energy Driven Desalination Technologies." *Renewable and Sustainable Energy Reviews* 41:1080–1118. doi: 10.1016/j.rser.2014.09.002.

Tiwari, G. N., H. N. Singh, and Rajesh Tripathi. 2003. "Present Status of Solar Distillation." 75:367–73. doi: 10.1016/j.solener.2003.07.005.

Ullah, Ihsan, and Mohammad G. Rasul. 2019. "Recent Developments in Solar Thermal Desalination Technologies: A Review." *Energies* 12(1). doi: 10.3390/en12010119.

Vishwanath Kumar, P., Anil Kumar, Om Prakash, and Ajay Kumar Kaviti. 2015. "Solar Stills System Design: A Review." *Renewable and Sustainable Energy Reviews* 51:153–81. doi: 10.1016/j.rser.2015.04.103.

Zhang, Ying, Muttucumaru Sivakumar, Shuqing Yang, Keith Enever, and Mohammad Ramezanianpour. 2018. "Application of Solar Energy in Water Treatment Processes: A Review." *Desalination* 428:116–45. doi: 10.1016/j.desal.2017.11.020.