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Portable Irrigation System Producing Water from Air for Sustainable Living: "ECO-WATER-GEN"

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Abstract

It is important to use sustainable and renewable resources efficiently for a sustainable life. In this direction, in this study, it is aimed to emphasize the importance of freshwater resources and renewable energy resources, which are important parts of life, and to raise awareness about protecting natural resources. In this context, a portable, plant watering system has been developed that uses solar energy to cool the gaseous water in the air in a controlled manner with the help of thermoelectric modules and fans, stores the water by condensation, and can irrigate in a controlled manner as needed. As a result of the experimental study, the amount of water produced by the system is equal to the theoretical calculations. In this way, with this system it will be possible to irrigate domestic plants or hobby gardens by obtaining the optimum amount of water through controlled condensation.

Keywords: *Sustainability, water efficiency, energy efficiency, irrigation system*

Sürdürülebilir Yaşam İçin Suyunu Havadan Üreten Taşınabilir Sulama Sistemi: "EKO-SU-JEN"

Öz

Sürdürülebilir bir yaşam için sürdürülebilir ve yenilenebilir kaynakların verimli bir şekilde kullanılması önem taşımaktadır. Bu doğrultuda, bu çalışmada yaşamın önemli parçalarından olan tatlı su kaynaklarının ve yenilenebilir enerji kaynaklarının önemini vurgulayarak, doğal kaynakları korumak konusunda farkındalık yaratmak amaçlanmıştır. Bu kapsamda, güneş enerjisini kullanarak, havada gaz formunda bulunan suyu, termoelektrik modüller ve fanlar yardımıyla kontrollü olarak soğutup, yoğuşma yoluyla suyu depolayan ve ihtiyaca göre kontrollü bir şekilde sulama yapabilen, taşınabilir, bitki sulayan bir sistem geliştirilmiştir. Deneysel çalışma sonucunda sistem ile üretilen su miktarı teorik hesaplamalar ile örtüşmektedir. Böylece bu sistem ile, kontrollü yoğuşma yoluyla optimum miktarda su elde edilerek, evsel bitkileri veya hobi bahçelerini sulamak mümkün olacaktır.

Anahtar Kelimeler: *Sürdürülebilirlik, su verimliliği, enerji verimliliği, sulama sistemi*

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1. Introduction

Today, natural resources are being depleted rapidly as a result of the rapid increase in population and industrialization. At the same time, not using renewable energy sources causes climate and environmental problems. Water, which is a natural resource, is one of the most important elements for life and people (Çakmak & Gökalp, 2011). It is an important resource that connects living things to itself throughout their lives and directly affects their lives (Kılıç, 2008). Although ¾ of the world is covered with water, only 3% of these waters are fresh water sources. Access to freshwater resources is becoming increasingly difficult due to rapid population growth and drought and global climate change. Therefore, water demand in the world is expected to increase by 55 percent by 2050 (Smedley, 2017). 75% of the earth is covered with water and 97% of the water body consists of salt water and 3% fresh water. Water is the main source of life and is of great importance as a necessity for health. Globally, 70% of the fresh water on earth is used to irrigate the soil and provide food, 22% for production and energy, and 8% for health purposes (Dost, 2017). Water indirectly affects nutrition. Agricultural areas are decreasing due to erosion caused by increasing population, global warming, wrong agricultural practices such as faulty soil cultivation and wrong agricultural policies, and the destruction of natural vegetation. Nutrition problems caused by declining agricultural lands "irrigated agriculture practice" is being solved with. Ecologically, the effect of water on soil formation is very important. One of the main factors that plays a role in the physical disintegration of the rocks that make up the solid part of the earth's crust and the transformation of these parts into fertile soil by chemical weathering is water. The nutrients in the soil are taken up by the plant roots and transported to the leaves, which are meters high, by the capillary effect, again with the presence of water (Çepel & Ergün, 2003).

Energy is an important input to civilized life (İbrahim, 2006). It is an important element in increasing the welfare level of societies and is used in all areas of life (Koç & Kaya, 2015). Today, the use of fossil-based energy sources as a resource causes global climate change and environmental problems. In addition, the extinction of fossil-based energy sources is among the important problems (Çelebi, 2021). The use of renewable and clean energy sources is of great importance in solving these problems.

In this study, in terms of water and energy efficiency, a pilot system has been developed that uses solar energy, cools the gaseous water in the air in a controlled manner with the help of thermoelectric modules and fans, stores water through condensation and irrigates plants automatically. With this system, domestic plants, hobby gardens and similar places will be irrigated with water obtained from the air with optimum efficiency. Thus, it is aimed to contribute to the protection of underground water resources by developing an irrigation system that takes its energy from the sun, which is a renewable energy source, and to raise awareness of people by drawing attention to the importance of water.

Since underground water resources are decreasing day by day, scientists are working on alternative methods to produce solutions to this issue. Existing studies on the developed technique include a device that produces water by condensing from metal surfaces by photoelectric effect in the US 6,945,063 B2 American patent document (Max, 2005), a device that produces drinking water by thermoelectric effect in the US 7,337,615 B2 American patent document (Reidy, 2008) and US 6,868,690 In the B2 American patent document, it is a device that can obtain drinking water through gas cooling (Faqih, 2005). The study in the US 6,945,063 B2 American patent document is based on the principle of obtaining water by condensation from the relative humidity in the air using only the Peltier effect. Although the basis of the work in the US 7,337,615 B2 American patent document is similar, this device is different in shape. In the study in the US 6,868,690 B2 American patent document, it is aimed to obtain water through gas systems used in refrigerators.

Unlike the previous studies, in this study, the cooling surface of the thermoelectric cooler module block with copper and aluminium cooler with fan circulation is controlled by the timer and the condensation of the water is ensured. After the condensation, the water collected in the tank is sent to the plants gradually with the help of the pump control unit and irrigation is carried out.

1.1. Water and Energy Efficiency

Due to the accelerated industrialization and rapidly increasing population after the industrial revolution, natural resources such as water resources began to be depleted rapidly. There are also difficulties in accessing water resources due to the use of non-renewable (exhaustible), fossil-based resources and the global warming and environmental problems caused by greenhouse gas emissions as a result. The efficient use of natural water resources and the use of renewable energy resources as an energy source are of great importance in solving water resources, energy and environmental problems. Water and energy efficiency refers to the effective use of resources.

Water is an important resource for providing the basic needs of humanity and for the development of sustainable agriculture, energy production, industry and transportation. In this respect, it is a necessity to use water efficiently and effectively in cities, buildings, agriculture and industrial areas. In this direction, between the protection and transmission of freshwater resources; Good water management should be ensured in every area between the distribution and removal of water (Kılıç, 2008). Water must be managed in a way that ensures efficiency in the stages of storage, transmission, use and recycling. It is important to protect and develop water basins in the management of water resources. Ground and surface waters within the borders of the basin, the surroundings of the basin, soil, those that demand and supply water and ecosystems that need water should be considered as a whole. The goals that form the basis of water efficiency are to use water sparingly, to take measures to improve water quality and to benefit from technological developments. Water efficiency, on the other hand, includes studies and measures to increase savings in agriculture, domestic use and industry, and to ensure the reuse of water, together with technological innovations. It aims to work to minimize water losses and remove waste without harming people and the environment (Kılıç, 2008). Water is also a renewable energy source that can provide energy production.

Energy efficiency is to manage and limit the amount of energy consumed, and to aim to use renewable and sustainable sources as an energy source. The efficient use of energy will reduce the energy-related impacts on the environment and health. Energy efficiency includes objectives such as obtaining products and services with less energy use, reducing the theoretical burden on infrastructure, reducing costs and reducing greenhouse gas emissions. Like any human activity, the effects of energy sources on the environment are significant (REN 21, n.d.). Fossil-based energy sources cause permanent, destructive environmental effects and harm human health. At the same time, their extinction is among the important problems. In order to alleviate the negative effects of climate change and to find solutions to environmental problems, using renewable energy sources is of great importance and is seen as a solution proposal. In order to ensure low emissions and reduce environmental impacts, the use of fossil-based energy should be avoided and energy-saving systems should be given priority. Renewable energy sources consist of solar energy, wind energy, biomass energy, geothermal energy, hydrogen energy, hydraulic energy and water (wave) energy. Renewable energy sources are clean, environmentally friendly and naturally flowing sources. Among the renewable energy sources, solar energy comes to the fore. Solar energy has an unlimited potential to be used and is a clean, renewable energy source that is widely used due to its versatile benefits (Çelebi, 2021).

It is used in versatile areas such as energy industry, industry, transportation, buildings, outdoor lighting. In this direction, large-scale studies should be conducted to address energy usage areas and supply solutions holistically and to become carbon neutral. To achieve energy efficiency by reducing energy consumption, the way energy needs are met must be redesigned, restructured and adverse environmental impacts drastically reduced (REN 21, n.d.). In this direction, renewable energy sources have great potential and it is of great importance to work on renewable energy technologies.

Measures to be taken to ensure water and energy efficiency are such as to protect natural resources, prevent the increase of environmental pollution, and reduce the intensity of greenhouse gas emissions. In this respect, in this study, an irrigation system design that can produce water by using solar energy is proposed.

2. Material and Method

In the study, first of all, literature was searched (Faqih, 2005; Max, 2005; Reidy, 2008; Nitheesh et al., 2019; Avhad et al., 2021). Afterwards, the Eco-Su-Jen system was designed. Theoretical calculations about the system were made and in the last stage, the system was tested experimentally. Accordingly, the results were compared and evaluated.

The proposed system in this study consists of three parts. The first part is the thermoelectric cooler module block with copper, aluminum heatsink, fan circulation and the water tank (Figure 1). In this section, the fan on the side surface of the water tank blows high humidity air onto the cold surface, while the cooling liquid circulating in the copper pipe is cooled by the peltier effect and this effect is transferred to the aluminum surface by conduction. If the "condensation temperature" of the humidity in the humid air in contact with the cold surface is lower than the cold surface temperature, the moisture condenses and tries to heat it by giving some of its latent heat to the air and some to the cold surface. As a result of this process that takes place gradually on the surface, the moisture in the air passes into the liquid phase through condensation and is collected in the tank.

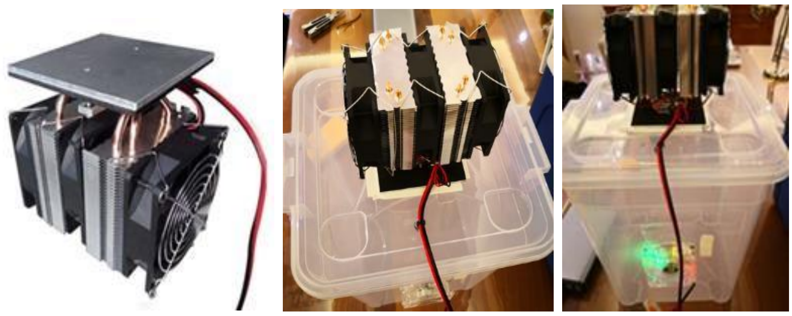

Figure 1. Thermoelectric cooler module block and water tank with copper, aluminium cooler, fan circulation used in the system

The thermoelectric effect is called both the Peltier and Seebeck effect in many sources (Thermoelectric, 2018; Thermoelectricity, n.d.). The reason for this is the independent work of the French physicist Charles Athanase Peltier (1834) and the Estonian-born German physicist Thomas Johann Seebeck (1821). Seebeck and Peltier effects (Figure 2) are inverse of each other. In this study, the Peltier effect was used. In the Peltier effect, when the thermoelectric module is energized from the outside, one side of the module heats up while the other side cools down (Adıgüzel, 2016). The thermoelectric effect is the conversion of temperature differences and electricity. When a temperature difference is applied to both sides of the thermoelectric module, a voltage difference occurs, or when voltage is applied from the outside, a temperature difference occurs on both sides of the thermoelectric module. This situation can be used to cool or heat objects or to measure the temperature of objects and to generate electricity as the heating or cooling process can be determined according to the direction of the applied voltage (Thermoelectric, 2018).

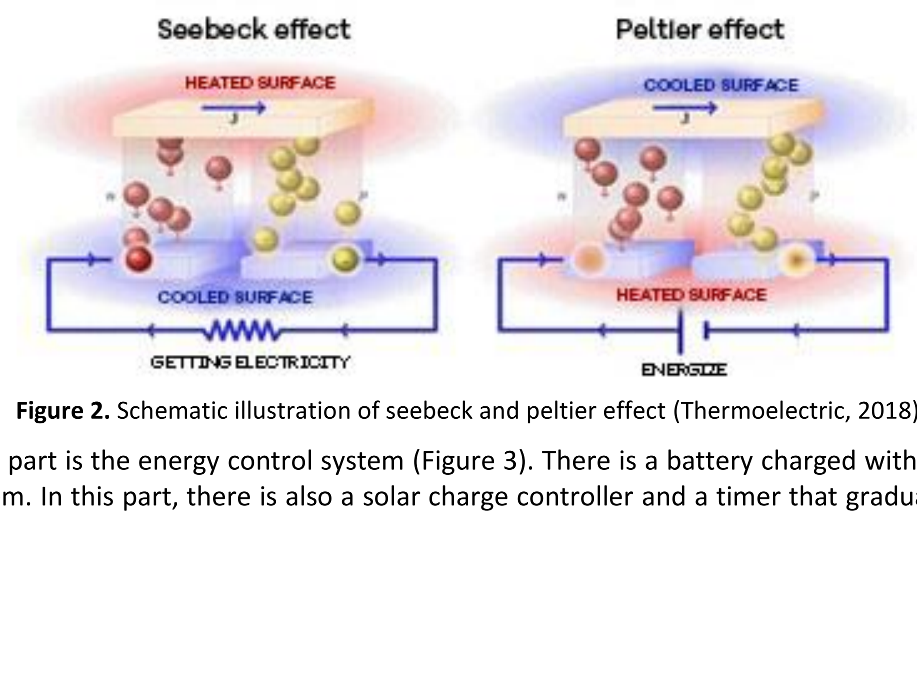

Figure 2. Schematic illustration of seebeck and peltier effect (Thermoelectric, 2018)

The second part is the energy control system (Figure 3). There is a battery charged with solar energy in the system. In this part, there is also a solar charge controller and a timer that gradually cools the surfaces. If the surface gets too cold, the condensation capacity decreases. In the system, there is a timer with start-stop feature that can adjust the condensation amount according to climatic characteristics.

Figure 3. Energy control system and carrying case

The third part is the smart irrigation unit. In this part, the water collected in the tank is sent to the plant with the help of an electronic mechanism, according to the need, and irrigation is carried out. In this part, the ready-made unit is used (Figure 4).

Figure 4. Controlled irrigation computer

Figure 5 shows the view of the Eco-Water-Jen system and Table 1 shows the technical features and cost prices of the materials that make up the Eco-Water-Jen system.

Figure 5. Eco-Water-Gen system view

Table 1. Eco-Water-Gen material, specification and cost table

Piece	Material	Technical specification	Cost (182$)
1	Monocrystalline solar panel	220 watts, 18.5 volts (max)	70$
1	Thermoelectric cooler module block with copper, aluminum heatsink, fan circulation	2 x TEC 12715 12 volts 240 watts	33$
1	Exterior air flow fan	8 cm case fan 12 volts	2$
1	Battery	12 volt 22 Ah Gel	25$
1	Solar charge control module	12 volts 6 A	5$
1	Optimum condensing efficiency timer	Handmade	15$
1	Auto fuse + voltmeter	6 A	3$
1	Plastic water tank – system block	10 liters	2$
1	Controlled irrigation computer	1-30 days set	25$
10	Connectors	Cable-terminal	2$

The amount of moisture that the air will carry varies depending on the temperature. As the temperature increases, the air expands and the amount of moisture that the air can carry increases; When the temperature decreases, the air contracts and therefore the amount of moisture that the air can carry decreases. In Table 2, it is seen that while 1 cubic meter of air has the capacity to carry a maximum of 1.06 g of moisture at (–20 ^{0}C), the same air mass can carry 50.09 g of moisture at 40 ^{0}C (Gönençgil, 2021).

Table 2. Moisture amounts that air can carry at certain temperatures (Gönençgil, 2021)

Temperature(^{0}C)	Max humidity (gr/m^3)
-20	**1,06**
-10	**2,35**
0	**4,85**
10	**9,39**
20	**17,33**
30	**30,66**
40	**50,09**

The humidity gap of the air is the difference between absolute humidity and maximum humidity. The sum of the relative humidity and the humidity gap should be 100. When absolute humidity reaches its maximum humidity, the air reaches its saturation point in terms of humidity. The relative humidity becomes 100% and the humidity gap of the air is closed. When the temperature increases in a place, the maximum humidity of the air increases and therefore the air moves away from the saturation point. While the humidity gap increases, the relative humidity decreases. Therefore, there is an inverse relationship between temperature and relative humidity. While the relative humidity is low in deserts and inland, it is high on the sea, in the equatorial region and in the poles (Gönençgil, 2021).

Calculations for real environment modeling:

The values used in the calculations were found with the help of a psychrometric diagram. Figure 6 shows the psychrometer and Figure 7 shows the psychrometric diagram. Since there are too many variables in condensation calculations, psychrometric diagrams developed in the 1900's are used today. The values in the diagrams vary according to the altitude of the cooling system above sea level. The calculations in this study were made at sea level, according to the condensation between 30^{0}C - 10^{0}C.

Figure 6. Psychrometer (Meteorology, ty)

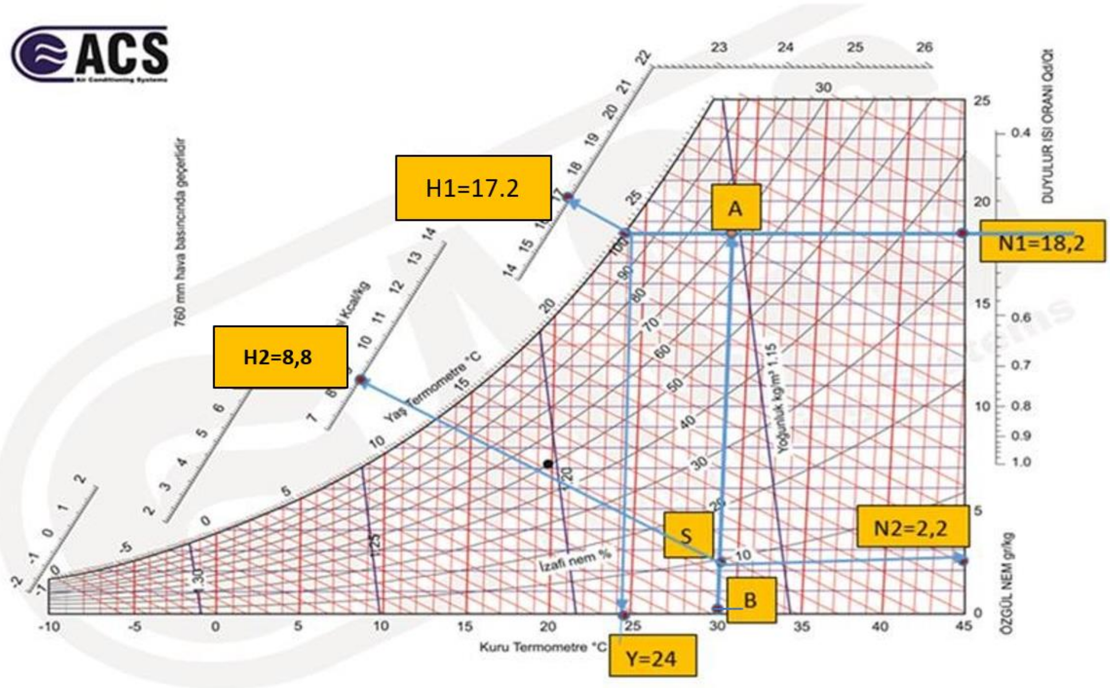

Figure 7. Psychrometric diagram (Meteorology, n.d.)

Psychrometric values of moist air where Point A will be used:
Temperature : 30 ^{0}C (Point B)
Relative Humidity : 70%
Specific Humidity : 18.2 gr/kg air (N1 point)
Enthalpy (ΔH) : 17.2 kcal/kg air (instant energy of H1:1kg air)
Condensation Temperature: 24 ^{0}C (Y Point)
Psychrometric values of S Point dehumidified air:
Temperature : 10 ^{0}C (S point)
Relative Humidity : 10%
Specific Humidity : 2.2 gr/kg air (N2 point)
Enthalpy (ΔH) : 17.2 kcal/kg air (instant energy of H2:1kg air)

The planning of the method of the study according to time is shown in Table 3.

Table 3. Method and timeline of the study

	MONTHS								
Job description	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**January**
Literature scan	x	x	x						
System design		x	x	x					
Material purchases				x	x				
Thermoelectric cooler module block assembly					x				
Energy control system installation					x				
Intelligent irrigation installation						x			
Theoretical calculations				x	x	x	x		
experiments						x	x	x	
Project Report writing							x	x	x

3. Findings and Discussion

Voltage and current values were kept constant in the experimental setup. During the operation of the thermoelectric module, the maximum temperature difference between cold and hot surfaces is 72˚C. The two thermoelectric modules used are TEC1-12715 coded and 40×40×8 mm in size. The maximum voltage used is 12 volts and the current is 20 amps. Under these conditions, the following values were obtained when the air was cooled to a value below the dew point temperatures:

a) Condensed moisture in 1 kg of air: Δ Humidity=N1-N2= 18,2 – 2,2 =16 gr/ kg air (1)

b) Latent heat emitted by condensed moisture: Q = 0,016 kg x 540 kcal/kg = 8,64 kcal/kg (2)

c) Humid air, while coming to point S at point A, has left its moisture, therefore, its internal energy has decreased. This reduction is enthalpy. ΔH = H1-H2 = 17,2-8,8 = 8,4 kcal/kg of air. (3)

d) In theory, Q = ΔE. Due to reasons such as air friction, instantaneous pressure differences, graphical error margins, this equation can never be fully realized. However, both values found are very close to each other. For these reasons, using any of them in calculations will give correct results for applications in daily life.

Daily water supply target with eco-water-gen: V = 2,4 L/day

For the Marmara region, an average of 2409 hours of sunshine per year (6,6 hours per day) and 1168 kWh/m ^{2} of energy were calculated (Turkey and Solar Energy, n.d.).

Hourly water production based on an average of 6,6 hours of sunshine:

V_s = 2,4/6,6 = 0,36 liters/hour = 0,36 kg/hour (4)

Vs = amount of moist air required to be passed through the system to obtain 0.36 liter/hour water = 0,36/0.016 = 22,5 kg air/hour. (5)

Assuming the specific gravity of the air at S point as 1,16 kg/m3, the flow rate of the air to be passed through the system = 22,5/1,16 = 19,4 m^3 / hour (6)

The amount of energy required for the system Q. Since ΔE=8,4 kcal is needed to produce 0,016 kg of water, the energy required to obtain 0,36 kg of water is:

Q = 0,36x 8,4/0,016 = 189 kcal (7)

Since the value of this energy in kWh is 860 kcal = 1 kWh:

Q = 1 x 189/860 = 0,220 kWh = 220 W. (8)

As a result of the experimental study, it was aimed to obtain 2.4 liters of water per day by meeting its own energy from the sun. Technical calculations were made for the Marmara region over 360 days, assuming 6.6 hours of sunshine per day. As a result, it has been observed that the amount of water obtained with the system in accordance with the experimental study coincides with the amount in the theoretical calculations.

The annual water production of the model produced in this study is 360x2,4 = 864 liters of water. (9)

The average cost price of pure water is 2.5 ₺/liter, so the average annual return is calculated as 2160₺. The time for the system used in this study to pay for itself was calculated as T= 3065/2160 = 1,42 years. (10)

4. Conclusion and Recommendations

In this study, a portable irrigation system that produces its water by condensation from the air is designed and it is aimed to show its applicability to daily life. Technically, the water obtained by condensation with the system is pure water (distilled). Pure water is harmful to human health because it does not contain minerals. For this reason, the water produced with the designed system can be used for plant irrigation or domestic needs.

The system pays for itself in less than one and a half years. In addition, the system can be built in very large sizes by using parallel modules when necessary. The average life of the materials used in the system is twenty years. Since the ratio of the system cost to the amount of water to be obtained will remain constant, the system of different sizes will work for many years by amortizing itself in less than one and a half years.

This study is a pioneer one for future studies. In this direction, it is recommended that a large-scale system be built and used for irrigation of large lands. In addition, for future studies, the water obtained by the system can be used as drinking water by bringing the mineralization, hardness and pH level to optimum levels. In addition, the water obtained can be used as drinking water, but for this it needs mineralization. In addition, it becomes drinkable when its hardness and pH level are brought to the desired level.

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The article complies with national and international research and publication ethics. Ethics committee approval was not required for the study.

Author Contribution and Conflict of Interest Declaration Information

All authors contributed equally to the article. There is no conflict of interest.

References

Avhad, S., Dandekar, B., Chandak, A., Kajale, P., & Gohel, NS (2021). Theoretical Analysis of Atmospheric Water Generator using Thermoelectric Cooler. Access Address (11.11.2021): https://ssrn.com/abstract=3989184.

Adıgüzel, D. (2016). *Temperature Controlled Thermoelectric Autonomous Combi Boiler Design.* (Master's Thesis). Gaziosmanpaşa University, Institute of Science and Technology, Tokat.

Çakmak, B. & Gökalp, Z. (2011). Climate Change and Effective Water Use. *Journal of Agricultural Sciences Research*, no:1, p.87-95.

Çelebi, N.G. (2021). *A Study on the Evaluation of Solar Settlements.* (Master's Thesis). Istanbul Technical University, Graduate Education Institute, Istanbul.

Çepel, N. & Ergün, C., (2003). Basic environmental problems. Access Address (11.06.2021): http://docplayer.biz.tr/6679796-Temel-cevre-sorunlari-prof-dr-necmettin-cepel-celalergun.html

Dost, A. T. (2017). Fundamental Source of Life: Water. Access Address (21.06.2021): https://geturkiyeblog.com/yasamin - basic - source - water/

Faqih, Abdul-Rahman Abdul-Kader M. (2005). Production of Potable Water and Freshwater Needs for Human, Animal and Plants from Hot and Humid Air. Patent No: US 6,868,690 B2.

Gönençgil, B. (2021). Climatology, (Pressure, Wind, Humidity). Access Address (17.06.2021): https://cdnacikogretim.istanbul.edu.tr/auzefcontent/ders/klimatology_basinc_ruzgar_nem/7/index.html

İbrahim, D. (2006). *Solar Energy Applications.* Istanbul: Composite Publications.

Kılıç, S. (2008). Water Management in the Process of Global Climate Change. *İ.Ü. Journal of Political Sciences,* no:39, pp.161-186.

Koç, E. & Kaya, K. (2015). Energy resources–renewable energy situation. *Journal of Engineers and Machines*, 56 (668), pp.36-47.

Max, M. D. (2005). Apparatus And Method For Harvesting Atmospherıc Moisture. Patent No: US 6,945,063 B2.

Meteorology. (n.d.). Ankara University Open Course Materials. Access Address (05.06.2021): https://acikders.ankara.edu.tr/pluginfile.php/7218/mod_resource/content/0/meteoroloji6.pdf#:~:text%20=a)%20Absolute%20Nem% 3A%20Unit%20volume,g%2Fkg%20%20%expressed.

Nitheesh, K., Ashik Ahamed, A. & Saravanan, S. (2019). Atmospheric water generation with the concept of peltier effect. *International Journal of Engineering Research & Technology* (IJERT). Volume 7; Issue 11.

Reidy, J. J. (2008). Thermoelectric, High-Efficiency Water Generating Device. Patent No: US 7,337,615 B2.

REN 21. (n.d.). Renewable Energy Policy Network for the 21st Century. Access Address (24.12.2020): https://www.ren21.net/

Smedley, T. (2017). Is the world running out of fresh water resources?” Access Address (11.06.2021): https://www.bbc.com/turkce/vert-fut-39646356

Thermoelectricity. (n.d.). Access Address (01.06.2021): https://stringfixer.com/tr/Thermoelectricity

Thermoelectric. (2018). Access Address (01.06.2021): https://www.lafsozluk.com/2018/08/thermoelectric - what is it - thermoelectric - effect.html

Turkey and Solar Energy. (n.d.) Sunmax Solar Energy Systems. Access Address (10.06.2021): http://www.sunmax.com.tr/index.php?t=s&i=14#:~:text=Akdeniz%20B%C3%B6 in the region%202956 20%hr%2CEge,B In %C3%B6,%201971%20hr%20%detected%C4%B1%C5%9Ft%C4%B1r.