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Heating Residences Using Solar Power

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Abstract

In this study, it was aimed to use the hot water produced using solar power in central heating systems in addition to places such as kitchen, bathroom and toilets, and a prototype was prepared. In the prototype, two 33.5x68.5 cm solar collectors, two boilers one of which is insulated (28 x 28 x 50 cm) and the other stripped (26.5 x 26.5 x 59 cm), a solar panel one radiator (40.5 x 60 cm), automated air relief cock, solenoid valve (12 V DC 14 W), two turbine motors (0.2 A, 220 V AC 40 W), one battery and two solar panels were used. The battery acts as a backup energy source in order for the water to be heated to the desired temperatures at nights, overcasts and times of precipitation, and it is charged using the energy from the solar panels. This is how the system may be used during winter months. As the electrical energy to run the system is taken from the sun, it contributes to minimisation of the increasing electricity costs and protection of the nature by reduction of air pollution. Proton IDE software was used to programme the PIC microcontroller. The software produced using this programme was placed on the PIC with Usburn programme using a Branner 8 PIC programmer.

Keywords: Solar panel; battery; solar energy; central heating system; controller card.

1. Introduction

Solar energy is an abundant, continuous, renewable and free energy resource. In addition to these, the fact that most of the environmental problems associated with the usage of traditional fuels are not seen in solar energy, makes this type of energy clean and environment-friendly.

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It is important that the emission of carbon dioxide (CO_2), the inevitable product of burning fossil fuels, is not seen in this energy type [1]. As solar energy has the characteristics to be an environmentally clean resource, it presents an alternative to fossil fuels. The annual amount of solar radiation energy is 160 times the potential of all fossil fuel reserves that have been detected so far. Additionally, the energy that can be produced is 15,000 times that annual energy production of all fossil, nuclear and hydroelectric power plants on earth.

Therefore, it is not an issue to find solar energy. The actual issue is to convert it into a form of energy that is suitable for usage in human activities [2-3]. Solar energy is used nowadays in climatisation of residences and work places (heating-cooling), cooking, obtaining hot water and heating swimming pools; greenhouse heating and drying agricultural products in agricultural technology; in industry, solar ovens, solar stoves and cookers, producing salt and fresh water from sea water, solar pump, solar batteries, solar ponds, and heat pipe implementations; in transportation-communication tools, signalisation and automation, and electricity production in a controlled manner [4]. According to the study conducted by the Energy Institute Directorate (EİE) in Turkey; total annual sunshine duration is 2640 hours, and 7.2 hours daily in Turkey. The average annual total radiation magnitude is 1311 kWh/m², and 3.6kWh/m² daily. Solar energy potential and sunshine duration in Turkey in different months are given in Table 1 [5-6].

Table 1: Monthly average solar energy potential in Turkey

Months	Monthly Total Solar Energy (Kcal/cm^2-monthly) - (Kwh/m^2-monthly)		Sunbathing Time (hour/monthly)
January	4.45	51.75	103.0
February	5.44	63.27	115.0
March	8.31	96.65	165.0
April	10.51	122.23	197.0
May	13.23	153.86	273.0
June	14.51	168.75	325.0
July	15.08	175.38	365.0
August	13.62	158.40	343.0
September	10.60	123.28	280.0
October	7.73	89.90	214.0
November	5.23	60.82	157.0
December	4.03	46.87	103.0
Total	112.74	1311	2640
Average	308.0 cal/cm^2-hour	3.6 kwh/m^2-hour	7.2 hour /day

While the Southeastern Anatolia is the region which receives the highest amounts of solar energy in Turkey, it is followed by the Mediterranean Region (Figure 1). The distribution of total annual solar energy potential among different regions in Turkey is given in Table 2 [5-6].

Table 2: The distribution of total annual solar energy potential among different regions in Turkey

Regions	Total Solar Energy (Kwh/M2-year)	Sunbathing Time (hour/year)
Southeast Anatolia	1460	2993
Mediterranean	1390	2956
Eastern Anatolia	1365	2664
Central Anatolia	1314	2628
Aegean	1304	2738
Marmara	1168	2409
Black Sea	1120	1971

2. Materials and Methods

In the designed system, 33.5x68.5 cm solar collectors, two boilers one of which is insulated (28 x 28 x 50 cm) and the other stripped (26.5 x 26.5 x 59 cm), a solar panel one radiator (40.5 x 60 cm), automated air relief cock, solenoid valve (12 V DC 14 W), two turbine motors (0.2 A, 220 V AC 40 W) (Figures 1-2-3), controlling circuits to manage the system (Figures 4-5), and one battery and two solar panels to satisfy the energy needs of the system were used.

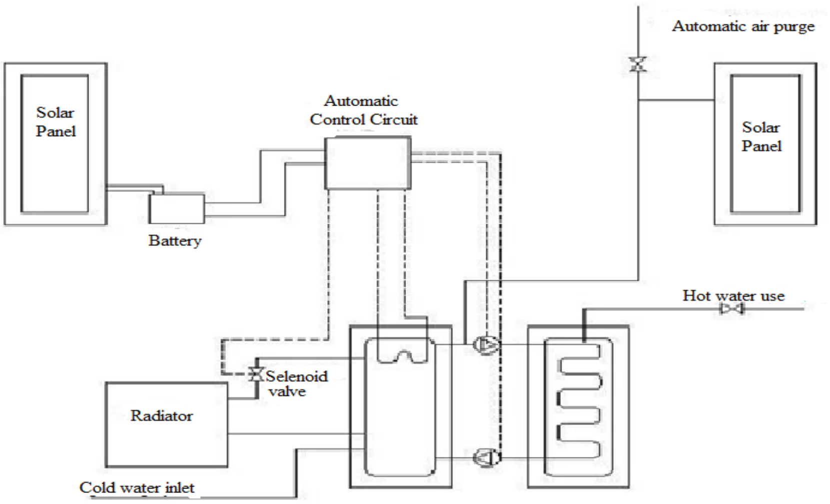

Figure 1: Design of the system to be used

The density of the heating fluid in the rectangular solar collector decreases as it is heated by the sun, and it starts rising to the casing around the insulated boiler containing the water coming from the mains supply. The heating fluid, which transmits its heat to the tap water here, increases in density and moves back to the collectors. This movement continues as long as there is sunshine and heats the running water. In this system, cold water is directly linked to the mains pressure. The system works in the pressure of the mains supply. The hot water pressure taken from the system is equal to that of the mains supply.

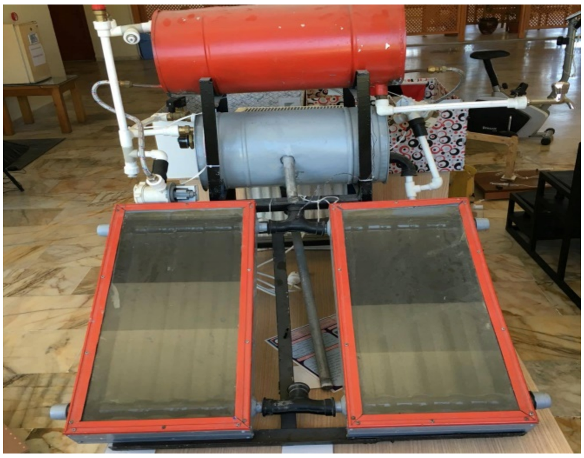

Figure 2: The appearance of the system without connecting solar panels

Figure 3: The latest version of the system that we have developed

Based on the working principles of the pressured systems; the pressure increases in parallel to the increasing water temperature, and the water reaches higher temperatures under pressure. Maximum temperature is achieved. The water heated in the insulated boiler is moved from the boiler exit to the radiator via ½ PVC pipes, circulates in the radiator, and finally comes back to the boiler. The setting is therefore heated. Additionally, the water coming out of the insulated boiler is carried to the pipe coil in the stripped boiler with one of the turbine motors. The water circulates in the pipe coil and heats the water in the stripped boiler. Then, the water leaving the pipe coil is brought back to the boiler with the other, reversed turbine motor.

The automated air relief cock connected to the exit of the insulated boiler controls the steam pressure caused by heating the water inside the boiler. When the pressure reaches the danger level 3Bar, the automated air relief cock releases the steam automatically until the steam in the insulated boiler runs out. The air relief cock included in the exit of the insulated boiler was put there to allow manual steam relief for cases of steam accumulation as a result of long-term usage.

2.1. Automated Controlling Card

The automated controlling circuit consists of two circuits connected to each other. One of these is the controlling circuit, and the other one is the driver circuit. The controlling circuit reads the values taken from temperature sensors, and compares them with the setting and tap water temperature values determined by the user. As a result of this comparison, it sends the required data to the driver circuit to process the necessary operations. It also shows the setting's temperature and the user-defined reference value on an LCD. The driver circuit received data from the control circuit. Based on the data received from the control circuit, it controls the turbine motors, solenoid valve and resistance.

2.2. Controlling Card Working Principle

The controlling card is based on a microprocessor. NPN transistors were used to drive the relays to be connected to PIC outputs. The POT in the circuit was used to adjust the desired room temperature reference value. The temperature values measured with the LM35 sensor in the circuit was connected to the analogue input of PIC16F877A. The PIC transmits the 8-bit digital values it continuously reads to the LCD panel in real time, therefore, the real time temperature values may be read on the panel. With this circuit, it is able to read temperature values in the interval between -40 and +100°C, and controls the heating within this interval. The outputs from the digital output parts of the PIC are sent to the driver circuit card using transistors. The relays in the driver circuit card are turned on and off based on the signal coming from the controlling card, and control the turbine pump, resistance and valve.

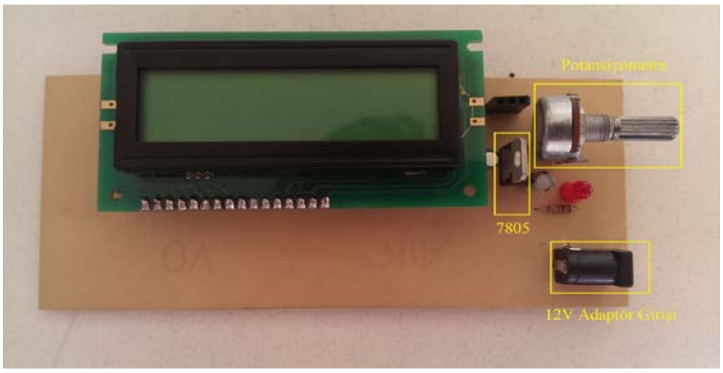

Figure 4: View of the controlling card

2.3. Driver Card Working Principle

The data received from the controlling circuit via the terminals numbered 1, 2, 3 in the driver circuit are input to the transistors as transistor trigger signals and the transistor starts transmitting when the trigger is received from the driver circuit. Transistors facilitate the working of the system by driving the double contact relays with 12V triggers.

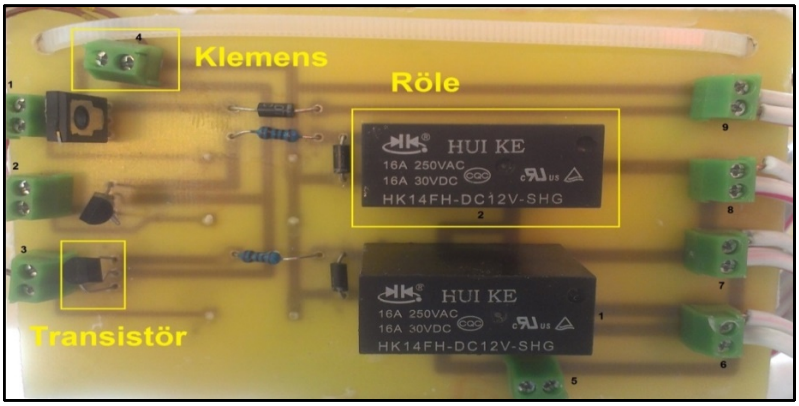

Figure 5: View of the driver card

The relay number 1 triggered by the PIC programme provides the start of turbine motors numbered 1 and 2, connected to the terminals numbered 6 and 7. The relay number 2, when triggered, turns on the resistance connected to the terminal numbered eighth. The data from the entry terminal turn the solenoid valve on and off.

3. Conclusion

A central heating system was designed in this study to produce hot water to be used in both daily hot water and heating needs of a household. While the hot water produced from the sunshine is used during the day, the energy in the battery charged with solar panels is used during the night. The obtained electricity energy is used to run turbine motors and heat water during the night. At the same time, as the electricity is produced from the solar panels, it does not have any costs except the installing cost. The designed system is open to usage in many areas in daily life, and it was also made open for improvement. As using the hot water for both central heating and daily water usage might create problems about hygiene, two separate boilers were used and the system comprised the combination of the controlling card and the driver card.

4. Comments

This study was conducted to container house which has 3x7m in size, 15 m^2 living space, two living room and toilet-bath. A radiator was used for this container house which has 40,5x60 cm size. Water storages' capacity are 40 cm^3 and 45 cm^3, solar collector's size 33,5x68,5 cm.

This design is suitable for each 15m^2 living space. Same proportions of these dimensions are upgrading is recommended for larger houses.

References

[1] Varınca, K. B., Varank, G., "Güneş Kaynaklı Farklı Enerji Üretim Sistemlerinde Çevresel Etkilerin Kıyaslanması ve Çözüm Önerileri", Güneş Enerjisi Sistemleri Sempozyumu ve Sergisi, İçel, 24–25 Haziran 2005.

[2] Ültanır, M.Ö., "21. Yüzyılın Eşiğinde Güneş Enerjisi", Bilim ve Teknik, Sayı: 340, S: 50-55, Mart 1996.

[3] Şen, Z., "Temiz Enerji ve Kaynakları", Su Vakfı Yayınları, İstanbul, 2002.

[4] Tsoutsos, T., vd., "Environmental Impacts From The Solar Energy Technologies", Energy Policy, 33, 289-296, 2005.

[5] Kamil B. V. , M. Talha G. , "Türkiye'de Güneş Enerjisi Potansiyeli ve Bu Potansiyelin Kullanım Derecesi, Yöntemi ve Yaygınlığı Üzerine Bir Araştırma", UGHEK'2006: I. Ulusal Güneş ve Hidrojen Enerjisi Kongresi, 21-23 Haziran 2006, Eskişehir

[6] Internet: http://www.eie.gov.tr/eie-web/turkce/YEK/gunes/tgunes.html, date accessed 1\9\2016.

[7] Internet: http://www.eie.gov.tr/MyCalculator/Default.aspx, date accessed 1\9\2016.

[8] Türkiye'nin Enerji Potansiyeline Bakış, İbrahim Atılgan, Gazi Ünv. Müh. Mim. Fak. Der. Cilt 15, No 1, 31-47, 2000

[9] Internet: www.mevzuat.gov.tr/MevzuatMetin/1.5.5627.doc, date accessed 1\9\2016.